South Bay Salt Pond Restoration Project
Restoring the Wild Heart of the South Bay

Final Environmental Impact Report, Phase 2, Eden Landing Ecological Reserve

Volume 2 | April 2019

Photo Credit: Cris Benton

California Department of Fish and Wildlife partnering with the U.S. Fish and Wildlife Service and California State Coastal Conservancy

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APPENDIX A

PHASE 2: PRELIMINARY OPTIONS FOR FUTURE ACTIONS

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South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay

Phase 2: Preliminary Options for Future Actions

SBSP Project Management Team

September 2010

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PHASE 2 DESIGN IDEAS
PROJECT MANAGEMENT TEAM WORKING DRAFT
25 August 2010

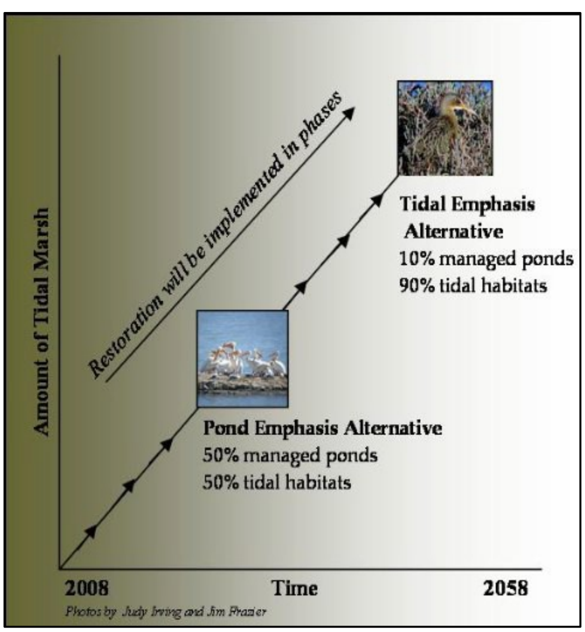
1. INTRODUCTION

The purpose of this brief report is to brief interested parties on the preliminary actions identified by the Project Management Team regarding the next phase of restoration and solicit input on these (and other) alternatives. The Project Management Team held a preliminary design charrette brainstorming workshop on May 13, 2010, and have refined their ideas in subsequent meetings through the summer. This document will serve as the baseline for an open dialogue with the stakeholders regarding Phase 2 of the Project.

The South Bay Salt Pond Restoration Project (Project) has three project goals:

- Wetland habitat enhancement and restoration
- Improved flood management
- Improved public access and recreation

These goals will be achieved as the Project is implemented in phases along an Adaptive Management continuum (see Figure 1 below). Adaptive Management is an integral part of the Project, allowing for lessons learned in earlier phases to be incorporated into subsequent phases as future restoration actions are formulated. Phase 1 Actions are currently underway, and the ultimate project configuration will be between the two “bookends” for the Project established in the EIS/R: a minimum of 50% tidal restoration to a maximum of 90% tidal restoration. Future phases of the Project will continue to fulfill the mission of the Project by integrating habitat restoration with flood management and wildlife-compatible public access.



Actions subsequent to Phase 1 will be based, in part, on the evaluation of adaptive management information collected in previous phases. For example, information collected in Phase 1 from monitoring and applied studies on bird response to pond management, methyl mercury, and public access- wildlife interactions will be instrumental in determining the extent and location of future tidal restoration and public access features. Future tidal restoration is also dependent upon the provision of flood management (either maintaining or improving existing flood protection levels). Additionally, public access actions will be included in future phases, either independent of, or in close coordination with, habitat restoration and flood management actions.

Guiding Principles

The overarching guiding principles for the selection of Phase 2 actions will be to first "do no harm" relative to flood impacts, and second to progress toward the 50:50 managed pond-tidal marsh "bookend" as outlined in the EIS/R. Collectively, these guiding principles mean that we are not able to take certain actions until adequate flood management levees are in place, and that ponds proposed to be managed ponds under the 50:50 scenario but tidal marsh under the 90:10 scenario will not be returned to tidal action as part of Phase 2. Until adaptive management results supply us with significant data to the contrary, the Project should adhere to the decisions made in previous planning processes.

Precedent Actions

Actions specific to any one of the three project goals of habitat restoration, flood management and public access may be dependent upon precedent actions. For example, many flood management actions proposed as part of the Project, such as levee construction, may wait for completion of the WRDA-authorized South San Francisco Bay Shoreline Study. However, the Shoreline Study is not expected to be complete for several years.

Evaluation Criteria

Phase 2 of the South Bay Salt Pond Restoration Project will take into consideration a number of evaluation criteria. Many of the criteria will be the same as those used in developing Phase 1 actions. Other criteria will be based on the results of Applied Studies and monitoring. Application of the criteria below, along with consideration of essential flood management actions and the layering of additional public access actions, will make implementation of future actions a varied mixture of habitat restoration, flood management, and public access activities occurring on unique schedules based on development of actions and associated design, funding and construction schedules.

Examples of this varied mix of Phase 2 actions could include:

- The construction of a flood management levee,
- Development of an additional viewing area,
- Tidal restoration of a pond on the bayside of the flood levee,
- Refinement of a Phase 1 Applied Study.

These actions will likely occur according to different time schedules, and in different pond complexes.

Alternatively, public access projects, such as completion of some Bay Trail spine segments, can proceed independently of changes in habitat. Many Bay Trail spine segments can and will be built (when funds are available) on existing or temporary levees that are ultimately proposed to be replaced with well-engineered flood protection levees.

However, the Project must be careful to avoid taking actions in Phase 2 that may impede restoration actions in subsequent phases. (Examples of such actions include breaching inboard ponds leaving bayside ponds more difficult to access, or providing public access in areas that may become tidal in the future and where public access and long-term operations and maintenance are not desired.)

II. PROPOSED TIMELINE

A preliminary draft timeline of the Phase 2 planning process is outlined below.

Phase 2 Action	2010				2011				2012				2013			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Design Charrette																
Specific Pond Complex Evaluations																
Stakeholder Meetings																
Release RFP																
Preliminary Design																
Environmental Review (NEPA/CEQA)																
Adaptive Management Input																
Regulatory Permitting																
Secure Funding																
Construction Documents																
Begin New Applied Studies																
Begin Construction																☼

III. EVALUATION CRITERIA

During the Phase 2 design charrette on 13 May 2010, the Project Management Team reviewed and revised the considerations used in selecting the set of Phase 1 actions. These criteria were adapted and expanded to include additional relevant criteria to be used in selecting the Phase 2 actions. These Evaluation Criteria, and the discussion that follows of potential preliminary range of options for Phase 2, are intended to be a starting point to engage the public and key stakeholders in an open dialogue regarding the next step in this important project.

Primary Evaluation Criteria

Likelihood of progress toward Project Objectives

- (Now) Will the action produce a significant habitat, flood management, or public access benefit?
- (Future) Will the action now lead toward greater success in later phases (e.g., current actions facilitate future acreage for restoration)?

  Considerations:
- Are relevant Adaptive Management findings available? If so, are these findings incorporated into the proposed action?
- Is there any new relevant information that was not available during earlier planning that is now available and should be considered in planning this action?

Opportunities for adaptive management

- What high priority studies can we implement to answer key questions/ uncertainties not currently being addressed?

  Considerations:
- How does the proposed action contribute to evaluating the risks and benefits of adaptive management actions?

Value in continuing to build Project support

- Does the Phase 2 action continue to build support for the project geographically (by complex or landowner), regionally, or for specific user groups?

Readiness to proceed

- If the proposed action were a standalone action, would it be likely to be permitted in a timely manner (within 5 years)?
- Ease of implementation and success. Is the project technically feasible? Are there significant constraints to designing and constructing the proposed action?
- Could construction commence in a timely manner (within 3 years of receipt of permits)?

Dependency on precedent actions

- Are there pre-requisites to implementing a particular action (e.g., flood management levee) that will not be completed within the Phase 2 timeframe, either by the SBSP project or by others? (See Guiding Principles section.)

Secondary Criteria

Visibility and accessibility

- Will the results be visible to the public and/or decision makers?
- Will the results be accessible to the public and/or decision makers?

<u>*Considerations:*</u>

- If other on-going or planned projects are nearby, how is the proposed action integrated with these projects?
- *Note:* Public access may be accomplished independent of the restoration and flood management aspects of the Project.

Balance (considered for the <u>suite</u> of Phase 2 actions)

- Does the slate of proposed actions represent an appropriate balance between the three project goals of habitat restoration, flood management, and public access?
- Is this balance evident within one complex, or across the entire Project Area?
- Does the action contribute to maintaining a balance between the two landowners (USFWS and CDFG)?
- Are the Phase 2 actions distributed throughout the Project Area, taking onto account the locations of the Phase 1 actions?

Availability of funding

- What is the amount of funding needed to carry out the action (planning, implementation, O&M, monitoring, Applied Studies)?
- What costs, if any, may be avoided by carrying out the proposed action?
- Is the level of funding needed for the entire project likely to be available?
- What are the funding sources, how secure are the funds and what restrictions might they apply?

IV. PHASE 2 OPTIONS

Using the guiding principles and evaluation criteria outlined above, the Project Management Team went through each complex at the 13 May 2010 Phase 2 design charrette and subsequent meetings to formulate the potential actions for the next phase of restoration.

As part of the charrette process, the Project Management Team also identified several Project-wide actions that warrant consideration for Phase 2. These are described below followed by sections outlining potential Phase 2 actions by pond complex.

Overall next steps include discussions with key stakeholders, regulatory agencies, and the public and a subsequent refinement of the Project options.

A. Ravenswood Complex Actions

Below are the preliminary ideas discussed at the Phase 2 design charrette for the Ravenswood Complex. A major constraint to additional tidal restoration at this complex is the flood management issue along Highway 84. Next steps to address flood management improvements at Ravenswood include setting up a meeting to discuss these issues with the City of Menlo Park, Caltrans, and PG&E. These discussions should begin in 2010 in order to be resolved by Phase 3.

Table 1. Ravenswood Complex Phase 2 Options.

#	Restoration Action	Flood Management	Habitat Created	Public Access Opportunity	Key Uncertainties/ Questions
1	R4 Tidal Restoration	Requires raised levee between R4 & R3	▪ Tidal marsh ▪ Planned upland transition on west side ▪ Impact to nesting western snowy plovers, small shorebirds using R4	▪ R4 spur trail near Greco ▪ Hunting/ fishing may be possible ▪ Temporary trail along new R3/R4 levee?	▪ Place to store fill ▪ Bayfront Park solid waste exposed to tidal action ▪ Impact on future tidal restoration at R3 ▪ Inboard R4 levee versus internal levee between R3/R4 ▪ Caspian tern island in R3? (R3/R4 levee needed) ▪ Better to restore R3/R4 as 1 block?
2	R5/S5 managed ponds	Levee from 84 to Bayfront Park	Uncertain which species to manage these ponds for at this time.	Trail from highway to Bayfront Park	
3	R1/R4/R2 seasonal + re-plumb R3/S5/R5	Internal levee (non-flood management) between R3 and R4	Allows better pond management for maximizing waterbird habitat		▪ Requires water control structures for R2 & R3 ▪ R1/R2 without levee floods 84 & PG&E substation
4	New water control structures at R ponds		Allows better pond management for maximizing waterbird habitat	Hunting may be possible	

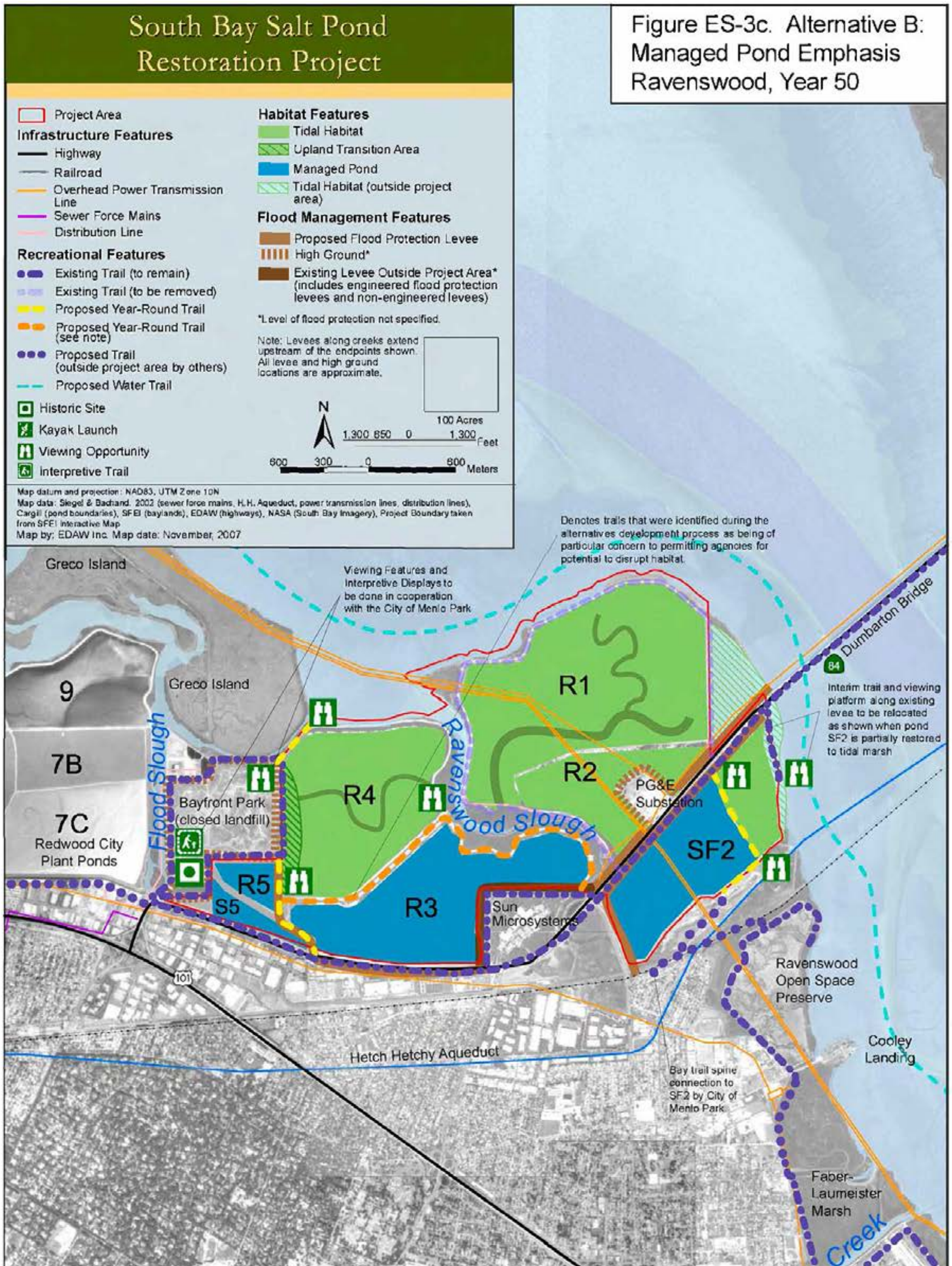


Figure ES-3c. Alternative B: Managed Pond Emphasis Ravenswood, Year 50

B. Eden Landing Complex

Below are the preliminary ideas discussed at the Phase 2 design charrette for the Eden Landing Complex. The general consensus of the PMT is that some form of tidal restoration in the southern half of the complex (between Old Alameda Creek and the Alameda Flood Control Channel) is the logical Phase 2 action. However, there are many options (see Table 2) for possible configurations of tidal restoration. Close coordination with the Alameda County Flood Control District is required to determine what actions can be taken prior to the construction of major flood management levees. In addition, careful consideration must be given to the existing water management regime and infrastructure to ensure that ponds not restored in Phase 2 can meet water management goals.

In addition, detailed designs for public access and recreation will involve close coordination and joint development with the East Bay Regional Park District to ensure expansion of trail options that to the extent possible meet the needs of the Project, the Department of Fish and Game (the landowner) and the District.

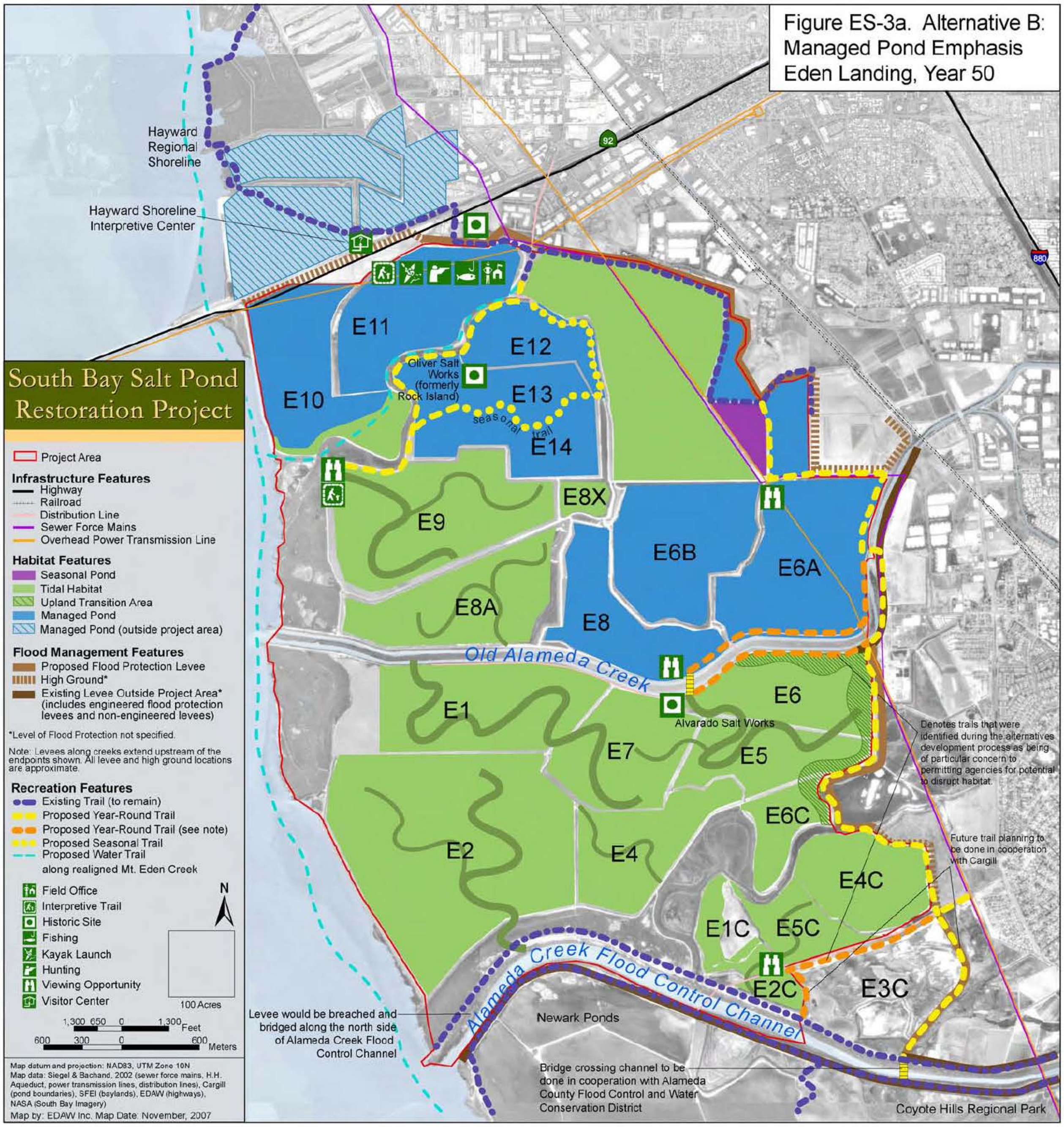
An Eden Landing working group has been initiated with the County and the Park District. Regular meetings will be established to closely coordinate on the necessary phasing of flood management and restoration actions. Next steps include involving other key stakeholders such as the Hayward Area Shoreline Planning Agency in the planning process. In addition, Cargill has been contacted to discuss options pertaining to the properties they have retained (Turk Island, “Cal” Hill and adjacent Pond E3C) in the southern Eden Landing area.

Table 2. Eden Landing Complex Phase 2 Options

#	Restoration Action	Flood Management	Habitat Created	Public Access Opportunity	Key Uncertainties/ Questions
1	E2 Tidal Restoration	New E1/E2 and E4/E7 levee improvements required.	▪ Tidal marsh including fish nursery habitat	▪ Spur trail along E6 on south side of Old Alameda Creek to Alvarado Salt Works (bridge will be needed if E6 becomes tidal in the future)	▪ Cargill mitigation pond (adjacent to E1) is example of how E pond restoration may respond ▪ E2-only option allows for continued inboard WQ mgmt through E1 intake.
2	E2 & E4 Tidal	New E1/E2 and E4/E7 levee improvements required.	▪ Tidal marsh including fish nursery habitat		▪ More separate pond intakes and outlets – desirable for operation but costly.
3	E5/E6/E6C Tidal	▪ G-1 levee along E5/E6 ▪ Add'l E6C inboard levee improvements ▪ E5/E4/E7 levee improvement required	▪ Tidal marsh including fish nursery habitat ▪ Upland transition habitat possible	EBRPD Bay Trail along new inboard flood management levee	▪ E12/E13 may inform what type of managed ponds are desirable at E5/E6 ▪ May increase scour along Old Alameda Creek
4	E1/E7 Tidal	Levee improvements in remaining ponds required, incl. E1-E2, E7- E2, E7-E4, E5-E7, E6-E7	▪ Tidal marsh including fish nursery habitat	▪ Spur trail along E6 on south side of Old Alameda Creek to Alvarado Salt Works	▪ Requires new intake in E6 to operate E2 pond system operation
5	E1/E2/E4/E7 Tidal	Levee improvements required to isolate E6-E5- E6C	▪ Tidal marsh including fish nursery habitat	▪ Spur trail along E6 on south side of Old Alameda Creek to Alvarado Salt Works	▪ Requires new E6 intake to operate remaining E6-E5-E6C pond system

Table 2. Eden Landing Complex Phase 2 Options

#	Restoration Action	Flood Management	Habitat Created	Public Access Opportunity	Key Uncertainties/ Questions
6	E1-7 + E6C Tidal	▪ G-1 levee along E5/E6 ▪ Add'l E6C inboard levee	▪ Tidal marsh including fish nursery habitat ▪ Upland Transition habitat possible		▪ E2C intake structure would require fish screen, new water control structure for E1C, E5C, E4C or operations budget for "Cal" Hill intake to E1C would be needed unless they remain seasonal (summer dry)
7	Eel Grass Subtidal Habitat (off E2)		▪ Fisheries		Review status of planned projects off of Eden Landing
8	G-1 pilot levee (adjacent to Ponds E6 and E5)	Pilot flood management levee project	▪ Upland transition habitat possible	EBRPD Bay Trail along inboard levee	▪ Needs to be coupled with wetland restoration
9	Managed pond improvements at E8, E6A and E6B		▪ Duck habitat in winter, nesting plover/shore- bird habitat in spring and summer		▪ New pumps required; need to assess the feasibility of this management possibility and identify long-term funding beyond Phase 2 timeline.



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C. Alviso Complex

Below are the preliminary ideas discussed at the Phase 2 design charrette for the Alviso Complex. A major constraint to additional tidal restoration at this complex is the need for flood management for large areas of Santa Clara County. Next steps to address flood management improvements at Alviso are largely dependent upon the South San Francisco Bay Shoreline Study (Shoreline Study).

The Shoreline Study is a Congressionally-authorized study being performed by the US Army Corps of Engineers together with the Santa Clara Valley Water District and State Coastal Conservancy to identify and recommend for Federal funding one or more projects for flood damage reduction, ecosystem restoration and related purposes such as public access.

Also, mercury continues to be a significant issue for the Alviso complex, and any tidal restoration planned in advance of the Applied Study results, including current Phase 1 actions, will continue to be carefully selected to avoid additional exposure risks.

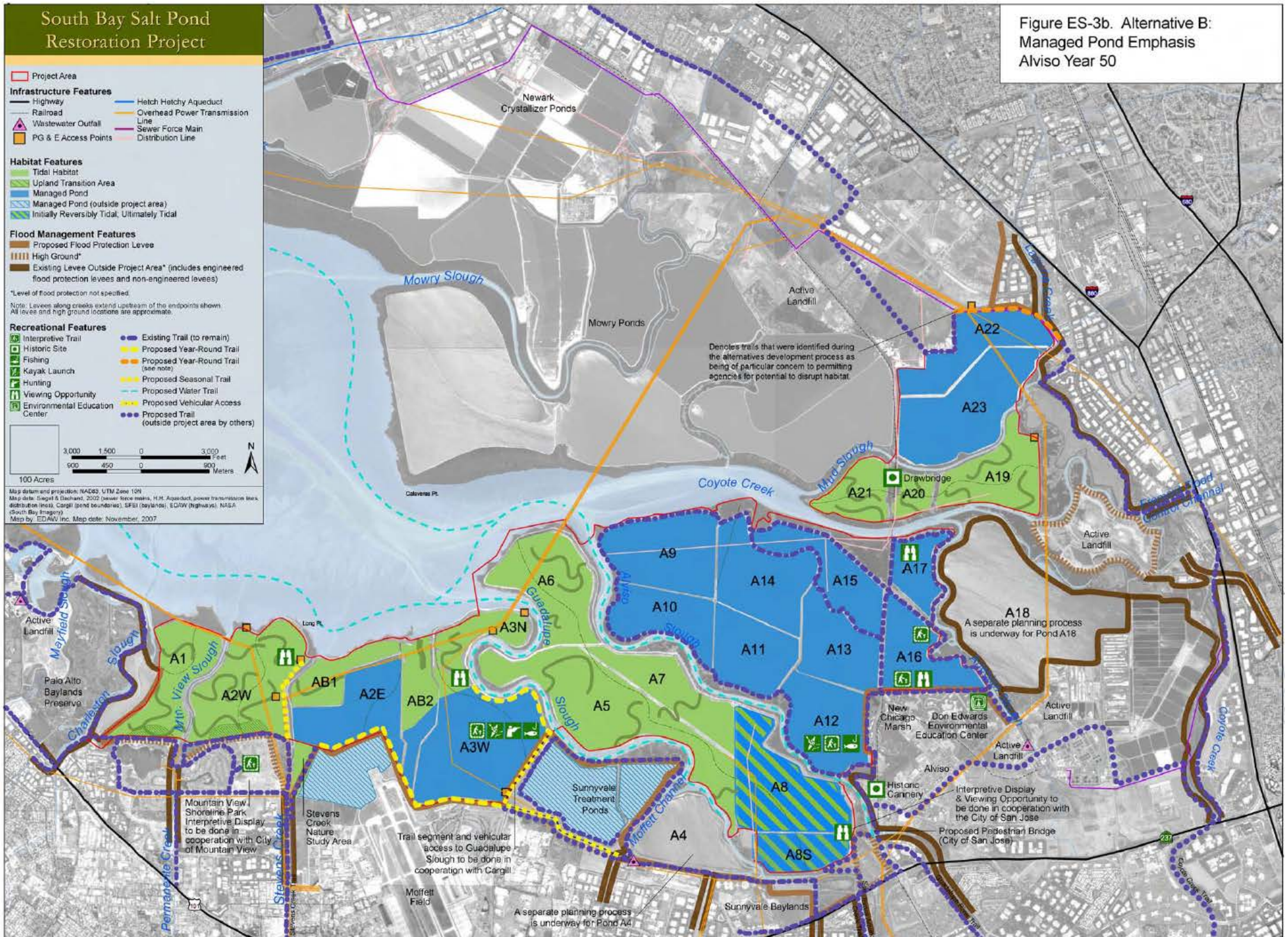
Table 3. Alviso Complex Phase 2 Options

	#	Optimal Restoration	Flood Management	Habitat Modified	Public Access Opportunity	Key Uncertainties/ Questions
Without Corps Levees	1	A1 tidal	Is A1/Charleston Slough levee needed?	Tie into existing restoration projects? Upland transition habitat possible.	Improved access to marsh on existing trail	▪ Landfill liner ▪ Possible preservation of islands within pond for tern colony
	2	A1 & A2W tidal		Habitat used by dabbling and diving ducks -- potential loss. Upland transition habitat possible.	Bay Trail enhancement	▪ If marsh, move trail on southern end of A2W? ▪ PG&E ▪ Fluvial tie-in for flooding ▪ Landfill liner
	3	Breach Island Ponds on mud slough	May need levee to protect north (A22/A23)		Water Trail access to marsh on Mud Slough	Feasibility study of benefits needed?
	4	A2W tidal		Future Upland transition habitat possible.	Bay Trail enhancement	
	5	A3W Seasonal Trail				
	6	A3W Managed Pond Enhancement				▪ Applied Study on pond management and algae/DO issues?

Table 3. Alviso Complex Phase 2 Options

	#	Optimal Restoration	Flood Management	Habitat Modified	Public Access Opportunity	Key Uncertainties/ Questions
With Levee 'Enhancement' Only	7	A3N tidal	Inland levee needed			▪ PG&E
With Corps Levees*	8	A9/10/11/14 fully tidal			Loss of A9 loop	▪ Need to find managed ponds elsewhere?
	9	Levee Stevens Creek to Sunnyvale west with restoration				
	10	Alviso levee and restore Ponds A9/10/11/12/13/14/ 15				▪ Railroad has to be raised to build Alviso levee
	11	A23 tidal				

*These are not under consideration for Phase 2 due to the likely timing of Corps flood management levee construction.


South Bay Salt Pond Restoration Project
Figure ES-3b. Alternative B: Managed Pond Emphasis Alviso Year 50
Project Area
Infrastructure Features
Highway
Railroad
Wastewater Outfall
PG & E Access Points
Hetch Hetchy Aqueduct
Overhead Power Transmission Line
Sewer Force Main
Distribution Line
Habitat Features
Tidal Habitat
Upland Transition Area
Managed Pond
Managed Pond (outside project area)
Initially Reversibly Tidal, Ultimately Tidal
Flood Management Features
Proposed Flood Protection Levee
High Ground*
Existing Levee Outside Project Area* (includes engineered flood protection levees and non-engineered levees)
*Level of flood protection not specified.
Note: Levees along creeks extend upstream of the endpoints shown. All levee and high ground locations are approximate.
Recreational Features
Interpretive Trail
Historic Site
Fishing
Kayak Launch
Hunting
Viewing Opportunity
Environmental Education Center
Existing Trail (to remain)
Proposed Year-Round Trail
Proposed Year-Round Trail (see note)
Proposed Seasonal Trail
Proposed Water Trail
Proposed Vehicular Access
Proposed Trail (outside project area by others)
100 Acres
Newark Crystallizer Ponds
Mowry Slough
Mowry Ponds
Active Landfill
Denotes trails that were identified during the alternatives development process as being of particular concern to permitting agencies for potential to disrupt habitat.
Coyote Creek
Mud Slough
Drawbridge
A22
A23
A19
A20
A21
A9
A10
A14
A15
A17
A11
A13
A16
A18
A separate planning process is underway for Pond A18
A12
A8
A8S
A4
A6
A3N
A7
A5
A1
A2W
AB1
A2E
AB2
A3W
Alviso Slough
Guadalupe Slough
Mayfield Slough
Charleston Slough
Mtn. View Slough
Palo Alto Baylands Preserve
New Chicago Marsh
Don Edwards Environmental Education Center
Alviso
Historic Cannery
Interpretive Display & Viewing Opportunity to be done in cooperation with the City of San Jose
Proposed Pedestrian Bridge (City of San Jose)
Sunnyvale Treatment Ponds
Moffett Channel
Sunnyvale Baylands
A separate planning process is underway for Pond A4
Moffett Field
Trail segment and vehicular access to Guadalupe Slough to be done in cooperation with Cargill
Stevens Creek Nature Study Area
Mountain View Shoreline Park Interpretive Display to be done in cooperation with City of Mountain View
Permanente Creek
Stevens Creek
Coyote Creek
Fremont Flood Control Channel

Project-wide Actions

Project-wide actions are those that the PMT felt were important to consider in Phase 2, but were not specific to an individual pond complex at this time. Upon further development, they may be focused on a specific geographic region, but for now are being considered at a landscape-scale.

Beneficial re-use of dredged material.

Get approval to opportunistically receive dredge material in 3-5 locations (matching the upland transition zones areas if possible) throughout the Project area.

Rationale: In light of sea-level rise, existing subsided ponds, potential reduction in suspended sediment concentrations in the Bay, and proposed broad upland transition zones, the Project can utilize as much sediment as possible. Since the inception of the Project, opportunities have arisen where unplanned sources of material were available. The Project is proposing to pursue approvals to receive material at various locations within the Project footprint as they become available. This will allow the Project to capitalize on sediment as it becomes available. Ideally these materials will be used to expedite marsh development, fill borrow ditches, and create broad upland transition zones. Applied Studies evaluating characteristics (such as contaminants) and placement of dredge materials would greatly inform future management actions.

Subtidal Habitat Goals pilot projects.

Pilot project(s) and/or studies at any of the complexes relative to the Subtidal Goals Project (e.g., eelgrass, oyster, living shoreline projects).

Rationale: The Draft Subtidal Habitat Goals Report is currently out for public review and will be finalized during the Phase 2 planning process. The long-term vision for the restoration of the South Bay by the PMT, Science Team, National Science Panel and Stakeholders Forum for the South Bay Salt Pond Restoration Project has always included subtidal habitat enhancements as part of the long-term vision. Numerous opportunities exist to further the goals of both projects through Applied Studies or pilot projects as part of Phase 2.

Public access and recreation study.

Continue to study user needs/wants for new public access and recreation features associated with the project.

Rationale: Public access and recreation is one of the three goals of the Project. However, planning for public use has been largely focused on site specific opportunities. The PMT will make a comprehensive evaluation of the needs and desires of the public in terms of public access and recreation is needed to help guide future phases of the Project to make sure that we are meeting the needs of the likely users.

V. PROJECT EVALUATION MATRIX

Potential Phase 2 options are laid out in the matrix below (Table 4) that takes into account the revised Phase 2 evaluation criteria described earlier in the report (see Section II, page 7). The purpose of the evaluation matrix below is to illustrate the Project Managers' initial assessment of each Phase 2 option, using the selection criteria described earlier. These criteria include:

- *Likelihood of progress toward Project Objectives*
- *Opportunities for adaptive management*
- *Readiness to proceed*
- *Visibility and accessibility*
- *Balance*
- *Availability of funding*
- *Value in continuing to build Project support**
- *Dependency on precedent actions**

Note: In general, actions that require a major precedent action, e.g. construction of a flood management levee, are not being considered in Phase 2. For that reason "dependency on precedent action" is not included in the matrix. In addition to "Value in continuing to build Project support," the "Visibility and Accessibility" criterion was also used as a proxy for assessing an action's overall value in continuing to develop public support for the Project

Table 4. Project evaluation Matrix for Phase 2 Actions.
(Ranking Convention: ○=Low, •=Medium, ●=High)

Restoration Action	Balance						Flood Protection Level[3]	Progress Toward Objectives[4]	Readiness to Proceed[5]	Value to the Project: Visibility and Accessibility[6]	Priority for Applied Study? (Y/N)[7]	Cost[8]
	Type[1]			Pond Complex[2]								
Beneficial re-use of dredged material	hr	fm		A	E	R	•	•	•	○	Y (1)	●
Subtidal Habitat Goals pilot projects	hr			A	E	R	●	●	•	○	Y (3)	•
Public access and recreation study			pa	A	E	R	●	●	○	○	Y (4)	●
R4 Tidal Restoration	hr					R	•	•	•	●	Y (5,7)	•
R5/S5 managed ponds	hr					R	●	•	•	●	N	•
R1/R4/R2 seasonal + re-plumb R3/S5/R5	hr					R	●	○	•	○	N	•
New water control structures at R ponds	hr					R	●	○	●	○	N	•
R4 spur trail			pa			R	●	●	●	•	Y (4,7)	●
Trail between Hwy and Bayfront Park			pa			R	●	●	●	•	Y (4,7)	●
E2 Tidal Restoration	hr	fm			E		•	•	•	•	Y (3, 9, 10)	•

Table 4. Project evaluation Matrix for Phase 2 Actions.
(Ranking Convention: ○=Low, •=Medium, ●=High)

Restoration Action	Balance: Type[1]			Balance: Pond Complex[2]			Flood Protection Level[3]	Progress Toward Objectives[4]	Readiness to Proceed[5]	Value to the Project: Visibility and Accessibility[6]	Priority for Applied Study? (Y/N)[7]	Cost[8]
E2/E4 Tidal Restoration	hr	fm			E		•	•	•	•	Y (3, 9, 10)	•
E5/E6/E6C Tidal Restoration	hr				E		○	•	●	●	Y (3, 5, 10)	○
E1/E7 Tidal Restoration	hr				E		•	•	•	•	Y (3, 9, 10)	•
E2/E4 + E1/E7 Tidal Restoration	hr				E		•	•	•	•	Y (3, 9, 10)	•
E1-6 + E6C Tidal Restoration	hr				E		○	•	●	●	Y (3, 5, 10)	○
Eel Grass Subtidal Habitat	hr				E		●	●	•	○	Y (3)	•
G-1 levee		fm			E		●	•	•	●	Y (5, 7)	○
Spur trail along E6 & E7 to Alvarado salt works			pa		E		•	●	•	•	N	●
EBRPD Bay Trail along inboard G-1 levee			pa		E		○	●	•	●	Y (7)	●

Table 4. Project evaluation Matrix for Phase 2 Actions.
(Ranking Convention: ○=Low, •=Medium, ●=High)

Restoration Action	Balance: Type[1]			Balance: Pond Complex[2]			Flood Protection Level[3]	Progress Toward Objectives[4]	Readiness to Proceed[5]	Value to the Project: Visibility and Accessibility[6]	Priority for Applied Study? (Y/N)[7]	Cost[8]
A1 Tidal	hr			A			•	•	•	●	Y (5,7)	•
A1 & A2W Tidal	hr			A			•	•	•	●	Y (5,7)	•
Breach Island Ponds on mud slough	hr			A			●	•	•	•	N	•
A2W Tidal	hr			A			•	•	•	●	Y (5,7)	•
A3W Seasonal Trail			pa	A			●	•	●	•	N	●
A3W Managed Pond Enhanceme nt	hr			A			●	•	●	○	N	●
A3N Tidal	hr			A			•	•	•	•	N	•

<u>Key:</u>
[1]hr=habitat restoration, fm=flood management, pa=public access or recreation
[2]A=Alviso, E=Eden Landing, R=Ravenswood
[3]Flood Protection Criterion:
- ○: FEMA flood management levee required
- •: Able to proceed without FEMA levee
- ●: No flood concerns/improves flood management

[4]Progress Toward Objectives:
- ○: Precludes planned progress to 50-50 Alternative
- •: Moves to/Equal to 50-50 Alternative
- ●: Moves past 50-50 Alternative toward 90-10

[5]Readiness Criterion:
- ○: Significant precedent actions needed (e.g., FEMA levee)
- •: Typical constraints (design, regulatory, etc.)
- ●: No impediments to proceeding

[6]Visibility and Accessibility Criterion:
- ○: Neither very visible nor accessible
- •: Visible, but not accessible, or vice versa
- ●: Both very visible and accessible

[7]See Table 5 below for referenced Applied Study number.
[8]Cost Criterion:
- ○: >$8 million
- •: $2-8 million
- ●: <$2 million

VI. APPLIED STUDIES

Many of the South Bay Salt Pond Restoration Project actions are specifically designed either to facilitate (or coordinate with Adaptive Management) a specific applied research question, or to respond to the findings of applied research regarding the optimal mix of tidal restoration, pond management, non-levee-dependent flood management and public access and recreation.

Phase 1 of the project includes the implementation of many Applied Studies. All of these studies are designed to provide the Project with important information about the potential for expanding tidal marshes while preserving habitat for pond-dependent species. Several Applied Studies in Phase 1 will also provide information on the effects of increased public access on the wildlife in the ponds and newly restored marshes.

As the Project Management Team developed the options for Phase 2, Project Lead Scientist Laura Valoppi, took the lead in developing concepts for relevant adaptive management Applied Studies that should proceed in Phase 2. The table below illustrates those proposed studies.

Table 5. Potential Phase 2 Applied Study Concepts

Number	Study Idea	All Complexes	Ravenswood	Eden Landing	Alviso
1	Dredge material and sediment plan -- number, sources, types ▪ Feasibility of use of dredge spoils	X			
2	*Spartina* hybrid issue ▪ How much hybridization is okay (genetic question)? ▪ How much invasive *Spartina* is okay before control actions are taken? This requires collaboration with others/ISP.	X			
3	Subtidal pilot project Collaboration with Subtidal Goals Project Eelgrass study/pilot project off E2	X		X	
4	Public access/use surveys/studies ▪ Different communities and user groups, languages ▪ Human disturbance on upland transition zones.	X			
5	Upland transition zones (possibly linked to Number 1 above) ▪ How, where? ▪ How to construct? ▪ How to best construct upland transition zones to maximize benefits to marsh species, especially clapper rail and salt marsh harvest mouse? ▪ Source of materials and stockpiles? ▪ What materials can be used vis-à-vis soil properties/texture? ▪ What contaminant concerns? ▪ Vegetation management: what to seed with? What is native in this habitat? How do we control non-native invasive vegetation on a large scale?	X	X	X	X
6	TAC recommended a long-term "holistic" mercury monitoring program for South Bay Salt Ponds ▪ PMT/TAC to reach consensus on biosentinels ▪ National panel to develop toxicity thresholds	X	X	X	X

Table 5. Potential Phase 2 Applied Study Concepts

Number	Study Idea	All Complexes	Ravenswood	Eden Landing	Alviso
7	What effect will a trail have on a planned transition zone habitat and species use? Could it make species more vulnerable to predation? (Linked to #4 above.) If E6/E5 made tidal first with upland transition habitat and trail adjacent – issue of increased predation or disturbance from trail to upland transition habitat		X	X	
8	Look at SF2 island/habitat for increase in number of snowy plover and shorebirds (re: potential loss of habitat for small shorebirds at R4)		X		
9	Salt pannes -- if they form in E2/E1: and E8A/E9: ▪ How do waterbirds use? ▪ Hg issues since wet/dry cycle? ▪ Muted Mt. Eden Creek pannes -- study those?			X	
10	How does opening/increasing tidal prism in Old Alameda Creek and/or Alameda Flood Control Channel affect fish resources in those channels?			X	
11	If A1/A2W became tidal and displaced dabbling and diving ducks, what effect on Pond A3W and its existing use by ducks? What is the carrying capacity of A3W? What are the effects of hunting within a smaller footprint of ponds?				X

APPENDIX B

EDEN LANDING PRELIMINARY ALTERNATIVES ANALYSIS REPORT

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South Bay Salt Pond Restoration Project

Eden Landing Preliminary Alternatives Analysis Report

June 2014

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Tables

Figures

Introduction

In 2003, Cargill Salt (Cargill) sold 15,100 acres of solar salt production ponds that had been owned and operated by Cargill in the southern San Francisco Bay. The sale and transfer to the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) became known as the South Bay Salt Pond Restoration Project (SBSP Restoration Project). The first phase of the SBSP Restoration Project will be completed in 2014. Phase 2 of the SBSP Restoration Project involves the selection, restoration design, environmental compliance, permitting, and construction activities at several former salt pond complexes under the ownership and management of USFWS or CDFW. The Alviso and Ravenswood complexes lie within the boundaries of the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), which is owned by USFWS. The Eden Landing complex, within the Eden Landing Ecological Reserve, is owned by CDFW.

The complexes consist of many individual salt ponds; several groups or "clusters" of these ponds are being analyzed for inclusion into the SBSP Restoration Project's Phase 2 actions. Phase 2 actions at the Alviso and Ravenswood complexes are being undertaken by the Refuge and are described in other reports and environmental compliance documents. At the Eden Landing complex, Phase 2 of the SBSP Restoration Project involves the restoration and enhancement of the ponds south of Old Alameda Creek. The preliminary alternatives for the ponds at the Eden Landing complex are the subject of this report.

This document presents the purpose, methods, and results of developing the preliminary alternatives at Eden Landing for Phase 2 of the SBSP Restoration Project, developing screening criteria for those alternatives, and applying those criteria to select specific alternatives for inclusion in the SBSP Restoration Project's Draft Environmental Impact Statement/Environmental Impact Report (DEIS/R).

The organization of the document is as follows:

- Section 1 discusses the purpose of an alternatives development and screening process and places this work in the context of the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), and the SBSP Restoration Project's three primary goals of habitat restoration, improved recreation and public access, and maintenance or improvement of current levels of flood risk protection.
- Section 2 presents the alternatives developed for this portion of Phase 2. Specifically, Section 2 discusses the individual components, the optional variations on those components, and the combinations of them that constitute the alternatives developed for inclusion in the DEIS/R. The DEIS/R will include evaluations and impact analyses of the habitat restoration, recreation and public access, and flood risk protection components. Based on those analyses and the comments received, some individual components of one or more of the draft alternatives may be selected and recombined into a Preferred Alternative for inclusion and analysis in the Final EIS/R.
- Section 3 presents the processes and methods by which the initial component actions were developed, modeled, analyzed, refined, and then selected. Section 3 includes more details about some of the key components, such as breach sizes, numbers, and locations.

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Section 1. Purpose

This document presents the methods, process, and results of the SBSP Restoration Project's Phase 2 alternatives development and screening process.

The alternatives themselves are developed in compliance with NEPA and CEQA. NEPA requires development and consideration of a range of "reasonable alternatives." CEQA requires alternatives that would "minimize significant impacts." In addition, the alternatives considered in a NEPA/CEQA document must meet the project's stated goals, purpose, need, and objectives. The SBSP Restoration Project has three primary goals: habitat restoration, improved recreation and public access, and maintenance or improvement of current levels of flood protection.

Previously, as part of NEPA and CEQA compliance, the project lead agencies completed a Programmatic EIS/R (PEIS/R) for the project as a whole. The PEIS/R developed long-term, end-project "target" habitat designations for each of the ponds in the project for each of two different programmatic action alternatives and a programmatic No Action Alternative:

- Programmatic Alternative A: no actions taken on the programmatic level; maintenance and operation of the ponds would proceed under "business as usual" conditions.
- Programmatic Alternative B: 50% (by acreage) restoration to tidal marsh and 50% managed ponds
- Programmatic Alternative C: 90% restoration to tidal marsh and 10% managed ponds

Programmatic Alternative C was selected and used for planning and implementation of Phase 1 actions. As part of the adaptive management approach to the project, the decision about when to cease restoration of tidal marshes may be reconsidered at a future time. When the total acreage of tidal marsh restoration is at or near 50%, there would be more specific decisions about whether to cease restoration of ponds to tidal marsh or continue to work toward the 90% target.

The intent of SBSP Restoration Project Phase 2 actions is to tier off of the PEIS/R. The preliminary alternatives considered were those that worked toward the end-project target habitat designation in the 50%-50% scenario presented in the PEIS/R. Even full implementation of these Phase 2 actions (i.e., restoring all of southern Eden Landing to tidal marsh) would not achieve the 50% tidal marsh threshold for the SBSP Restoration Project as a whole.

This document demonstrates the SBSP Restoration Project's success in meeting requirements to develop and consider a broad range of project action alternatives and a No Action Alternative for the Eden Landing ponds considered under Phase 2. This document includes map figures to explain and illustrate each of the preliminary alternatives and matrices to summarize each alternative's components. These alternatives encompass the full range of actions that may eventually be implemented as part of SBSP Restoration Project Phase 2 actions at Eden Landing.

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Section 2. Components and Preliminary Alternatives

The Eden Landing complex is in the Eden Landing Ecological Reserve (ELER), which is owned and operated by CDFW. This complex is near the eastern end of the San Mateo Bridge and is south of State Route (SR) 92 where it passes through Hayward in Alameda County. The Phase 2 actions at Eden Landing are focused on the ponds in the southern half of the ELER (specifically, the area south of the Old Alameda Creek channel and north of the federally constructed Alameda Creek Flood Control Channel [ACFCC]). Public access components include alignment of the San Francisco Bay Trail "spine" such that the trail connects from the existing San Francisco Bay Trail within the northern half of ELER to the existing Alameda Creek Regional Trail operated by the East Bay Regional Park District (EBRPD) along ACFCC.

2.1 Background and Goals

The southern portion of ELER includes 11 ponds that are described here in three groups based on their locations within the Eden Landing complex and their proximity and similarity to each other. As noted in Section 1, all of these ponds are intended to be restored to tidal marsh under both Programmatic Alternative B (a 50%-50% mix of tidal marsh and managed ponds) and Programmatic Alternative C (a 90%-10% mix of tidal marsh and managed ponds). These groups of ponds are addressed in the habitat restoration, added and improved public access and recreation opportunities, and flood risk protection measures considered in Phase 2. The groups are as follows:

- The Bay Ponds: Ponds E1, E2, E4, and E7 are the four large ponds closest to San Francisco Bay.
- The Inland Ponds: Ponds E5, E6, and E6C are somewhat smaller ponds in the northeast portion of the complex.
- The Southern Ponds: Also called the C-Ponds, Ponds E1C, E2C, E4C, and E5C are in the southeastern portion of the complex. They are separated from the Inland Ponds and the Bay Ponds by an Alameda County–owned freshwater outflow channel and diked marsh areas known collectively as "the J-ponds." The Southern Ponds surround a natural hill known as Turk Island that is on a private inholding.

The groups of ponds are intended to simplify the discussion of the ponds and the restoration alternatives rather than repeating names of individual ponds. These groups are discussed in more detail in the sections that follow.

Phase 1 actions at the Eden Landing complex were focused on the northern half of Eden Landing (north of Old Alameda Creek). They included adding managed pond improvements to Ponds E12, E13, and E14; restoring Ponds E8A, E8X, and E9 to tidal marsh; adding a kayak launch into Mt. Eden Creek; and adding and improving several trails and interpretive features.

Under the PEIS/R, all of the ponds in southern Eden Landing are intended to be restored to tidal marsh. This remains the plan and the expectation for these ponds; however, the Adaptive Management Plan developed by the SBSP Restoration Project and used to adjust both short-term management actions and long-term restoration planning depends on leaving open the possibility of some portions of southern Eden Landing remaining as managed ponds to achieve broader project goals. One example of these goals could be a need to retain pond habitat for diving birds, dabbling ducks, or other wildlife species. Further, much of the restoration may be constructed in stages and may require features to improve coastal flood risk protection to address "de facto" coastal flood protection that is currently provided by the intact southern Eden Landing ponds. This protection will be provided either by constructing levee improvements, a flood wall system, or other improvements to address coastal flood risk protection on the inboard sides of the ponds or by building a land mass on the outboard sides of the Bay Ponds. At least one of these two solutions must be in place in the ponds prior to restoring full tidal action into the pond complex.

The PEIS/R also laid out several goals for the major recreation and public access facilities at southern Eden Landing. These goals varied depending on whether Programmatic Alternative B or C was chosen. Alternative C was selected, but the Adaptive Management Plan could stop restoration and related project activities at any point between Alternative B and Alternative C. Thus, the exact list of program-level recreation and public access goals addressed in the Phase 2 actions may vary, but they will be drawn from the options in the PEIS/R or designed to achieve similar purposes.

Some recreation/public access options from the PEIS/R included in Phase 2 consideration at southern Eden Landing are:

- Maintain the existing trail that runs along the top of the large federal levee that forms the southern edge of the complex (i.e., the northern edge of ACFCC) (This option would involve constructing bridge(s) over any breaches that would be opened in that levee.)
- Complete the Bay Trail spine along the eastern edge of the pond complex
- Add a spur trail along the northern edge of Pond E6 from the Bay Trail spine to the site of the former Alvarado Salt Works
- Convert the above-referenced spur trail into a loop by building a footbridge over Old Alameda Creek and a trail back to the Bay Trail spine

2.2 Components and Variations

For Eden Landing, the recreation/public access components under consideration are developed, described, screened, and combined into partial alternatives separately from the habitat restoration and flood control components. The recreation/public access components are considered separately because the conceptual designs for the recreation/public access components can more easily be developed if done separately from the restoration and flood control components. Later in this document, these two different sets of components are developed into full alternatives for inclusion and analysis in the Phase 2 DEIS/R.

Coastal Flood Risk Protection Components

Primary coastal flood risk protection can be provided by standard approaches, such as constructing engineered levee improvements and/or a flood wall on the backside of the complex between the developed areas and the Inland Ponds and Southern Ponds. A new approach under development by Alameda County provides coastal flood risk protection by means of a "land mass"—a wide and high earthen feature—that would be constructed along the existing outboard levees of Ponds E1 and E2. The land mass feature would be designed to preclude catastrophic failures that sometimes occur on traditional levee features and may also include a broad slope that provides habitat elements such as an upland transition zone (UTZ). The land mass would function like a barrier island. More detail on the land mass is presented in Appendix A. Each of the alternatives developed below has either an engineered levee or a land mass to provide coastal flood risk protection.

Other coastal flood risk protection may be designed in the Phase 2 projects at Eden Landing. For example, a mid-complex levee may be constructed along a north-south alignment between the Bay Ponds and the Inland Ponds. At its southern end, a mid-complex levee would cross the Alameda County–owned J-ponds to connect with the western levee of Pond E1C and the ACFCC levee. Where possible, this mid-complex levee would be built on top of the existing internal berms and levees of these ponds. The mid-complex levee could be temporary or permanent. In its temporary use, it would allow for staged restoration by providing flood protection to the areas behind it while the Bay Ponds are breached and restored to tidal marsh, after which it could be removed or breached to allow tidal marsh restoration in the inland and/or southern ponds. In its permanent use, it would allow the Bay Ponds to be restored to tidal marsh, but either the Inland Ponds or the Southern Ponds (or portions of both) could be maintained as enhanced managed ponds.

Restoration Components

The restoration components considered for the Eden Landing complex fall into three categories of actions. These are discussed in turn and summarized in Table 1.

The first category of restoration components concerns the restoration goals of the various pond groups. The Bay Ponds are the simplest because they would be breached to become tidal marsh. The Inland Ponds and/or the Southern Ponds could be breached to become tidal marsh at the initial stage of the project, or—as explained above—could be enhanced as managed ponds behind the mid-complex levee. If the latter, they could remain that way indefinitely (“permanently”) or they could be temporarily managed until becoming part of a staged tidal restoration. There are components that cover each of these eventualities, though, as noted in Section 2.1, the intent is that the Inland Ponds and Southern Ponds would be restored to tidal marsh.

The second category of restoration components considers the use of material or water from external projects. The material could be upland fill material from construction projects or dredge material from channel maintenance or deepening projects. The material could be used for constructing UTZs (discussed below), adding habitat islands (also discussed below), building the land mass, or raising the bottom elevations of certain subsided ponds to speed their return to marsh-plain elevation. The water would be treated water from the Union Sanitary District (USD) and would be used to facilitate establishment of brackish marsh within portions of the ponds and/or native vegetation on the UTZs.

The third category of restoration components is habitat enhancements. One enhancement is adding habitat islands in some of the ponds for bird roosting, foraging, or nesting. Islands could be constructed from imported fill, as discussed above (second category), or by reinforcing and leaving portions of existing levees in place and breaching around them. As these ponds are subsequently breached and tidal marsh habitat develops, these islands would naturally transition to “marsh mounds,” which would be used as high-tide refugia for California clapper rail (*Rallus longirostris obsoletus*), salt marsh harvest mouse (*Reithrodontomys raviventris*), and other species. Another enhancement is constructing UTZs to increase flood protection, buffer against sea-level rise, and increase habitat diversity. There are options for UTZs in the Inland Ponds or the Southern Ponds if these become tidal marsh. However, if those pond groups are retained as enhanced managed ponds, then the UTZs would be built against the permanent version of the mid-complex levee within the Bay Ponds. Shells or sand toppings could be added to the top of the land mass, to remaining levees, or to constructed habitat islands to improve their suitability for nesting western snowy plover (*Charadrius alexandrines nivosus*). A final component in this category is creating deepwater channels to direct flows into different portions of the ponds and to improve the habitat quality and connectivity for fish species.

Table 1 lists all of these coastal flood risk protection and restoration components and the variations being considered for each of them. Some components have only two variations or options: implement or do not implement. An example of this component is armoring or otherwise controlling the sizes of the breaches. The armoring option would be implemented where the breach needs to remain at its constructed width, most notably wherever breach size affects coastal flood risk protection or where a bridge may be necessary to span the breach to provide ongoing access for operations and maintenance or for public access. Other components have a range of degrees of implementation or a range of locations where they are implemented: for example, how many UTZs are constructed and in which places. The alphanumeric codes in Table 1 are provided as a shorthand way to refer to certain configurations. For example, building the land mass would be component 1b; building the backside levee would be component 1c.

The combination of these various components into preliminary alternatives is discussed below.

Table 1. Restoration and Flood Control Components and Variations

Code #	Restoration and Flood Control Components	Component Variations Letter				
		a	b	c	d	e
1	Primary Flood Control	As-Is	Land Mass	Backside Levee		
2	Mid-Complex Levee	No	Yes - Temporary	Yes - Permanent		
3	Upland Transition Zone	No	In Inland Ponds	In Bay Ponds	In Southern Ponds	Against Land Mass
4	Inland Ponds	As-Is	Tidal Marsh	Temporary Managed Ponds	Permanent Managed Ponds	
5	Southern Ponds	As-Is	Tidal Marsh	Temporary Managed Ponds	Permanent Managed Ponds	
6	Breach Control	No	Yes (at bridges)			
7	Accept Dredge / Upland Material	No	Yes - for Land Mass	Yes - for UTZ	Yes - for Pond Bottoms	
8	Freshwater from USD	No	Yes - Inland Ponds - Brackish Marsh	Yes - Inland Ponds – Brackish Marsh and/or UTZ	Yes - Southern Ponds - Brackish Marsh and/or UTZ	
9	Deepwater Pilot Channels	No	Yes			
10	Islands/Mounds in Ponds	No	Yes - Managed Pond Islands	Yes - Marsh Mounds		
11	Shell Topping on Land Mass	No	Yes			

Recreation and Public Access Components

Seven primary components address public access and recreation, and two of these components have variations to achieve a similar goal and recreational experience or opportunity. Almost all of these components can be decided on independently. Any or none of these components may ultimately be chosen based on their feasibility and potential impacts. No components directly conflict with others, and very few are dependent on others being implemented. The exceptions are noted below. The recreational and public access components are:

1. Complete Bay Trail spine through Phase 2 Area
    - 1a – Bay Trail spine alignment placed on ELER levees on eastern side of (from north to south) Ponds E6, E5, E6C, and E4C; the southernmost portion of the alignment would be constructed on a levee east of Cargill Pond 3C (CP3C) (the trail would be on county-owned land to the east or be placed on CDFW land)
    - 1b – Bay Trail runs along an alternate route to the east of ELER on land owned by the county or landowners other than CDFW or Cargill
2. Spur trail on south side of Old Alameda Creek to Alvarado Salt Works
3. Maintain existing trail to bay on ACFCC Levee – this is essentially a bridge over an armored breach or alteration of the ACFCC levee to maintain the current trail
4. Trail around portions of the Southern Ponds; some components require acquiring the Cargill inholdings (Pond 3C, Turk Island, and Cal Hill)
    - 4a – Loop trail from Bay Trail spine around northern and western ends of the Southern Ponds; connects with the ACFCC trail
    - 4b – Cuts across the southern end of the Southern Ponds along the border of Cargill Pond 3C; then turns south to join the ACFCC trail
    - 4c – Turk Island Summit Loop Trail; initially, the same trail as component 4a but turns south over the Turk Island summit and then goes southeast to ACFCC
5. Pedestrian and bicycle bridge over ACFCC; this component would connect with the trail system in Coyote Hills Regional Park to the south
6. Trail on north side of Old Alameda Creek; this component requires component 2 to be chosen; it would run along the northern side of Old Alameda Creek and include a bridge to cross the creek and connect to the spur trail at the Alvarado Salt Works
7. Add recreational information and/or an interpretive feature along the ACFCC levee trail at a location to be determined

Table 2 lists these recreation and public access components. The combination of these various components into alternatives is discussed below.

Table 2. Recreation and Public Access Alternative Components

Code No.	Component Description
1	a – Complete Bay Trail spine through Phase 2 Area
	b – Bay Trail alternate route (east of ELER)
2	Spur trail on south side of Old Alameda Creek to Salt Works
3	Retain existing trail to bay on ACFCC levee (includes bridge over breach)
4	a – Loop trail around perimeter of Southern Ponds
	b –Trail through Southern Ponds
	c – Turk Island summit loop trail
5	Pedestrian / bicycle bridge over ACFCC
6	Trail on north side of Old Alameda Creek with bridge to #2
7	Recreation info and/or interpretive feature near Southern Ponds breach or culvert location

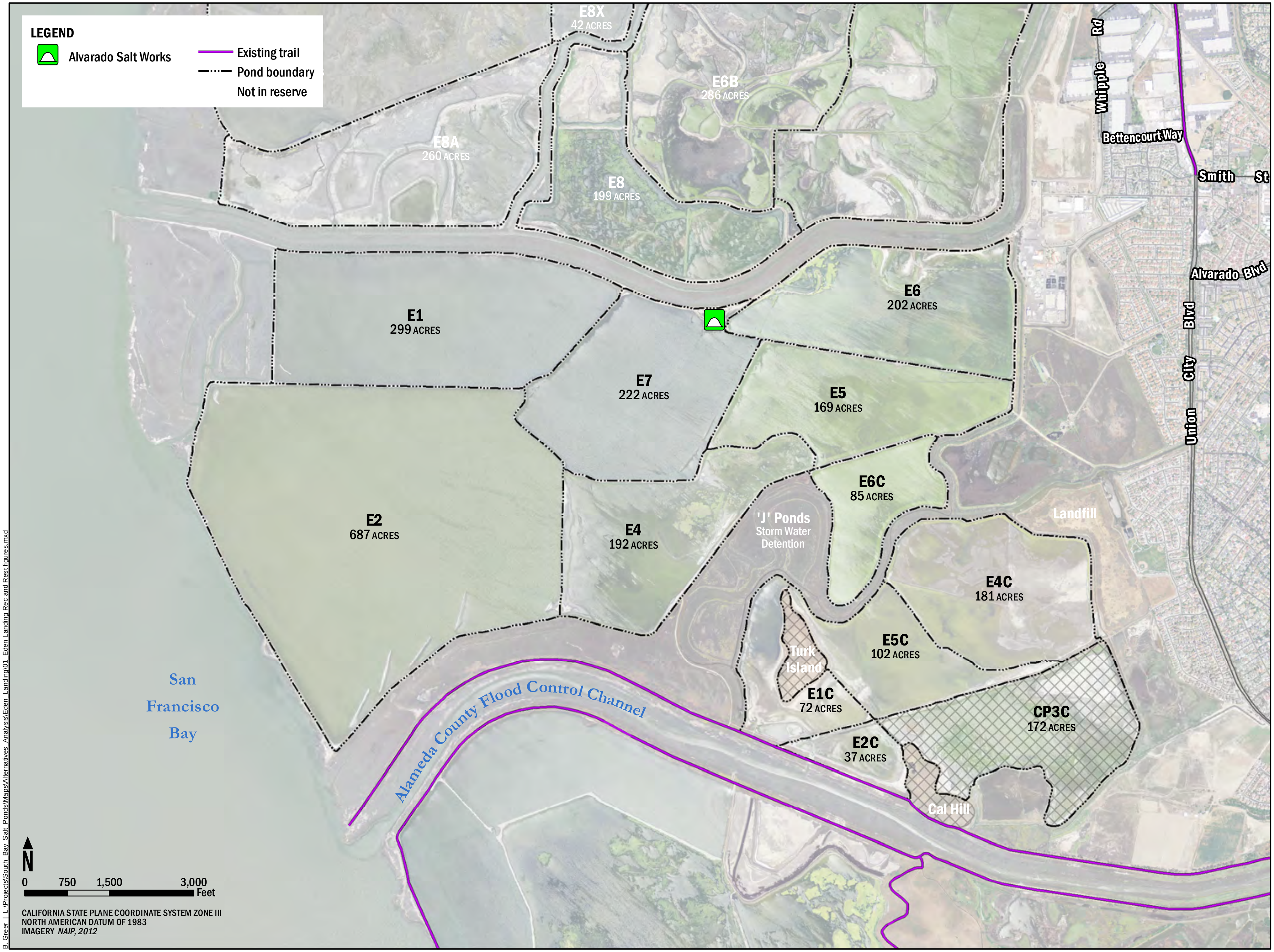
2.3 Development of Alternatives

Table 3 shows the combination of the above restoration and flood control components into four preliminary alternatives to achieve the SBSP Restoration Project goals plus a No-Action Alternative (“No Action” is the NEPA term; the equivalent term under CEQA is “No-Project

Alternative”). The names and numbers of the alternatives are for purposes of planning and internal discussion only. The names and numbers provide an indexing system and a brief description of the overall intent or effect of each alternative. They do not convey any order of preference or priority. Maps of these alternatives are presented on Figures Rest1 through Rest5.

Similarly, Table 4 shows the combination of the recreation and public access components into three preliminary alternatives and a no-project alternative. These alternatives are named and ordered in an array that reflects the provision of the fewest new access and recreation features to the greatest number of new features in this interim step of developing alternatives; they do not reflect any preference or priority. Maps of these alternatives are presented on Figures Access1 through Access4.

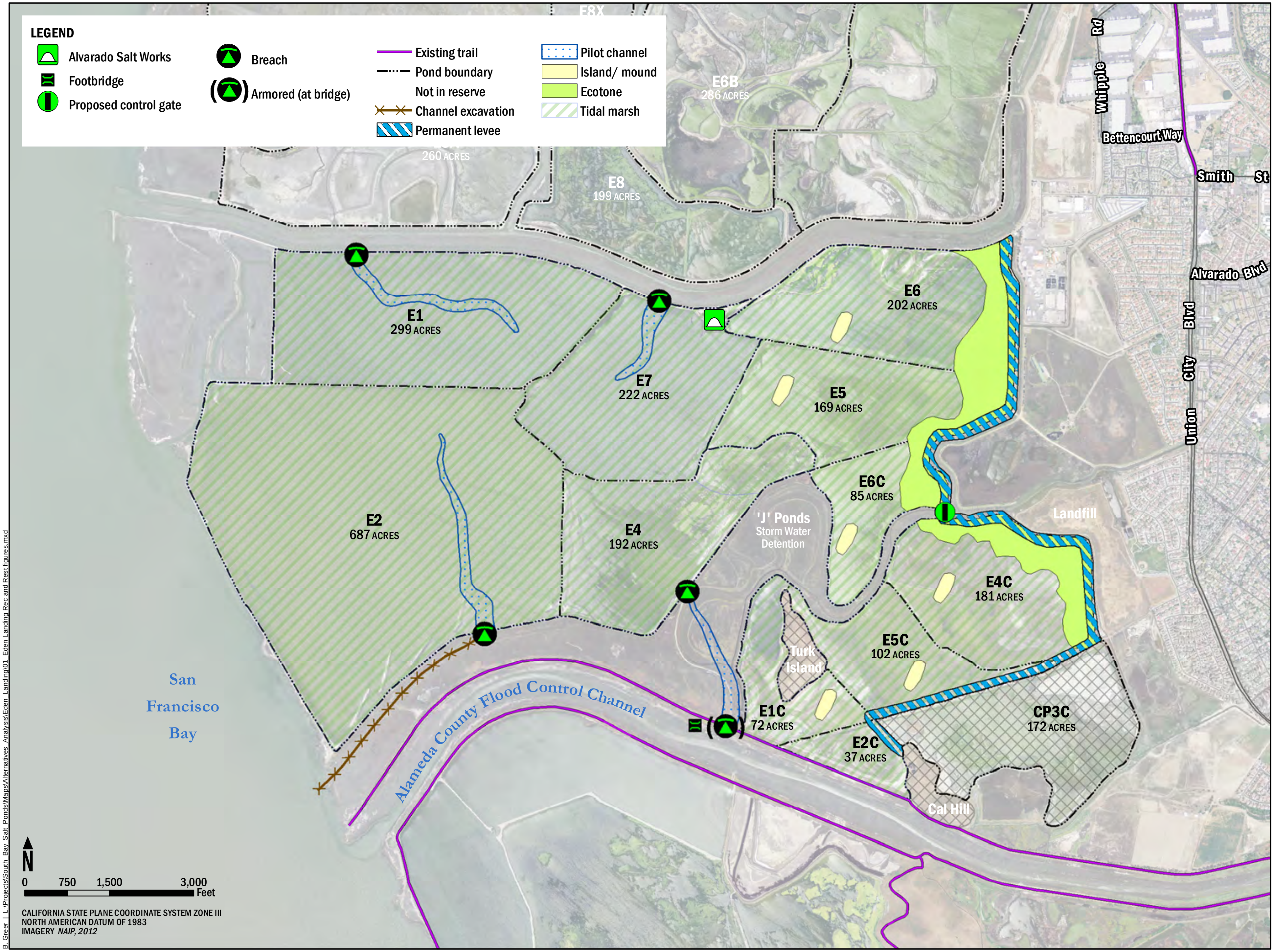
The figures are presented on the pages that follow.



URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Rest1
No Project / No Action Alternative



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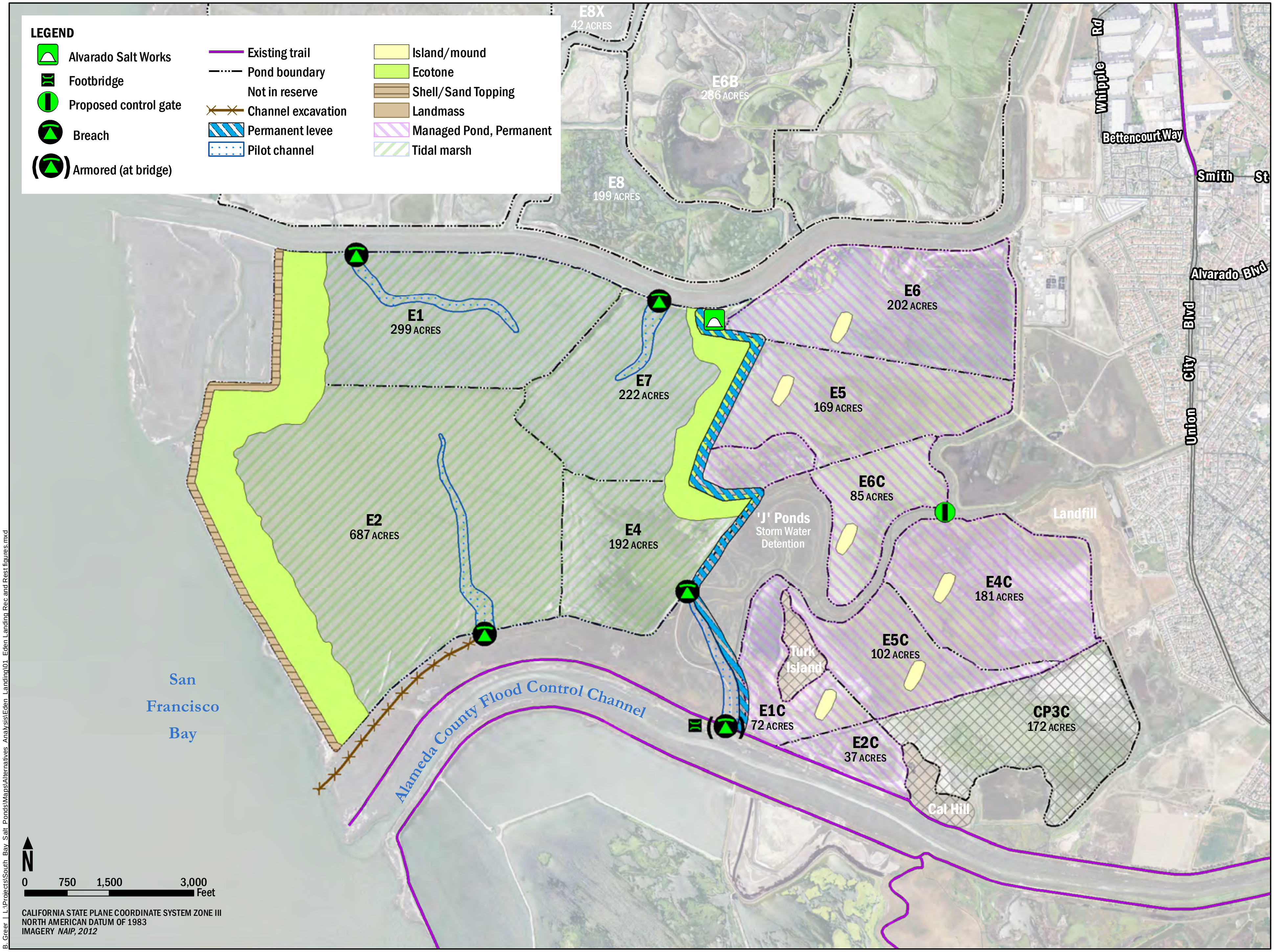
URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Rest2
Flood Protection from Backside Levee



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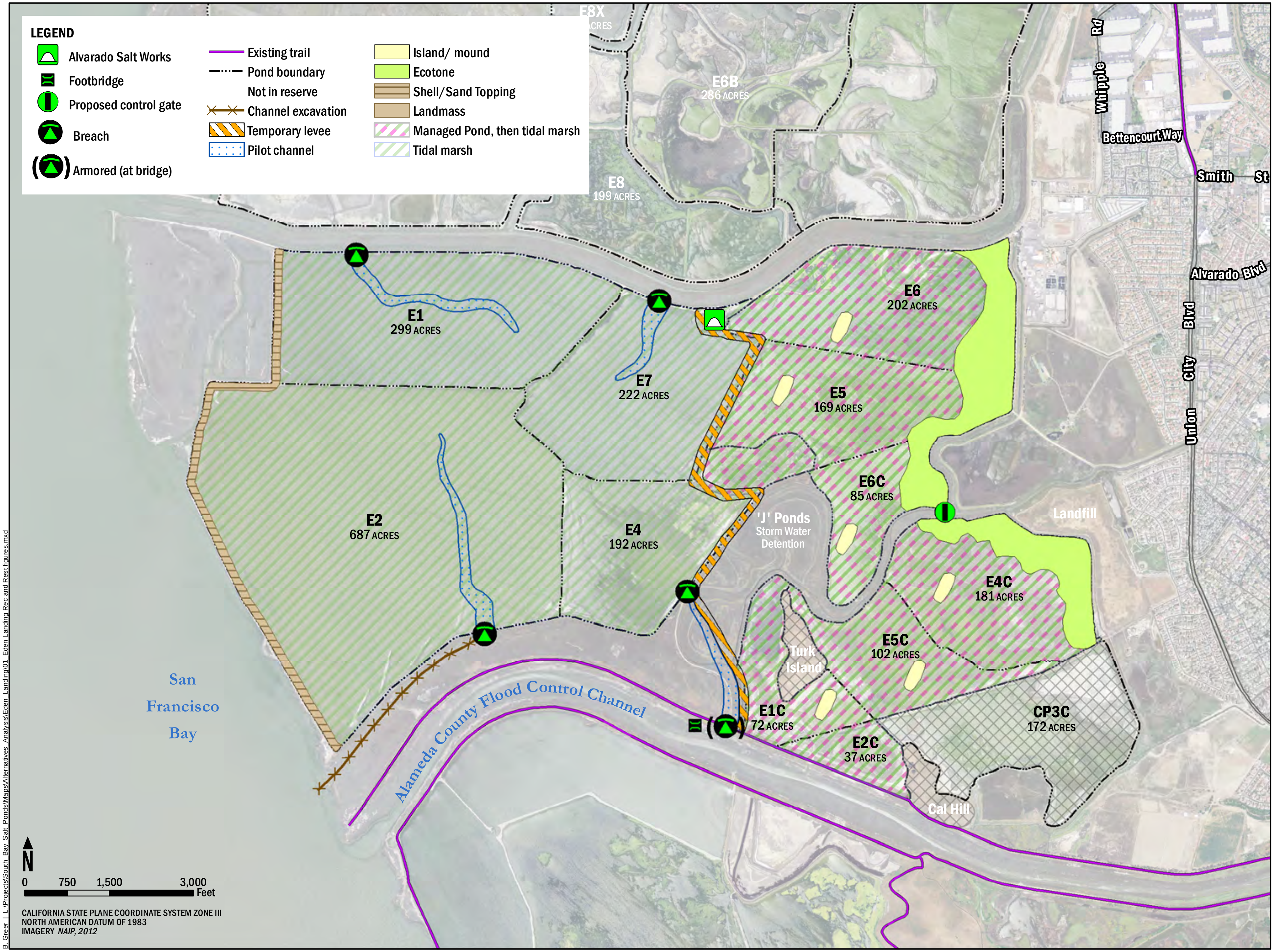
South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Rest3
Mix of Marsh & Ponds



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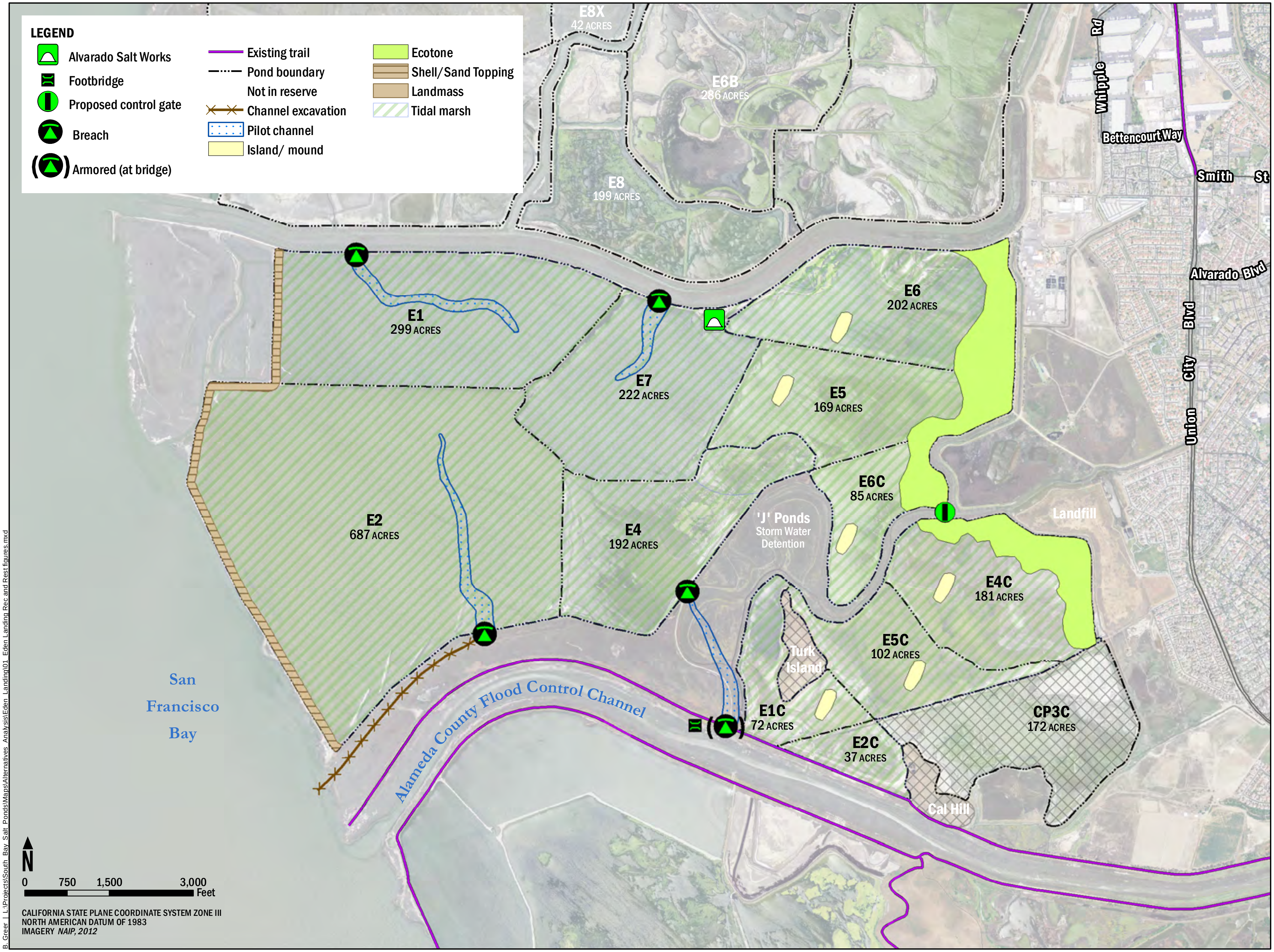
URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

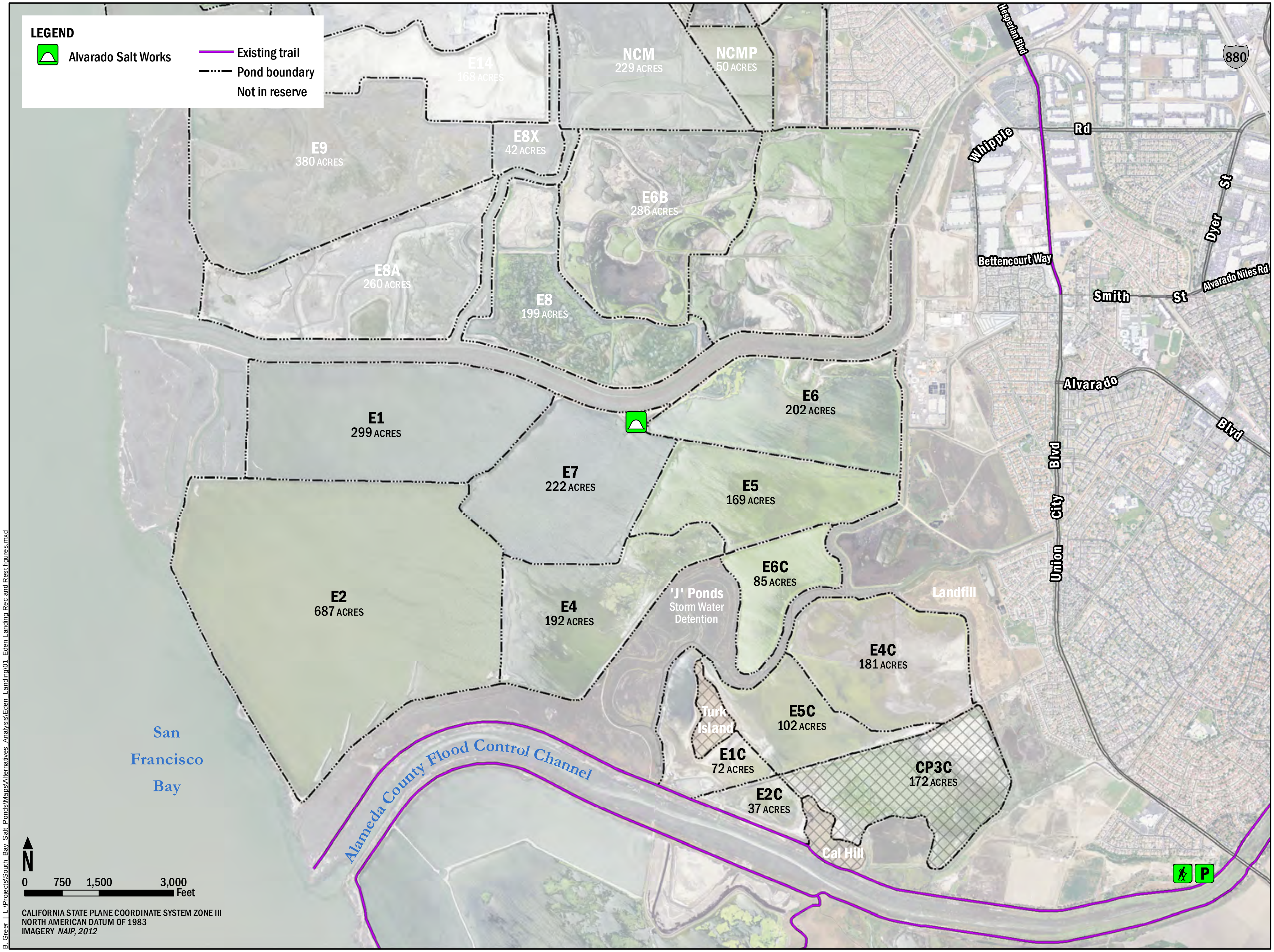
Rest4
Full Tidal Restoration (phased)



URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

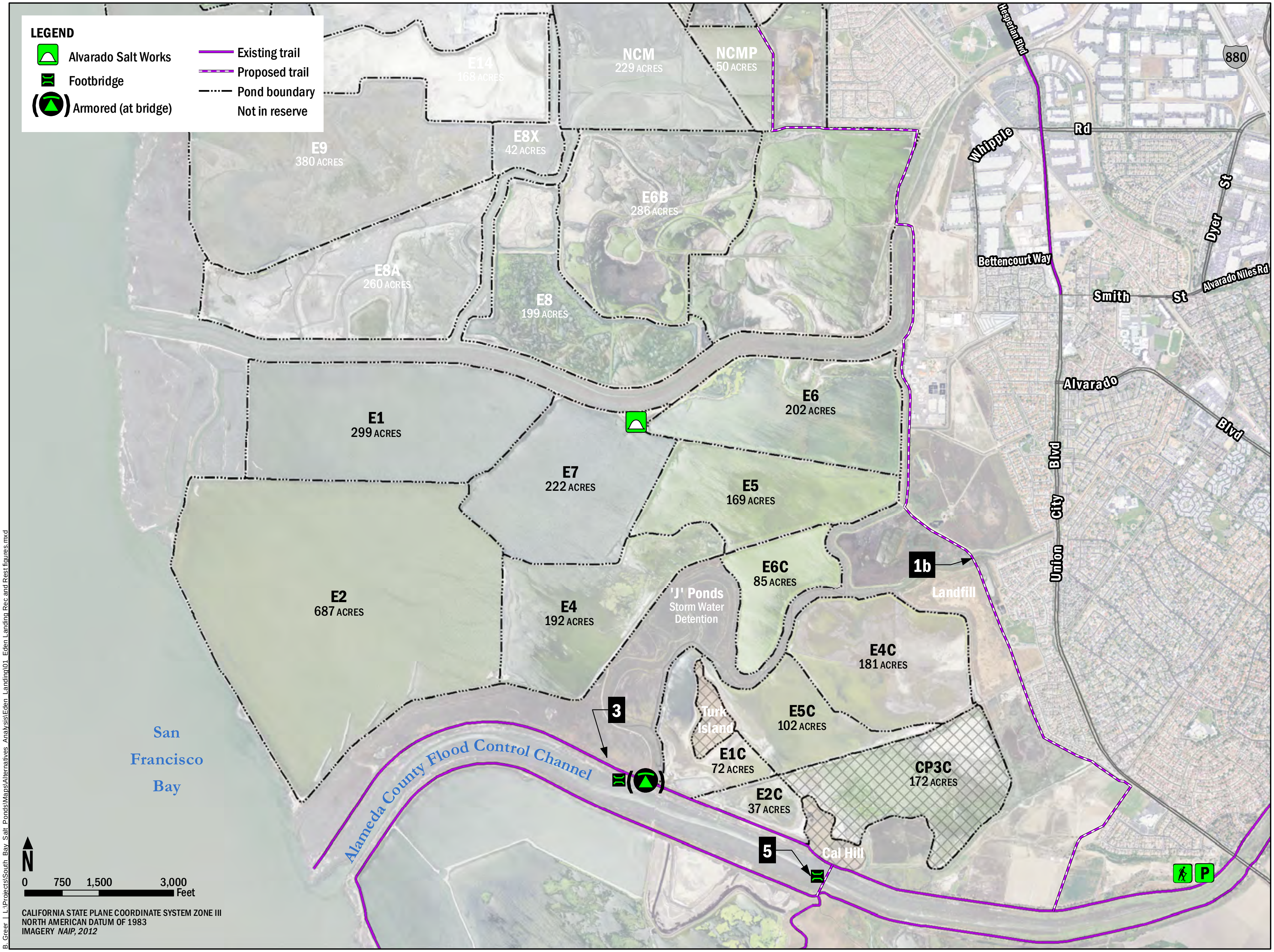
Rest5
Full Tidal Restoration (unphased)



URS

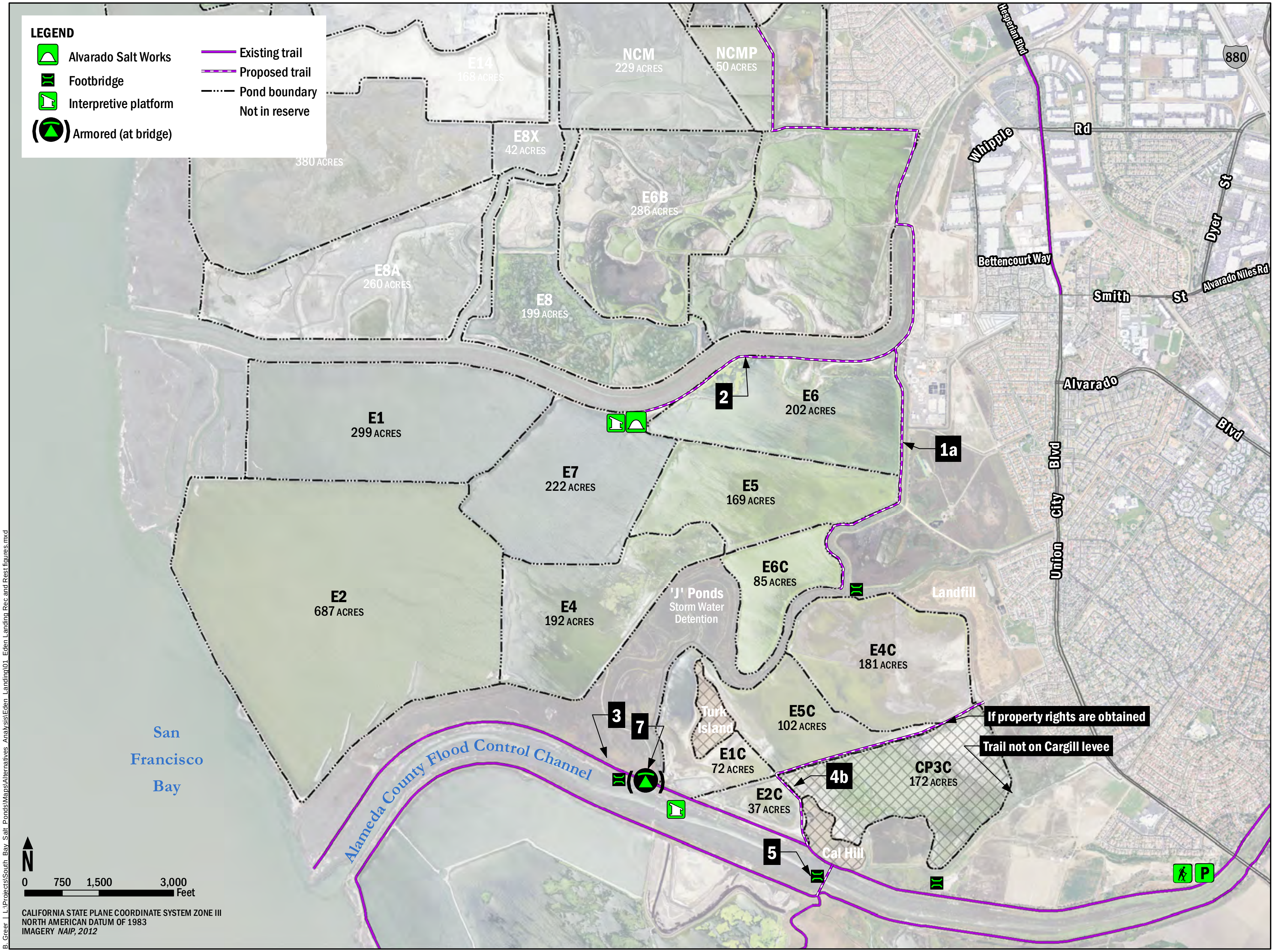
South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Access1
No Project / No Action Alternative



URS South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Access2
Least Recreation



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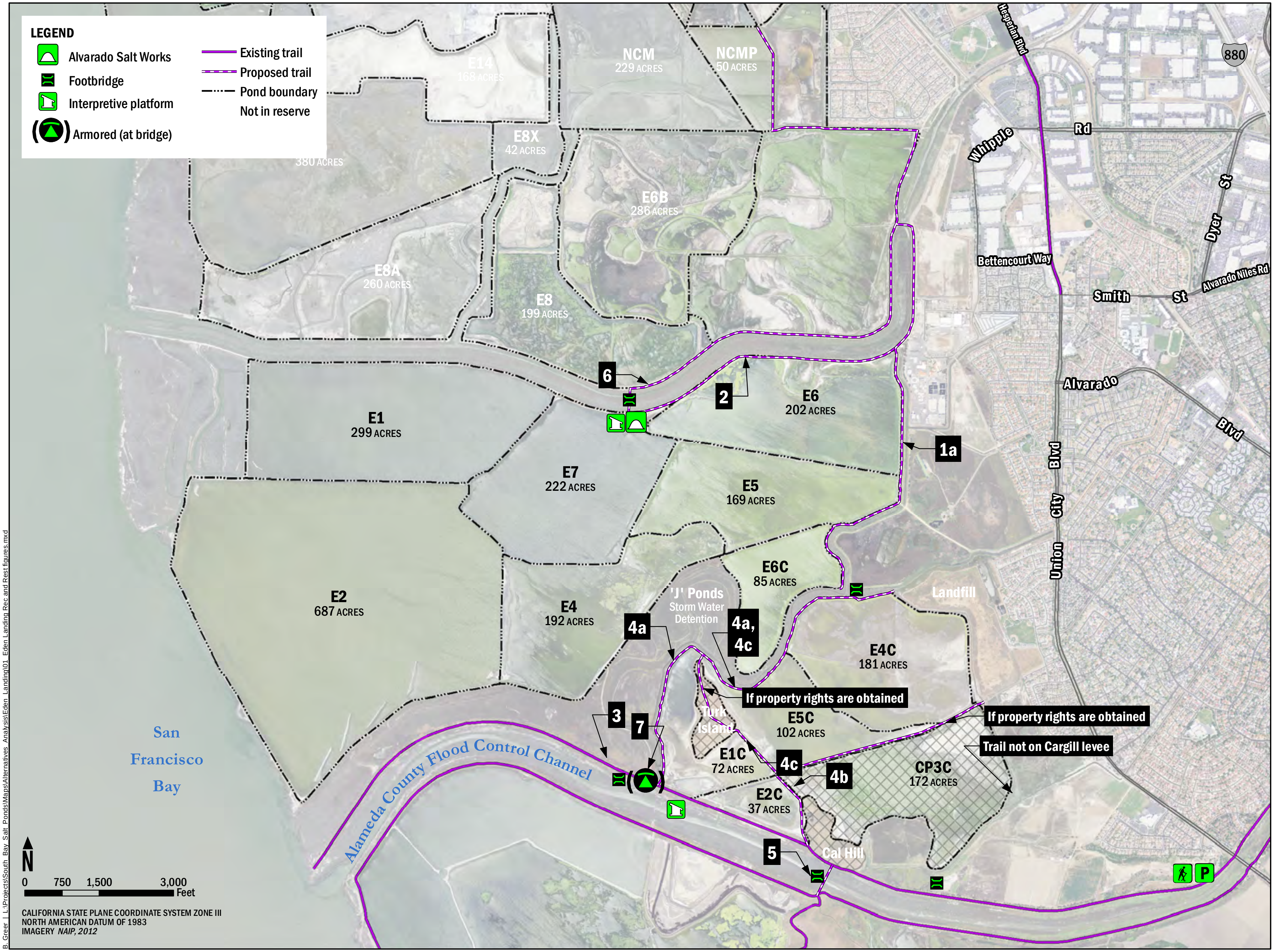
URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Access3
Medium Recreation



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URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Access4
Most Recreation

Table 3. Restoration and Flood Protection Preliminary Alternatives

Fig. #	Preliminary Alternative Name (or Description, Purpose)	Primary Flood Control	Inland Ponds	Southern Ponds	Multi-Staged Resto-ration	Mid-Complex Levee	UTZs	Habitat Enhance-ments	Breach Control	Accept Dredge/ Upland Material	Fresh Water from USD
Rest1	No Action (No-Project)	Current (1a)	As Is (4a)	As Is (5a)	No	No (2a)	No (3a)	No (9a, 10a, 11a)	No (6a)	No (7a)	No (8a)
Rest2	Flood Protection from Backside Levee	Backside Levee (1c)	Tidal Marsh (4b)	Tidal Marsh (5b)	No	No (2a)	Yes (3b, 3d)	Yes (9b, 10c)	Yes (6b)	Yes (7c, 7d)	Yes (8c, 8d)
Rest3	Mix of Tidal Marsh and Managed Ponds	Land Mass (1b)	Managed Ponds (4d)	Managed Ponds (5d)	Yes	Yes – Perm. (2c)	Yes (3c, 3e)	Yes (9b, 10b, 11b)	Yes (6b)	Yes (7b, 7c, 7d)	Yes (8b)
Rest4	Full Tidal Restoration (staged)	Land Mass (1b)	Tidal Marsh (4c then 4b)	Tidal Marsh (5c then 5b)	Yes	Yes – Temp. (2b)	Yes (3b, 3d)	Yes (9b, 10b/c, 11b)	Yes (6b)	Yes (7b, 7c, 7d)	Yes (8b then 8c, 8d)
Rest5	Full Tidal Restoration (one-stage)	Land Mass (1b)	Tidal Marsh (4b)	Tidal Marsh (5b)	No	No (2a)	Yes (3b, 3d)	Yes (9b, 10b, 11b)	Yes (6b)	Yes (7b, 7c, 7d)	Yes (8c, 8d)

Table 4. Recreation and Public Access Preliminary Alternatives

Fig. #	Preliminary Alternative Name (Description*)	Recreation/Public Access Options
Access1	No-Project / No-Action	None
Access2	Least Recreation	1b, 3
Access3	Medium Recreation	1a, 2, 3, 4b, 5, 7
Access4	Most Recreation	1a, 2, 3, 4a, 4c, 5, 6, 7

*The use of terms such as “least” or “most” recreation is not intended to reflect a preference for or bias toward any particular degree of recreation. Rather, the terms are descriptions of the number of recreation and public access components included in that assemblage of components.

These components (i.e., those specific to restoration and flood control or to recreation/ public access) were then combined to form alternatives that would address all three project goals. These alternatives are those that would be carried forward into conceptual design and for consideration in the DEIS/R that will be prepared for Phase 2 activities at Eden Landing.

Two other adjustments were made. First, the recreation and public access components were reconfigured according to land ownership as follows:

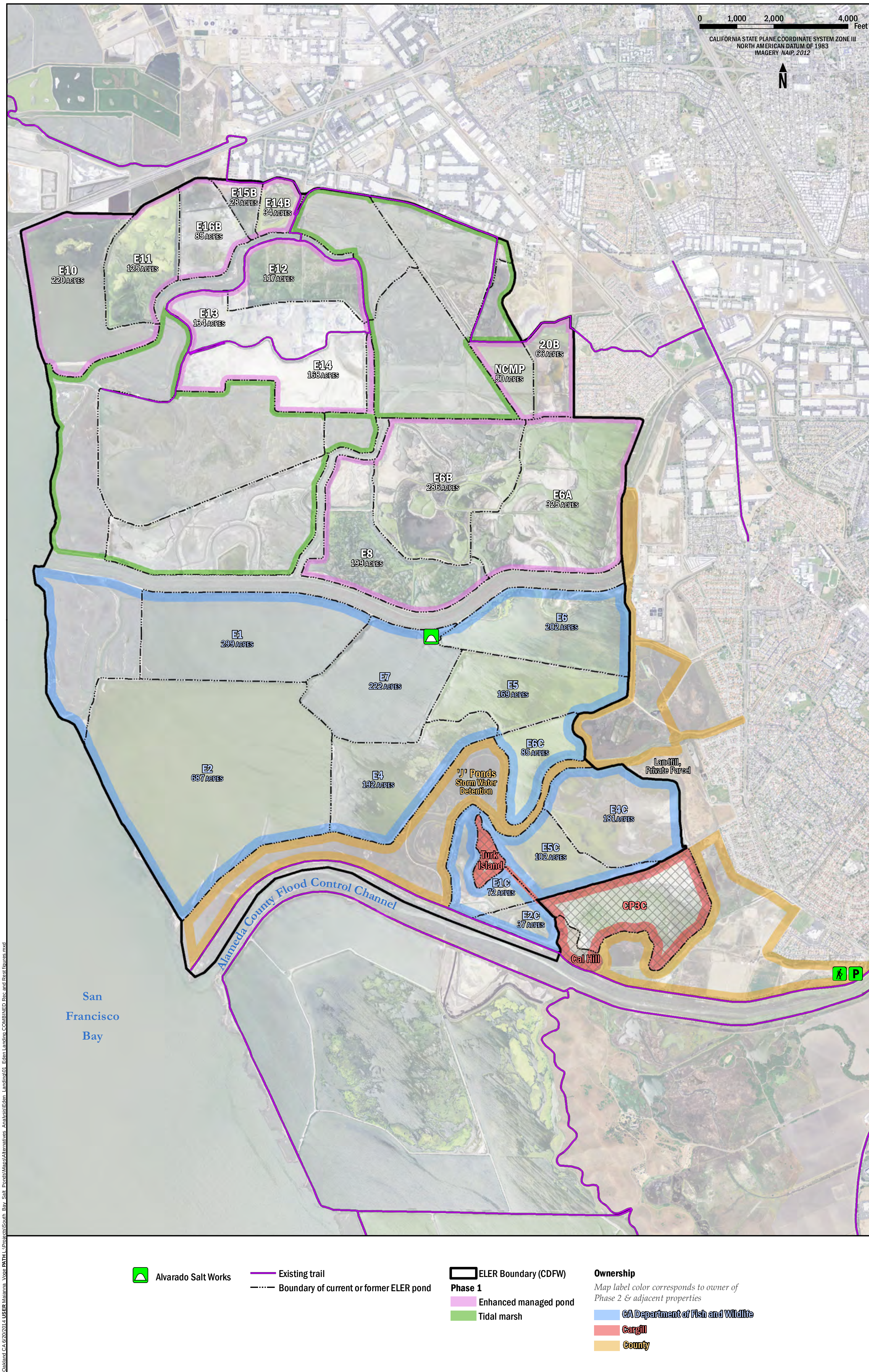
- No Action Alternative
- New recreation on Alameda County (and some CDFW) land
- New recreation entirely on CDFW land
- New recreation on lands acquired from Cargill & existing CDFW land

Note that the ownership was not used as a way to select the alternatives or the individual components. Rather, it was used as a way to group components and to illustrate how the range of options to include in the eventual selection of a Preferred Alternative would change based on the land that is available or that becomes available at that time.

Second, the backside levee and associated components in Rest2 were combined with the one-stage tidal recreation and associated components in Rest5. This combination reduced the number of preliminary alternatives to be carried forward without losing any individual component.

- No Action Alternative
- Flood protection from backside levee / one-stage tidal restoration
- Flood protection from land mass / mix of tidal marsh and managed ponds
- Flood protection from land mass / staged tidal restoration

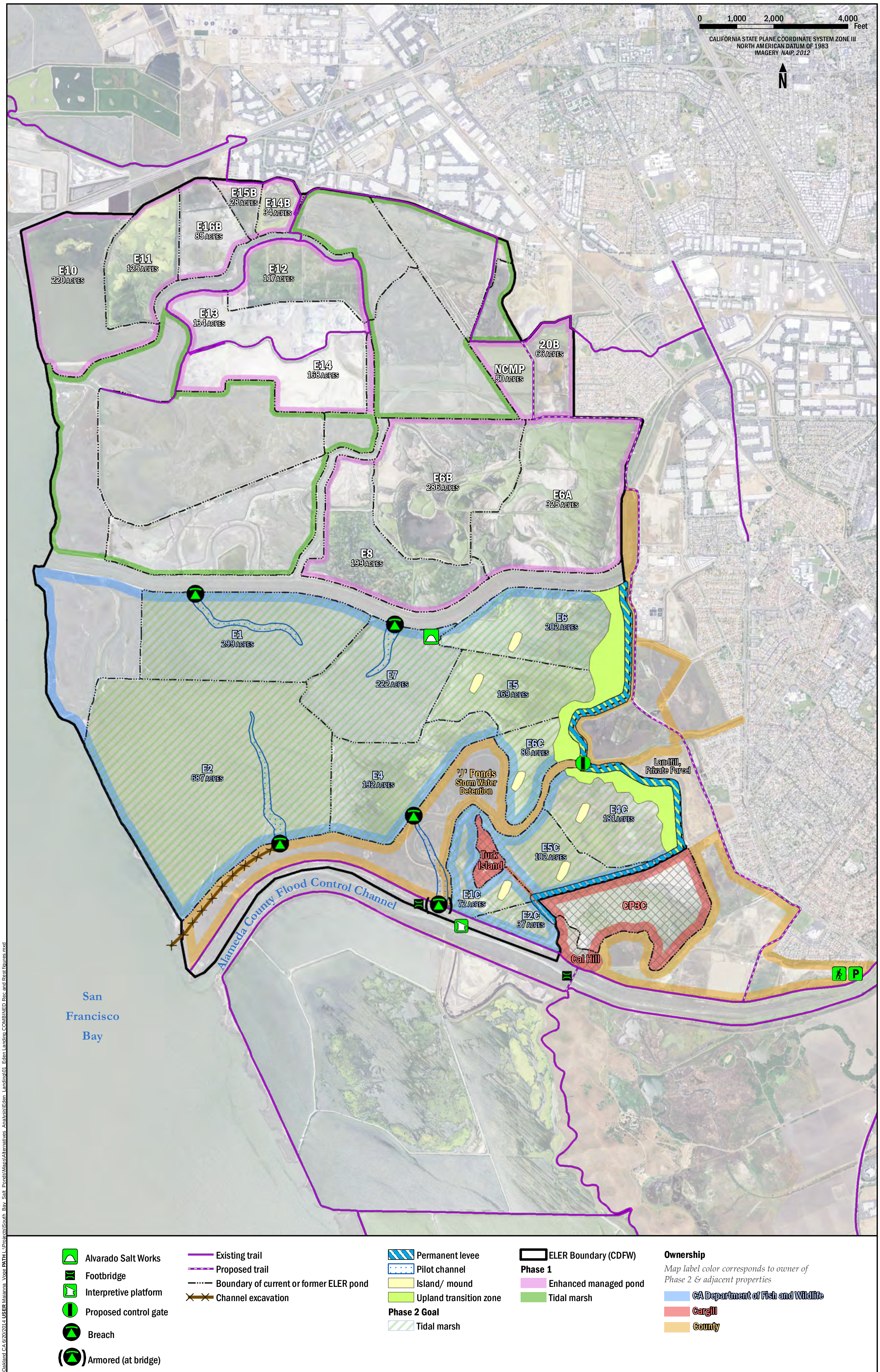
Following those adjustments, the components were then combined into three preliminary action alternatives and a No Action (No-Project) Alternative. These preliminary alternatives will be refined as needed and evaluated in the DEIS/R for Phase 2 at Eden Landing. They are named Eden1 through Eden4, as noted in Table 5, which describes these preliminary alternatives and the components that make them up. Maps of these preliminary alternatives are presented as Figures Eden1 through Eden4 on the pages that follow.



URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Eden1



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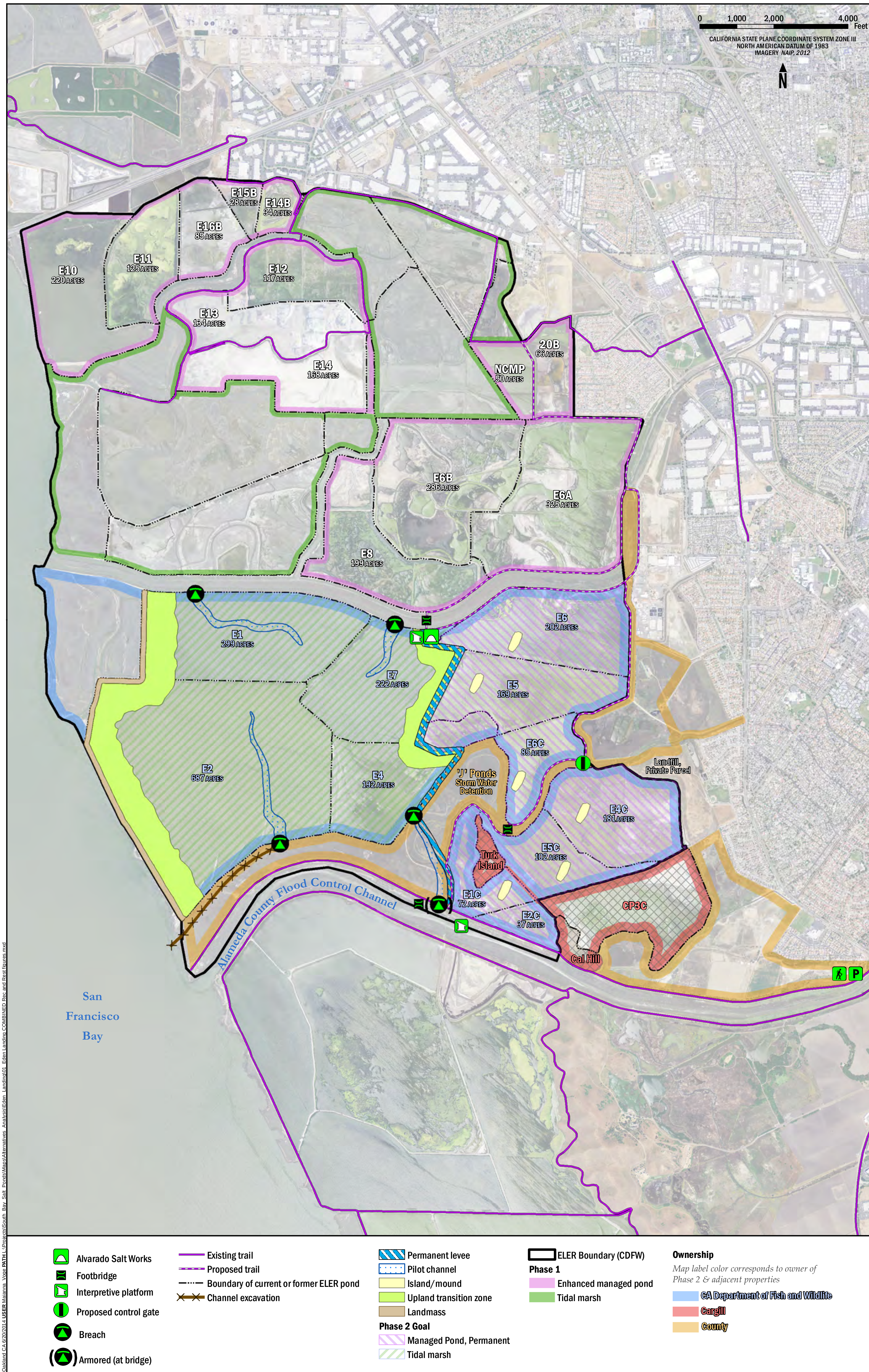
URS South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

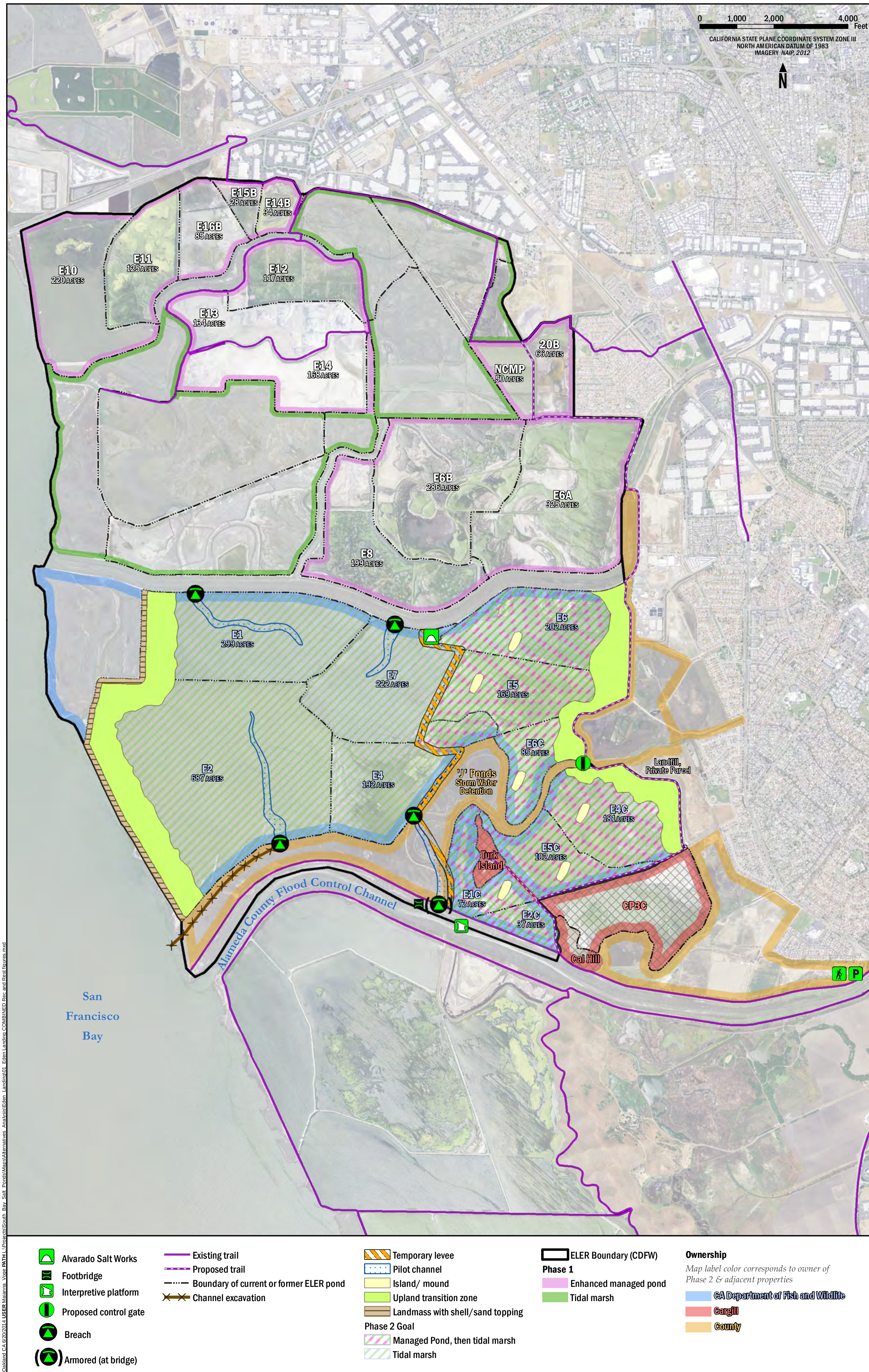
Eden2



URS

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Eden3



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South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Eden4

Table 5. Preliminary Alternatives for Evaluation in DEIS/R as SBSP Restoration Project, Phase 2 Actions at Eden Landing

Alternative Name / Figure #	Alternative Description	Primary Flood Control	Inland Ponds	Southern Ponds	Multi-Staged	Recreation Components	Mid-Complex Levee	UTZs	Habitat Enhance-ments	Breach Control	Accept Dredge/ Upland Material	Fresh Water from USD
Eden1	No-Project / No-Action	Current	As Is	As Is	No	None	No	No	No	No	No	No
Eden2	Backside Levee / One-stage Tidal Marsh Restoration / Recreation on Alameda Co. Land	Backside Levee	Tidal Marsh	Tidal Marsh	No	1b, 3, 5, 7	No	Inland Ponds and Southern Ponds	Deepwater channels; islands/marsh mounds	Armored at bridged breaches	For land mass, UTZs, and (if sufficient quantities available) for pond bottom elevation increases	On UTZs in Inland Ponds and Southern Ponds
Eden3	Mix of Tidal Marsh and Managed Ponds / Recreation on CDFW Land	Land Mass	Managed Ponds	Managed Ponds	Yes	1a, 2, 3, 4a, 6, 7	Yes - Permanent	Bay Ponds and Land Mass	Managed pond islands; shell topping on Land Mass			Into Inland Ponds for brackish marsh
Eden4	Two-staged Tidal Restoration / Recreation on CDFW land and land acquired from Cargill	Land Mass	Managed Pond, then Tidal Marsh	Tidal Marsh	Yes	1a, 4b, 4c, 7	Yes - Temporary	Inland Ponds, Southern Ponds, and Land Mass	Deepwater channels, islands/marsh mounts, shell topping on Land Mass			Into Inland Ponds (first for brackish marsh then for UTZ) and Southern Ponds (for UTZ)

Section 3. Alternative Development Process and Methods

Section 2 explained the development of the individual components and their rearrangement into preliminary alternatives. That discussion focused largely on the components, what they were intended to achieve, and their different combinations into preliminary alternatives for analysis in the DEIS/R. Other components and combinations of components not discussed in Section 2 had previously been created, developed, discussed, and eventually screened out as being unfeasible, prohibitively costly, or unacceptable from the position of one or more stakeholders.

In contrast, Section 3 presents the methods and processes by which some of the important details of these components were developed and selected. That is to say, Section 2 focuses on the "what," while Section 3 focuses on the "how" and "why." These ideas are presented in different sections to make the alternatives easier to find and compare with the maps that illustrate them, while separating out the details of the larger process, the modeling that went into certain aspects of the design, and so on.

The initial concepts for the preliminary conceptual designs were first drawn from the PEIS/R and the end state for each pond under Programmatic Alternative C. Then, the SBSP Restoration Project conducted an assessment of more recently developed ideas for enhancing restoration efforts by combining them with an innovative new idea for coastal flood risk protection—the land mass concept (discussed below)—and different staging options for restoration actions and recreation/public access improvements.

These options were explored and summarized in an Opportunities and Constraints Memorandum (O/C Memo), which was reviewed by the SBSP Restoration Project's Project Management Team (PMT) and key stakeholders within it, including Alameda County. The memorandum was made available to outside stakeholders through the SBSP Restoration Project website. The O/C Memo was revised based on stakeholder input and several revised conceptual designs were presented at the Project's annual Stakeholder Forum meeting.

In parallel with these efforts, the Alameda County Flood Control District (ACFCD) was conducting modeling and analysis on its own to determine the potential "solution space" for coastal flood risk protection using various combinations of breach numbers, sizes, and locations and what the associated tidal elevations were on the eastern edge of the Eden Landing complex. These models were run with and without a land mass in place.

The land mass, as has been presented at SBSP Restoration Project meetings, Stakeholder Forums, and other events by Rohin Saleh (MS, PE, Supervising Civil Engineer Watershed Planning Section, Alameda County Flood Control District), is a concept intended to obviate the need for a traditional backside levee placed directly between a developed area and a tidal body of water. The land mass would be a large earthen feature placed at some distance from the developed community, much like a barrier island is, with a smaller body of water between it and the developed land. The land mass would achieve with its large size (greater than 100 feet width at the top elevation and extending several thousand feet lengthwise) what more formally engineered levees achieve with tighter compaction of materials, footings, internal structures, and so on. ACFCD modeling efforts indicate that building a land mass on the western edge of Eden Landing and limited breaching of the levees within the interior of ELER to a small number of locations would dampen even the largest tidal flows and provide the necessary coastal flood risk protection to the developed lands behind the ponds. "Necessary", here, is defined as providing sufficient flood protection such that the Federal Emergency Management Agency (FEMA) does not place those properties in its 100-year flood event inundation maps. Importantly, ACFCD also maintains that this protection could be provided at a lower cost than what it would take to build an engineered levee near the developed area. These costs include but are not limited to land or easement acquisition, design, construction, and certification.

A goal of ACFCD's modeling was to determine feasible numbers, sizes, and locations of breaches in the exterior, perimeter, and interior levees that may be sufficient to provide adequate tidal exchange while maintaining coastal flood risk protection. Through this modeling, together with a series of workshops and meetings, the ACFCD, CDFW, and the SBSP Restoration Project were able to determine the feasibility of combined habitat restoration and coastal flood risk protection actions.

This determination led to the selection of up to four suitable sites for breaches on the northern and southern boundaries of southern Eden Landing. The breach locations were chosen to capitalize on the historical slough locations (as seen on digitized maps from before the levees were built for salt production). A breach in the northern ACFCC levee could be up to 100 feet wide and armored to allow a bridge to be placed on it (thus maintaining the current trail access to San Francisco Bay on that levee). The ACFCC armored breach would allow tidal flow from ACFCC into Pond E4 and provide adequate drainage. This breach may be fitted with a culvert, fish passage guide, or other infrastructure to help migrating steelhead or other salmonids enter and exit the high-value nursery and forage habitat that the pond interiors would become; this decision is for a future design stage and after additional negotiation with the National Marine Fisheries Service.

A second breach near the bay front would connect Pond E2 with the bay through an excavated channel through tidal marsh at the western end of the J-ponds. The excavated channel would be approximately 3,000 feet long.

The two northern breaches along Old Alameda Creek into Ponds E1 and E7 would not be armored or controlled, so their initial breach sizes (100 to 200 feet wide) could increase over time. Smaller breaches would be created along interior pond levees and could also be left unarmored and allowed to widen over time.

Working within that solution space, the Project then looked for habitat enhancements that could meet the habitat requirements of various species or guilds to provide habitat complexity and connectivity and to take advantage of opportunities for beneficial reuse of dredged material or material from upland construction projects or of treated water from the Union Sanitary District. The locations and combinations of these and other enhancements were discussed in Section 2.

The SBSP Restoration Project held a number of workshops to consider specific placement of the UTZs that had been previously described in the PEIS/R. Habitat islands for high-tide refugia and for use by nesting birds were added, drawing on the early results of the SBSP Project Science Program and applied studies. These islands would be created from grading remaining portions of levees or by constructing entirely new islands, but this decision is for a later design stage. The results from applied studies were discussed at workshops and were used to combine habitat features with suitable recreation and public access features.

The recreation and public access components were developed in collaboration with CDFW, the State Coastal Conservancy (SCC), EBRPD, the Association of Bay Area Governments (ABAG), other stakeholders, and the Project's contractors. Much like the restoration and habitat-enhancement features, the ideas for these components were initially pulled from the PEIS/R, included in the O/C Memo, and augmented with the Bay Trail Plan, the San Francisco Bay Conservation and Development Commission (BCDC) guidelines, and other sources. The recreation/public access components included some ideas that had not been previously considered because they are private land holdings that are not part of Eden Landing complex.

Several options would depend on the SBSP Restoration Project acquiring fee-title from Cargill for Pond 3C (also referred to as "CP3C") or uplands known as Turk Island and Cal Hill. The full list of many different recreation/public access components was presented at several working sessions. Some were infeasible because of access problems, expense, or conflict with restoration or flood control goals. Those were removed, but those that could become feasible if ownership changes or access easements were acquired were left in.

As noted in Section 2, consideration of all possible combinations of the restoration, recreation, and flood protection components would not have been feasible to present and analyze in an EIS/R. To narrow the options, CDFW, Alameda County, the PMT and other stakeholders decided to combine feasible restoration and coastal flood risk protection actions in such a way as to provide suitable locations for a reasonable range of recreation/public access improvements. This decision allowed development and screening of components and their combination into feasible preliminary alternatives that meet the SBSP Restoration Project goals to implement integrated habitat restoration, high-quality public access improvements, and coastal flood risk protection. These preliminary alternatives were presented to the PMT, the Stakeholder Forum, and other stakeholders; were refined as necessary; and combined into the most feasible preliminary alternatives for SBSP Restoration Project Phase 2 actions at Eden Landing. The combination of components required an analysis of feasibility (i.e., which restoration/public access components were technically possible to combine with the various restoration and flood control components), and the results of this analysis eliminated some, but not many, of the combinations.

Three primary combinations of restoration and flood control components were judged as most appropriate to include together: the backside levee would provide all necessary flood protection, so it was combined with full, one-stage tidal restoration. The land mass concept for flood protection allows tidal restoration with the improvement/construction of a mid-complex levee. That levee may be either temporary, which would leave the Inland Ponds and Southern Ponds as managed ponds for some time before they become tidal. If the Adaptive Management Plan findings show the need for more managed ponds, then the mid-complex levee could instead remain permanent, leaving the Inland Ponds, the Southern Ponds, or a subset of those ponds as enhanced managed ponds. These three main combinations of restoration and flood control components were then modified with enhancements like islands, UTZs, reuse of treated water, various fill materials, and so on.

Because it is extremely difficult and expensive to analyze more than three or four alternatives in an EIS/R, the process was similarly limited to three action alternatives for recreation/public access (ranging from new recreation opportunities on existing CDFW lands, on Alameda County lands, or a combination of both, as well as possible opportunities on other lands that may be acquired from Cargill). Those public access improvements were combined with the three primary action alternatives for habitat restoration and coastal flood risk protection to form the Preliminary Alternatives Eden2, Eden3, and Eden4, as described in Section 2. Combined with the No-Action/No-Project Alternative, this resulted in the preliminary Eden Landing Alternatives described in Section 2 and shown in the map figures. That list was presented to the PMT and stakeholders for their review, comment, and approval before being officially selected for analysis in the DEIS/R.

The DEIS/R will include evaluations and impact analyses of each of the individual components for habitat restoration, public access/recreation, and flood management. From those analyses and the comments received, some individual components of one or more of the draft alternatives may be selected and recombined into a Preferred Alternative for inclusion and analysis in the Final EIS/R.

APPENDIX C

PUBLIC SCOPING

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Scoping, or early consultation with persons or organizations concerned with the environmental effects of the project, is required when preparing a joint EIS/R. NEPA regulations Section 1506.6 requires that agencies make diligent efforts to involve the public in preparing and implementing their NEPA procedures. Pursuant to NEPA, a Notice of Intent to prepare an EIS/R for the South Bay Salt Pond Restoration Project, Phase 2 at Eden Landing was published in the Federal Register on June 20, 2016. Pursuant to CEQA Guidelines Section 15082, a Notice of Preparation was distributed to responsible agencies and the public on May 24, 2016. These notices announced a public comment period during which comments were received on the appropriate scope of the EIS/R. A public scoping meeting was held on June 30, 2016 to solicit comments on environmental issues to be addressed in the EIS/R. Scoping comments received during the scoping period, which ended July 20, 2016) are presented here.

I. Scoping Comment Letters Received (letters follow)

- Gayle Totton, Native American Heritage Commission
- Stacy Moskol
- L. Goldzband, Long-term Management Strategy
- Karen Vitulano, U.S. Environmental Protection Agency, Region IX
- Mike Giari, Port of Redwood City
- John Coleman, Bay Planning Commission
- Sandra Hamlat, East Bay Regional Parks District
- Carin High, Citizens Committee to Complete the Refuge
- Jeffrey Volberg, California Waterfowl
- Brenda Goeden, San Francisco Bay Conservation and Development Commission
- Lee Chien Huo, Bay Trail
- Erika Castillo, Alameda County Mosquito Abatement
- Ngoc Nguyen, Santa Clara Valley Water District

II. Summary Table of Scoping Comments

#	Commenter	Topic(s)
1	Gayle Totton, Native American Heritage Commission	Suggests including AB 52 and SB 18 consultation.
2	Stacy Moskol	Concerns about diving duck populations at E1 & E2, invasive plants islands clustering the marsh species and making them vulnerable to predators. Supports habitat transition zones.
3	L. Goldzband, LTMS; for other LTMS agencies and people	Supports beneficial reuse of dredge material, especially using Port of Redwood City and Port of Oakland material. References the Moffatt and Nichol feasibility study.
4	Karen Vitulano, EPA	Include sea-level rise (SLR) explicitly in the alternatives analysis. Include habitat transition zones. Place levee breaches at tidal marsh channels. Include beneficial reuse of dredged material. Identify and quantify all wetlands and waters of the U.S. and evaluate impacts on them. Discuss existing water quality conditions and how they would change: discuss runoff of sediments and pollutants, effects on fisheries, possible use of herbicides (including volumes, frequencies of application, etc.). Detailed discussion of ambient air conditions, NAAQS and nonattainment areas, estimate emissions from all project phases. Include evaluation of climate change effects from the project. They want details of invasive species control including costs. Requests details of funding costs for all project phases.

#	Commenter	Topic(s)
5	Mike Giari, Port of Redwood City	Supports beneficial reuse of dredge material, especially using Port of Redwood City. References the Moffatt and Nichol feasibility study.
6	John Coleman, Bay Planning Commission	Supports beneficial reuse of dredge material, especially using Port of Redwood City. References the Moffatt and Nichol feasibility study.
7	Sandra Hamlat, EBRPD	Points us to several applicable Master Plan policies that we need to include and address. Also expressed serious concern about the alternatives going onto city streets. They prefer the routes with bridges and then note that the bridges need to be drivable for 6,000-lb. maintenance trucks. The bridges that cross OAC and ACFCC need to have removable center sections so that the channels can be dredged.
8	Carin High, Citizens Committee to Complete the Refuge	General support; request to include the following information: baseline data of all species; mapping showing depths and salinities of ponds; existing management challenges that may affect the Phase 2 actions; species that may be displaced by the Phase 2 actions and possible places for them to go. Recommend phased tidal marsh restoration (Alt Eden D), along with an implementation timeline. Request details on how managed ponds would be managed; invasive species management; outboard levee; and root wads. Address species near the proposed public access trails and what measures could be used to protect those species.
9	Jeffrey Volberg, California Waterfowl	Would like to maintain or increase hunting opportunities at Eden Landing.
10	Brenda Goeden, BCDC	Clarifies BCDC jurisdiction at Eden Landing. Refers to the Bay Plan and its guidance. Fill in the bay for restoration. Encourages maximum feasible public access. Encourages beneficial reuse of dredged material. Recommends alternatives that consider SLR adaptation and other aspects of it. Public access features should be built to avoid future impacts from SLR. Include habitat features that protect shorelines.
11	Lee Chien Huo, Bay Trail	Support for Bay Trail inclusion at southern Eden Landing. Wants the Bay Trail as close to the bay as possible, has views of the bay, that is separated from streets, and that has connection with shoreline parks. To that end, they like the Route 1 trail through Eden Landing, and they want the bridge over the ACFCC.
12	Erika Castillo, Alameda County Mosquito Abatement	Support for including vector control in the EIS/R. Provided several measures to reduce possible future impacts from mosquitoes. Prefers unphased tidal marsh restoration (Alt Eden B) for best avoidance of mosquito issues.
13	Ngoc Nguyen, Santa Clara Valley Water District	Supports beneficial reuse of dredge material, especially using Port of Redwood City. References the Moffatt and Nichol feasibility study.

III. June 30, 2016, Scoping Meeting: Agenda and Sign-In Sheet

APPENDIX D

SOUTHERN EDEN LANDING PRELIMINARY DESIGN MEMORANDUM

ATTACHMENT 1. SOUTHERN EDEN LANDING RESTORATION PRELIMINARY DESIGN: 1D AND 2D HYDRODYNAMIC MODELING

ATTACHMENT 2. EDEN LANDING GEOTECHNICAL INVESTIGATION AND ANALYSES

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MEMORANDUM

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

FROM: AECOM

DATE: October 2016

RE: **Southern Eden Landing Restoration Preliminary Design**

1. INTRODUCTION

This memorandum documents the preliminary design of the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 actions at the southern half of the Eden Landing Ecological Reserve (ELER). For the purposes of this document, these ponds are referred to as the southern Eden Landing Ponds. This memorandum provides information for the CEQA and NEPA clearance, regulatory agency permitting processes, and a basis for the next, more detailed design phase.

1.1 Project Background

The ELER, and the southern Eden Landing Ponds within it, are owned and operated by the California Department of Fish and Wildlife (CDFW). This complex is near the eastern end of the San Mateo Bridge, south of State Route (SR) 92 as it passes through the City of Hayward in Alameda County (see Appendix A, Figure A-1). 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). Existing public access components include alignment of the San Francisco Bay Trail "spine" such that the trail connects from the existing SF Bay Trail within the northern half of ELER to the existing Alameda Creek Regional Trail operated by East Bay Regional Park District (EBRPD) along ACFCC.

The Phase 2 Eden Landing preliminary design, along with the rest of the SBSP Restoration Project, is managed by the SBSP Project Management Team (PMT), which includes the State Coastal Conservancy (SCC), U.S. Fish and Wildlife Service (USFWS), CDFW, Santa Clara Valley Water District (SCVWD), and others.

The Programmatic EIS/R for the SBSP Restoration Project (EDAW 2007) prescribed the initial framework under which restoration would proceed. In that document, program-level alternatives range from a restoration design of 50/50 tidal action/managed pond scenario for the entire restoration project area (Programmatic Alternative B) to a 90/10 tidal action/managed pond scenario for the entire restoration project area (Programmatic Alternative C) (see Appendix A, Figures A-11 and A-12). Programmatic Alternative C was selected and used as a foundation for project-level planning. Phase 1 of the project has since been completed, and involved restoring clusters of ponds at all three pond complexes. The Phase 1 actions at northern Eden Landing were completed in 2016 and included year-round and seasonal trails, a kayak launch, and a combination of tidal marsh restoration and enhancements to managed ponds to improve habitat for various species.

A design charrette was held May 13, 2010 to discuss conceptual restoration design ideas for Phase 2 of the project. Ideas proposed in the charrette document were further refined in coordination with the PMT to develop memoranda that described the opportunities and constraints associated with the construction or implementation of design ideas (URS 2012).

From this, through a year-long process of developing and screening alternatives, modeling the tidal and fluvial peak water elevations that would result, and assessing rational combinations of recreation and public access alternatives, three conceptual designs for action alternatives were developed and finalized with the PMT and other stakeholders including the Alameda County Flood Control and Water Conservation District (ACFCWCD), the EBRPD, and the Association of Bay Area Governments (ABAG). These three preliminary design concepts are described in detail in the Eden Landing Preliminary Alternatives Analysis Report (URS 2014a) and served as the basis for the alternatives proposed in this preliminary design memorandum.

This set of three alternatives was developed for conceptual design and analysis in the site-specific Public Draft EIS/EIR for Phase 2 at Eden Landing. Following the public comment period, a preferred alternative that best meets the project objectives while providing a cost-efficient design will be identified in the Final EIS/EIR. This memorandum describes the work conducted as part of the conceptual level design.

1.2 Organization and Scope

This memorandum presents the conceptual (approximately 10% to 30%) design for the Phase 2 action alternatives at the southern Eden Landing Ponds. It also briefly documents the design constraints and considerations that formed the basis for the conceptual design.

The preliminary design memorandum is organized as follows:

- Section 1: introduction, organization, and limitations
- Section 2: objectives, design constraints, and considerations
- Section 3: preliminary design analyses, including hydraulic modeling, salinity/water quality management approaches, and topography and geotechnical data
- Section 4: preliminary design including restoration components, construction implementation

1.3 Limitations

This memorandum provides a preliminary design based on information available at the time and professional judgment pending future engineering analyses. Future design decisions or additional information may change the findings, and corresponding professional judgments presented in this memo. Additional engineering 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, unless we have been given an opportunity to review and concur with such conclusions in writing.

2. OBJECTIVES, DESIGN CONSTRAINTS, AND CONSIDERATIONS

The southern Eden Landing Ponds includes 11 ponds that are described in three groups in this memorandum, 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 are the four large ponds closest to San Francisco Bay, bordered to the north by the OAC and to the south by Alameda County-owned property including the Alameda County Wetlands and the ACFCC.
- The Inland Ponds: Ponds E5, E6, and E6C are somewhat smaller ponds in the northeast portion of the complex. They are bordered to the north by OAC, to the east by the Union Sanitary District Waste Water Treatment Plant and Alameda County owned property (used by the Southern Alameda County Radio Controllers Aircraft Club), and to the south by an Alameda County-owned freshwater outflow channel and diked marsh areas known collectively as the “J-Ponds”.
- The Southern Ponds or C-Ponds: Also sometimes called the C-Ponds, the Ponds E1C, E2C, E4C, and E5C are in the southeastern portion of the complex. They are separated from the Inland Ponds and the Bay Ponds by the J-Ponds. The Southern Ponds are bordered to the east by property owned by Cargill (Cargill Pond 3C).

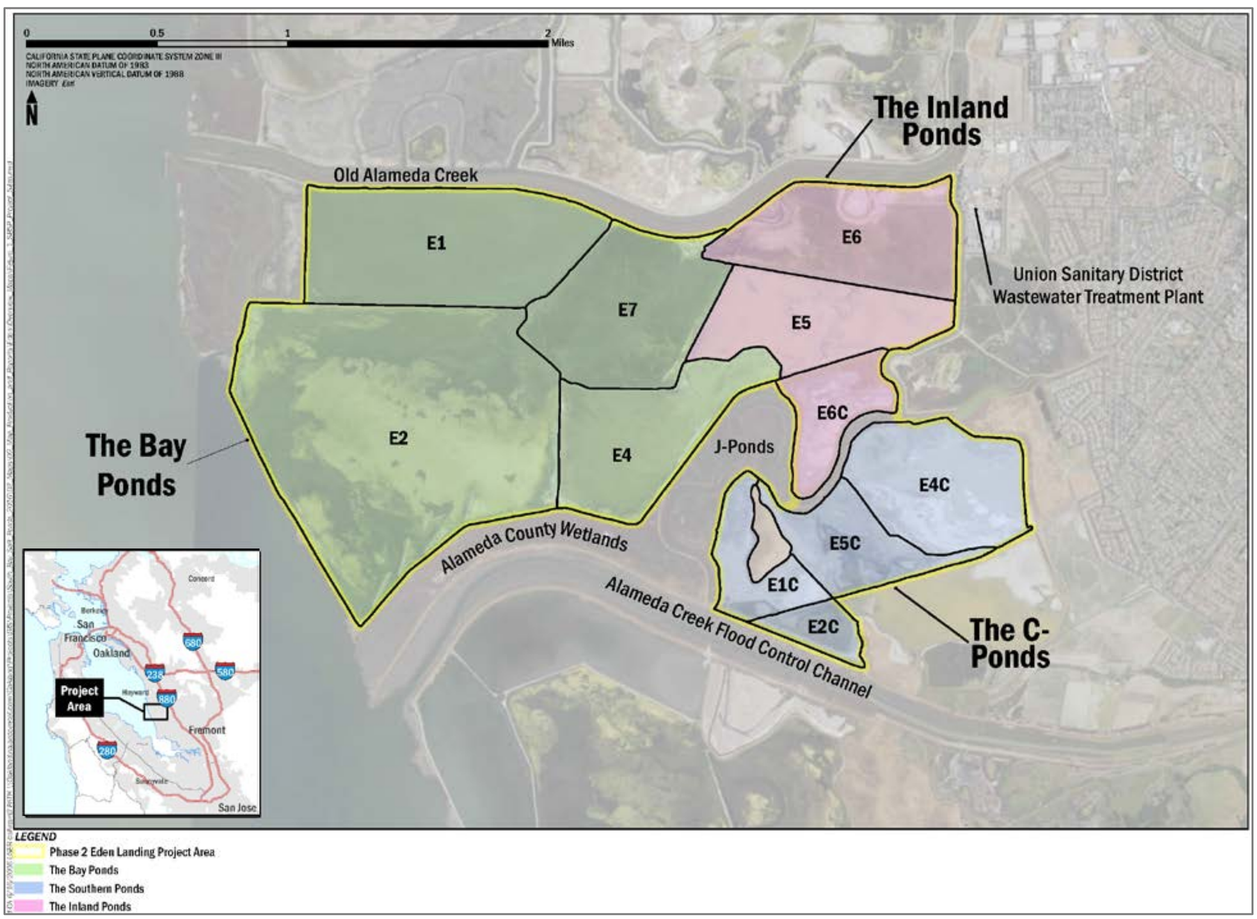

Figure 2.1. Project Vicinity Map

2.1 Objectives

The Phase 2 objectives for southern Eden Landing include a restoration action objective, a flood protection objective, and a recreation and public access objective. The objectives are summarized below.

- *To restore and enhance a mix of wetland habitats*. Restored habitat should be of sufficient size, function, and appropriate structure to promote restoration of special status species, support current migratory bird species that utilize existing salt ponds and associated structures, and increase abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components (EDAW et al. 2007). In particular, under both Programmatic Alternative B and Programmatic Alternative C, the entire southern Eden Landing ponds would all be restored to tidal marsh. Under Alternative D a portion of the Eden Landing ponds would be restored to tidal marsh.
- *To provide flood protection in the South Bay*. All project designs and features (e.g. levee improvements) would provide the same level of protection as existing features (i.e. match existing outboard levee elevations), and restored tidal marsh is expected to provide additional flood protection in the long-term. Additionally, at Eden Landing, the flood protection options must direct attention to the topic of fluvial flooding and drainage in the federal ACFCC and not increase current flood risk or reduce the level of protection currently provided against both tidal and fluvial flooding.
- *To provide wildlife-oriented public access and recreational opportunities*. Public access activities may include hiking, wildlife viewing, occasional hunting and fishing, and other wildlife-compatible recreational activities.

The restoration preliminary design summarized in this memorandum was developed taking into account several design constraints and considerations. Design constraints are limiting factors that must be considered while developing the design. Design considerations are issues that contribute to design formulation, but are not limiting factors.

2.2 Design constraints

- *Flooding.* The primary constraint on the introduction of tidal action is that – following breaching of the Eden Landing ponds – fluvial and/or tidal flooding could increase in the areas to the east of the ponds unless additional flood protection is provided. Thus, in order to introduce tidal action to southern Eden Landing, additional flood protection may be required. There are two primary options for coastal flood protection: a landside and a mid-complex levee. Multiple-staged (or phased) restoration could be supported by a mid-complex levee, which could be kept either permanently or temporarily for adaptive management purposes and/or monitoring wildlife response to restoration activities.
- *Breaches.* The number, size, and location of internal and external levee breaches were sized to allow tidal flows into the ponds at southern Eden Landing. AECOM performed hydrodynamic modeling to simulate regular daily tides as well as 100-year tides separately and in combination with peak storm water outflows (e.g., 100-year fluvial flows) under a range of breach scenarios. The alternatives developed and presented here satisfy the SBSP Restoration Project's goal of filling and draining the ponds with each day's tides while still providing the same or better flood protection against extreme tidal and fluvial elevations.

- *Federal Levees.* The ACFCC is bordered by the northern and southern Federal levees. Breaching the northern levee to connect the C-Ponds or the Alameda County Wetlands to the ACFCC would require a permit from the ACFCWCD, a Section 408 permit from the U.S. Army Corps of Engineers (USACE), potential de-authorization of a portion of the Federal project, and act of Congress to do so, and potential construction of additional Federal levees to protect against the 100-year fluvial flows. For these reasons, full breaches in the ACFCC were eliminated in the design and replaced with water control structure (i.e., culvert) options for the purpose of fish passage from ACFCC into southern Eden Landing.
- *Erosion and scour.* Reintroducing tidal flows into southern Eden Landing may result in erosion and scour of the OAC, which will be the main conveyance channel for the increased tidal prism entering southern Eden Landing. An undersized or non-hardened levee breach may result in erosion and scour of the remaining levee; in some places, this effect is a goal of the project. Tidal flows through new breaches are also expected to scour channels in the tidal marsh.
- *Volume of fill material.* The ability to construct habitat transition zones between pond bottoms and the adjacent uplands or levees, the bay-side levee, the mid-complex or landside levee, and extent of levee enhancements will depend on the volume and type of fill available for reuse. Fill material may come from onsite pilot channel excavation or from offsite (upland) construction sources. From a construction perspective, the excavation and placement of material is ideally balanced on a site understanding that different material types may not be used for all purposes.
- *Public access near sensitive species habitat.* Providing recreation and public access is a key goal of the project, but in some areas, public access may negatively affect wildlife using the area.
- *Permitting.* Impacts to wetlands, fill volumes, and impacts to special-status species could all affect the ability to obtain permits on the desired schedule.
- *Long-term maintenance.* Constructed features such as levees, trails, and water control structures will need to be maintained into the future.
- *Soils and hydrology*. Habitat restoration is in part dependent on the soils and hydrology of the site. Habitat opportunities are limited by the existing or constructed environmental conditions. Because the C-Ponds will continue to experience a muted tide due to the limited conveyance through culverts (as opposed to a breach), habitat establishment may be slower and of a different value compared to the other restored areas in the complex.
- *Existing rights-of-way, easements, and utilities.* These features may serve as constraints to installation of control structures, culverts, or other features. The preliminary design needs to consider rights-of-way owned by Alameda County, the Cargill Company, and others. These groups would need to be notified and included during the design process if construction would impact their properties, facilities, or rights-of-way.

2.3 Design considerations

- *Reconnection of historic sloughs.* The design breach locations consider the position and size of historic slough systems, taking advantage of areas where natural conditions may already exist for channel formation and water exchange capacity.
- *Sedimentation.* The existing levees, if left in place, will help slow the discharge of flood and tidal waters, increasing the potential for natural sedimentation within the ponds. This sedimentation is desired to raise pond surface elevations to levels that promote the growth of tidal marsh vegetation species and to provide resiliency for sea level rise.

- *Predation.* Levee breaches may serve to isolate habitat from upland predators. Connecting levees through bridges and trails for public access may limit this value.
- *Fish nursery habitat.* The tidal marsh habitat and channel network provided through the restoration of tidal action into the ponds could provide protected fish nursery habitat, ultimately increasing fish and populations and recreational opportunities for fishing and birding.
- *Habitat transition zone habitat.* The primary purpose of the habitat transition zones is to provide habitat complexity and refugia for tidal marsh wildlife species during high tides. In addition, the transitional area will provide resiliency to sea level rise and may provide opportunity for improved public education and outreach.
- *Western snowy plover.* Ponds in northern Eden Landing were enhanced for and are currently being managed to provide habitat for nesting western snowy plover. This provides some latitude for emphasizing tidal marsh restoration in southern Eden Landing. However, additional habitat to support this species may be able to be provided in the short-term (e.g., by leaving large sections of breached levees as habitat islands or by retaining some of the Inland Ponds or C-Ponds as managed ponds with habitat suitable for western snowy plover nesting). Long-term maintenance of these features would continue under a managed pond scenario, however would cease with the tidal marsh restoration scenario as the islands will either become vegetated or eroded over time. Substrate (e.g., shells, salt, sand), visual screens, and size and location (e.g., distance from trails) are all factors in the design of western snowy plover habitat.
- *Hydrology.* The number and location of the breaches and the decision to utilize and expand existing borrow ditches influences filling and draining of the restored ponds. Hydrology was assessed and modeled to inform the preliminary design.
- *Recreation.* Retained levees provide opportunity for recreation and educational signage describing the restoration. Breaches and sensitive wildlife habitat may limit locations for recreational opportunities.
- *Site access.* In addition to serving as recreational facilities, trails increase accessibility for scientists to study wildlife and conduct required monitoring, while also increasing access for maintenance and operational activities.
- *Water quality.* Adequate circulation, more of an issue in managed ponds than in the breached and tidal ponds planned for southern Eden Landing, remains necessary to prevent dissolved oxygen (DO) levels from dropping too low. Pond design elements, such as complete tidal drainage, can reduce the risk of low DO.
- *Material quality.* Imported fill material from upland sources will require environmental screening to assess suitability based on material type and constituent concentrations (USFWS 2012). A Quality Assurance Project Plan (QAPP) and permit will be required to accept upland fill placement at southern Eden Landing.

3. AVAILABLE DATA AND PRELIMINARY DESIGN ANALYSES

AECOM developed a two-dimensional hydrodynamic model using MIKE21 to refine the design of restoration features including levee breach and pilot channel dimensions, levee raising and lowering heights and locations, and culvert locations and numbers. A one-dimensional hydraulic model using HEC-RAS was also developed to efficiently analyze culvert sizes for the C-Ponds and Inland Ponds, as HEC-RAS has a more robust culvert routine and the model runtime is minutes instead of hours with MIKE21. Analyses were performed on the three project action alternatives (Alternatives Eden B, C and D). These alternatives are graphically depicted in Appendix A on Figures A-3, A-4, and A-5.

3.1 Site Topography and Project Datum

Table 3.1 lists the three sources of topographic and bathymetric data used in this preliminary design and associated modeling analysis.

Table 3.1. Topographic and Bathymetric Data

Data Source	Year Collected	Horizontal Datum	Vertical Datum	Projection
USGS 2010 SBSP Project LiDAR	2010	NAD83	NAVD88	UTM-10 10N
USGS 2005 SBSP Project Bathymetry	2003-2004	NAD83	NAVD88	CA State Plane III
USGS (Foxgrover et al.) 2007 South San Francisco Bay Bathymetry	2005	NAD83	NAVD88	UTM-10 10N

The available site topography is high-accuracy LiDAR from the 2010 USGS San Francisco Coastal LiDAR project (San Francisco, Marin, Solano, Contra Costa, Alameda, San Mateo, Santa Clara counties, California). The LiDAR data was collected between June 11, 2010 and July 11, 2010.

USGS (2005) also conducted a bathymetric survey of the SBSP Project pond complexes between August 2003 and March 2004 using a shallow-water sounding system to measure water depths with a precision of 1 cm. The system was comprised of a single beam echosounder, a differential global positioning system (DGPS) unit, and a laptop computer on a shallow-draft kayak with a trolling motor. Sample depths were converted to elevation based on water surface elevations recorded every 15-20 minutes at the ponds. Transects were made at 100 meter intervals.

The below water elevations in the Bay adjacent to the project site were obtained from 2005 Hydrographic Survey of South San Francisco Bay, California by Foxgrover et al. (USGS), published in 2007. These data consisted of xyz data collected using a single beam acoustic sampler.

The digital elevation point files used in the hydrodynamic model were generated by merging the three sets of data using the horizontal spatial reference system of NAD83, CA State Plane III meters and vertical datum NAVD88, meters.

The data from the bathymetric survey of the SBSP pond complexes and the bathymetric survey of the South Bay were inserted into areas with no LiDAR coverage (to prevent overlapping points between the datasets). To reduce the number of LiDAR points for use in CADD and the hydrodynamic model, the LiDAR datasets were down sampled using a “model key point” algorithm. “Model key points” are points selected to represent local topography and are not removed during a point thinning process. This algorithm thins the ground class within a user-specified vertical tolerance. Areas which exhibit a greater variation in the terrain have more model key points than in areas with a smaller variation in terrain (for example a parking lot). The vertical tolerance parameter required for the algorithm mandates that a triangulated irregular network (TIN) surface generated from the model key points would be within the user-specified distance of a TIN surface generated from the original ground points. The algorithm vertical tolerance parameter was set to 6 inches (0.15 meters) for this study.

In general, the project site is comprised of fairly flat pond bottoms separated by levees. Many of the levees have borrow ditches directly adjacent to them. Figure 3.1 depicts the distribution of pond bottom elevations of the three groups of ponds, most of which are between MSL and MHW. About half of the pond bottoms are 1 ½ to 2 feet or more below MHW and less than 10% are higher than MHW. The C-Ponds are the highest group of ponds, followed by the Inland and Bay Ponds.

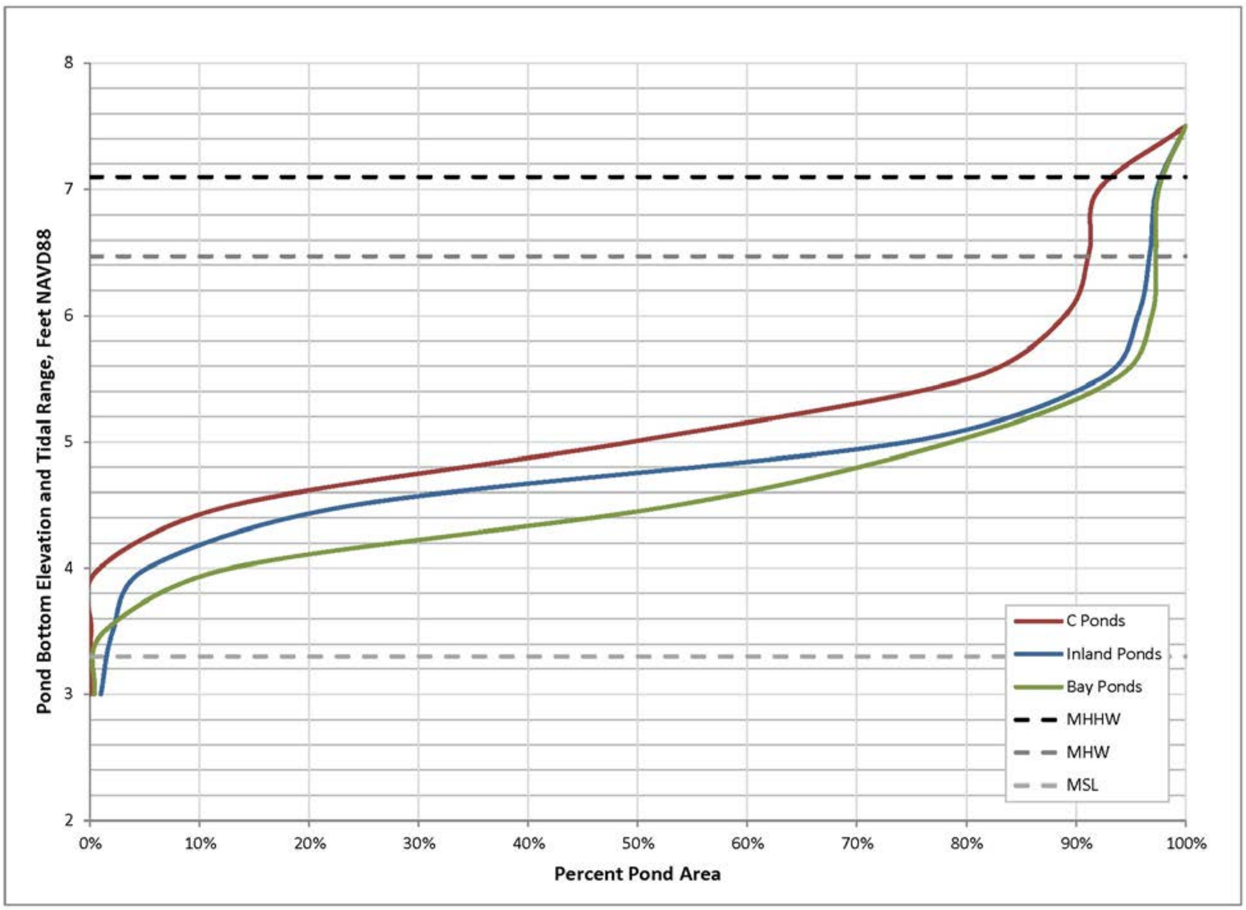

Figure 3.1. Average Pond Group Bottom Elevations

3.2 Historical Slough Network

The historical slough network (mid-1800s) in the project vicinity is shown in Figure 3.2 (SFEI 2013). As indicated by the red arrows and the dashed line, approximately half of the Bay and Inland Ponds historically drained to the south across the present-day Alameda County property and towards the present location of the ACFCC. A large part of Pond E2 drained directly to San Francisco Bay. Because breaching the federal ACFCC levees and the County's J Pond Stormwater Detention Basin levees is a design constraint, recreating the historical slough network was not possible. The proposed levee breach and pilot channel designs described in this memo attempt to align with historical slough features where possible.

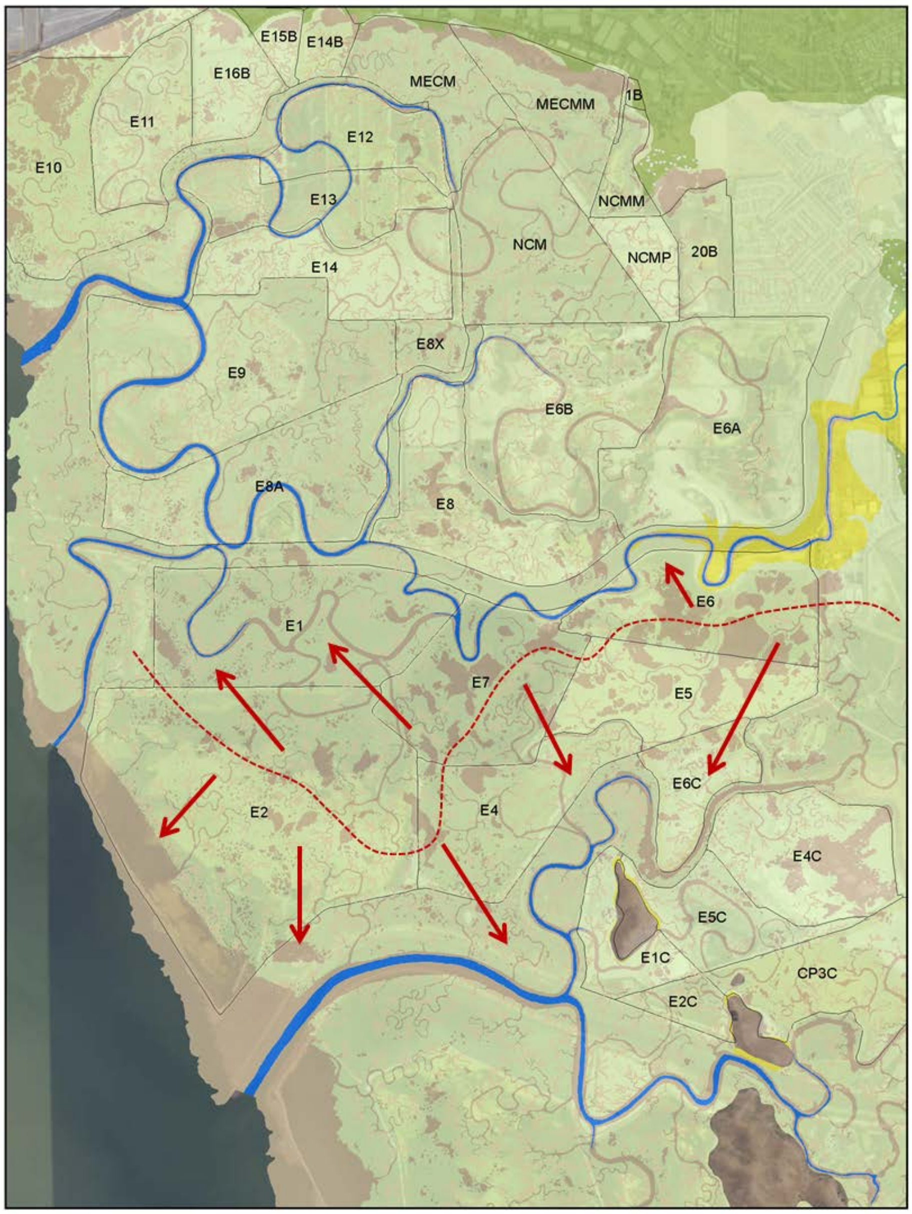

Figure 3.2. Historical Tidal Sloughs and Local Watershed Division

3.3 Hydrologic Data

Water Levels

Water surface elevations representative of tides at Eden Landing were obtained from the Redwood City tide gauge (NOAA gauge 9414523), located roughly 7 miles (11 kilometers) west of Eden Landing. The 6 minute daily tide data were obtained from National Oceanic Atmospheric Administration's Tides and Currents website (NOAA 2016) and converted to NAVD88 using NOAA conversions listed in AECOM 2016. Table 3.2 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. Sources of conversions from tidal to geodetic (NAVD88) datum are listed in Table 3.2.

Table 3.2. 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 2016	NOAA 2016

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

Riverine Discharge

The hydrographs for the 10- and 100-year discharge events from the OAC and ACFCC are shown in Figure 3.3. The hydrographs were obtained from DHI (2015). To confirm that the hydrographs represent a reasonable approximations to the 10- and 100-year events HEC-SSP V2.0 was used to analyze 56 years of peak flow data collected in the Federal Flood Control Channel at Union City (USGS # 11180700, located 0.2 mi upstream of Interstate 880 crossing). The analysis resulted in a 100-year peak flow of 30,410 cfs and a 10-year flow of 14, 116 cfs consistent with the hydrographs in DHI (2015). Sufficient data were not available for the OAC so the DHI (2015) values were assumed to also be sufficiently accurate for conceptual design.

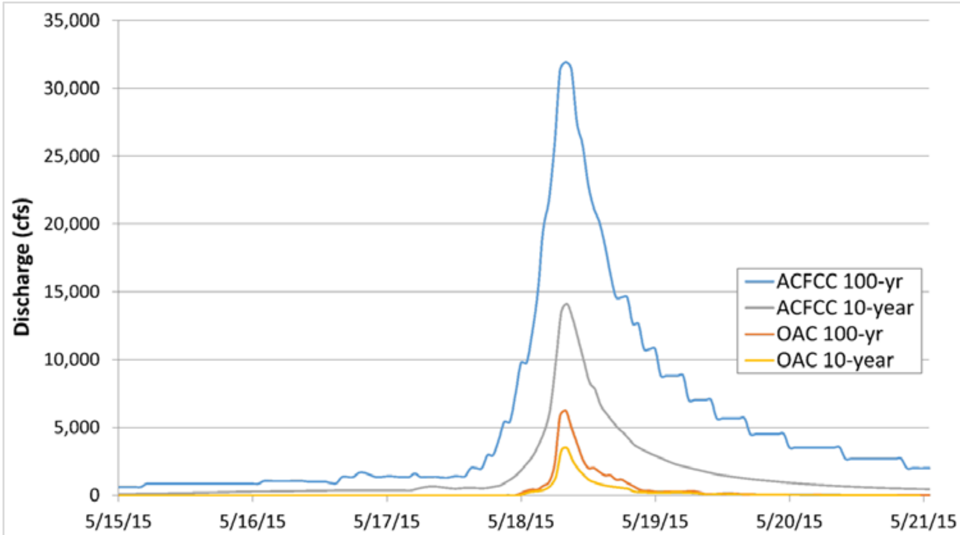

Figure 3.3. 10- and 100-year Discharge Event Hydrographs of ACFCC and OAC

3.4 Hydraulic Modeling

AECOM developed a two-dimensional hydrodynamic model using MIKE21 to refine the design of restoration features including levee breach and pilot channel dimensions, levee raising and lowering heights and locations, and culvert sizes and numbers. A one-dimensional hydraulic model using HEC-RAS was also developed to analyze culvert sizes for the C-Ponds and Inland Ponds. The methodology and results of both of these analyses are located in Attachment 1.

The result of the modeling analyses are the restoration features shown in Alternatives B, C, and D Figures (Appendix A Figures A-3, A-4, and A-5) and the content of this preliminary design beginning in Section 4 of this memo.

3.5 Water Quality Management Approaches in Managed Ponds

Currently the southern Eden Landing pond complex is managed to meet water quality objectives in accordance with the Initial Stewardship Plan, Phase 1 actions and the requirements of the Regional Water Quality Control Board's (RWQCB) Final Order, and other regulatory requirements (CDFW 2016). Alternatives C and D include continued pond management of the Inland and C-Ponds, where current management practices would continue and be supported with the installation of additional water control structures, many of which are replacements of existing deteriorating structures.

Described below are the hydraulic design criteria and managed pond operations for key water quality objectives including salinity, dissolved oxygen, and pH. The following information coincides with CDFW's (2016) System E2 and E2C Operation Plan and PWA's (2009) northern Eden Landing Pond E12/E13 Restoration Preliminary Design.

3.5.1 Hydraulic Design Criteria

The design of the managed pond hydraulics and water control structures for the Inland and C-Ponds in Alternatives C and D is based on the following design criteria.

1. Provide water level flexibility through the use of water control structures to adaptively adjust the depth and area of shallow water habitat.
2. Rely on gravity-driven flow where possible to manage water depths and meet discharge criteria. Minimize pumping.
3. During normal operations, reduce the amount and frequency of manual management of the ponds.
4. Provide management flexibility and redundant flow paths where possible.
5. Provide for supplemental approaches to salinity management when managed pond discharge criteria are not met through normal operations.

3.5.2 Managed Pond Operations

In the Inland Ponds, managed pond hydraulics are designed to flow from the OAC into Pond E6, through Pond E5 and E6C, using gravity-flow water control structures (with gravity flows driven by the tides). Water will exit in a similar path. Combination gates at both the inlets and outlets throughout the ponds will allow for flexibility in water level control.

In the C-Ponds, managed pond hydraulics are designed to flow from the ACFCC into Pond E2C, then through breaches and culverts into Ponds E2C, E5C, and CP3C. Pond E4C is fed with water from Pond E5C. Weekly readings of pond salinity and water levels, as well as visual structure inspections, will continue in ponds proposed for pond management.

3.5.2.1 Salinity

Salinity in the C-Ponds is currently maintained between 35-44 parts per thousand (ppt) over the summer, with a maximum discharge salinity of 44 ppt. Pond salinity is decreased by increasing pond inflows, in addition to circulation with adjacent seasonal ponds (such as E5C, E4C, and E1C). Whereas intake gates are usually kept fully open, discharge gate settings are routinely modified. By adjusting flow rates in this way, salinity throughout the ponds can be manipulated over a period of days to weeks.

The Inland Ponds are typically operated in the summer as seasonal (dry) or as “batch” ponds, which retain high salinity waters. Salinity in batch ponds typically increases from approximately 30 ppt in May to 120 ppt by November. Water levels and salinities in the Inland Ponds are controlled by inflows from the Bay Ponds. At the end of the evaporation season (typically October), higher salinity water from the Inland Ponds is rerouted through the Bay Ponds where it is diluted to below 44 ppt prior to discharge into the Bay. Circulation flows can also be reduced to increase pond salinity if intake salinity or pond salinity is low (~20 ppt at the intake or 30 ppt in the ponds).

These salinity management practices will continue in the C-Ponds and Inland Ponds for the managed pond Alternatives C and D.

3.5.2.2 Dissolved Oxygen

Currently the ponds are managed to retain water if dissolved oxygen falls below, or is anticipated to fall below, the trigger value of 3.3 mg/L. Discharge gates are adjusted on an approximately weekly basis. Pond E2C waters may be periodically drained into the adjacent seasonal ponds to improve circulation and water quality. Continued monitoring of receiving waters is being conducted to identify potential effects of low dissolved oxygen discharges and to evaluate whether the slough conditions meet water quality objectives. These operations will continue for the managed pond Alternatives C and D.

3.5.2.3 pH

Currently if the pH of the discharge is expected to fall outside the range of 6.5 to 8.5, an analysis of the impact of discharge pH on the receiving water waters may be performed; if the pH in the receiving waters approaches 9.0, samples may be collected from the receiving waters for analysis. Corrective measures (outlined above for dissolved oxygen and salinity) may be implemented to reduce pond discharges if it is determined that receiving water quality is being impacted. These operations will continue for the managed pond Alternatives C and D.

3.6 Geotechnical Analysis

There is limited existing geotechnical data available near the Eden Landing Pond Complex and no available subsurface data within the project area. Two previous geotechnical investigations conducted by ACFCWCD in 2011 and AMEC (2009) in 2010 provide some general geotechnical information near the project area.

The ACFCWCD's investigation of the ACFCC levees in 2011 included a series of soil borings, cone penetration tests (CPTs), and laboratory testing along the north levee of the ACFCC from the intersection of the creek and Union City Boulevard and extending downstream towards the Bay approximately 8,650 feet. The western extent of the investigation was near Pond CP3C, just south of Cal Hill. AMEC conducted an investigation in 2010 of the northern Eden Landing Ponds E8/E9 and E12/E13. The investigation included three soil borings, collection of bulk samples, and laboratory testing. Data from both of these investigations may aid in the design of project elements and provide general information about the subsurface conditions in the Eden complex, but due to the investigations occurring outside the project area, an additional investigation is recommended to support detailed design.

AECOM executed a subsurface investigation in the summer of 2016 to obtain data within the project area. Six soil borings were collected across the project area located in the vicinity of specific project elements such as levee raisings and bridge installations (see Figure 3.4). Soil samples were collected during drilling and analyzed based on the material encountered and the design inputs needed in the boring locations. Laboratory tests and geotechnical analysis are summarized in Attachment 2, Eden Landing Geotechnical Analysis.

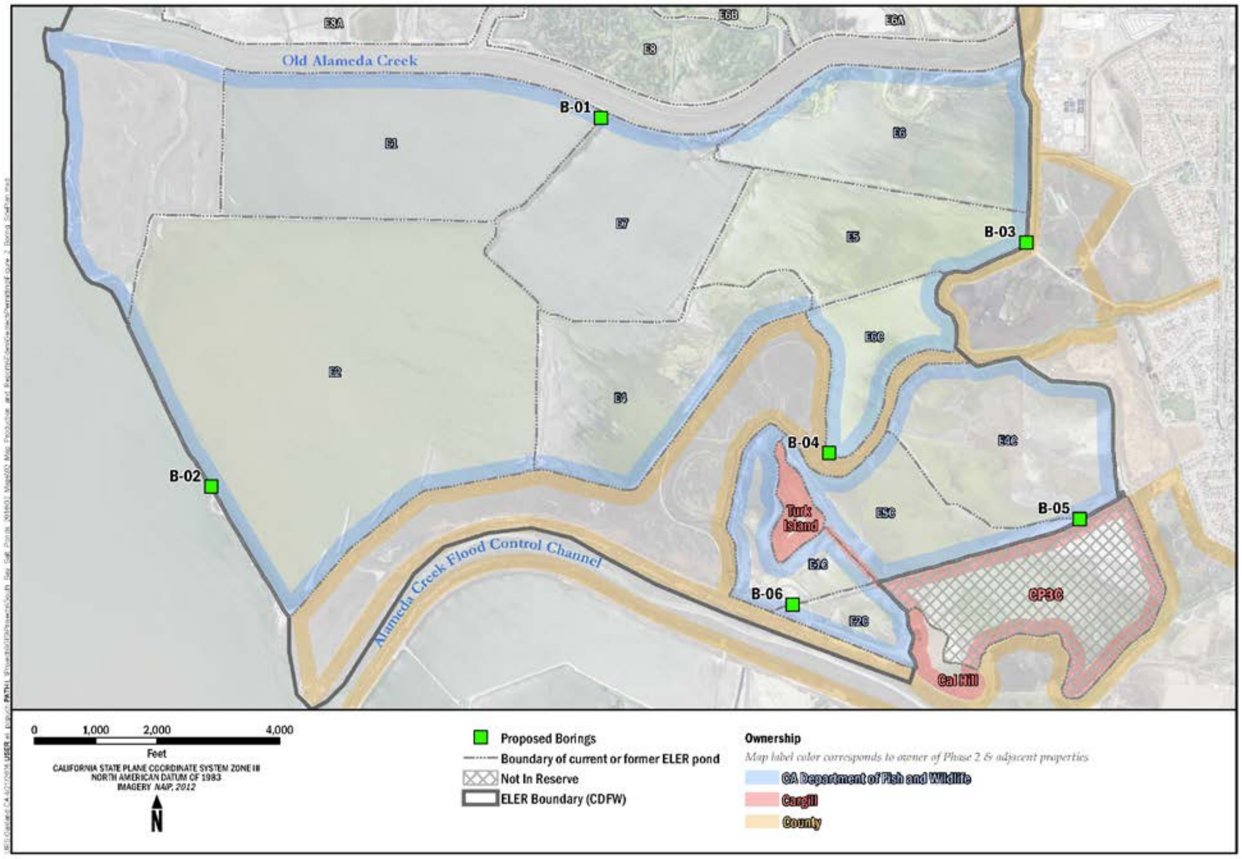

Figure 3.4. Boring Locations

During future design phases, this geotechnical data will be used to assess the existing levees' ability to support construction equipment, to perform seepage and slope stability analysis for raised levees, to evaluate the potential magnitude of consolidation settlement induced by placement of additional levee fill, and to design foundation elements for water control structures, bridge abutments, and boardwalks. Consolidation settlement will also be evaluated in areas designated for habitat transition zone fill; placement of additional fill may be required to account for settlement and achieve the proposed finished grade.

For this preliminary design, conservative assumptions were made for proposed slopes and bulking factors. Later design phases will be based off the geotechnical investigation results.

4. PRELIMINARY DESIGN

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

4.1 Preliminary Design Components

4.1.1 Site Clearance and Demolition Activities

Prior to performing construction activities, existing vegetation in areas that will be disturbed will be cleared and disposed of off-site. Similarly, sensitive vegetation located in the immediate construction areas will be handpicked, salvaged and replanted elsewhere, as appropriate.

Southern Eden Landing contains two stretches of existing power distribution lines, shown in Figure 4.1:

- Approximately 9,500 feet of power lines and 30 power poles located along the southern OAC levee.
- Approximately 8,000 feet of power lines and 35 power poles located in and near the C-Ponds, not including the span crossing the ACFCC.

In Alternatives B, C and D, the power lines and poles located along the southern OAC levee will be demolished as they currently power the pump between the OAC and Pond E1, which will be removed as part of the restoration project (in all alternatives). All other power lines and poles, including those located in and near the C-Ponds, will remain in place and operational. Proposed breaches (described in Section 4.1.4) in the C-Pond levees will not impact the current location of these lines and poles.

Existing water control structures are also shown in Figure 4.1 and detailed in Table 4.1. Two water control structures in the Island Ponds (E6 – E5 and E5 – E6C) and two water control structures in the C-Ponds (ACFCC – E2C and E2C – CP3C) will be replaced or repaired as necessary for continued operation. All remaining water control structures and associated support structures will be demolished. Demolished materials will be salvaged for re-use elsewhere, or disposed or recycled off-site. Levee breaches will be created where water control structures are removed, except at the E2-Bay, E6C-E4C, ACFCC-E1C, and E2C-E5C water control structures where the levee will be backfilled to match pre-removal heights and widths. Locations where the levees will be backfilled are noted in Table 4.1, and are a result of either maintaining flood control protection or access to Cargill or Alameda County property.

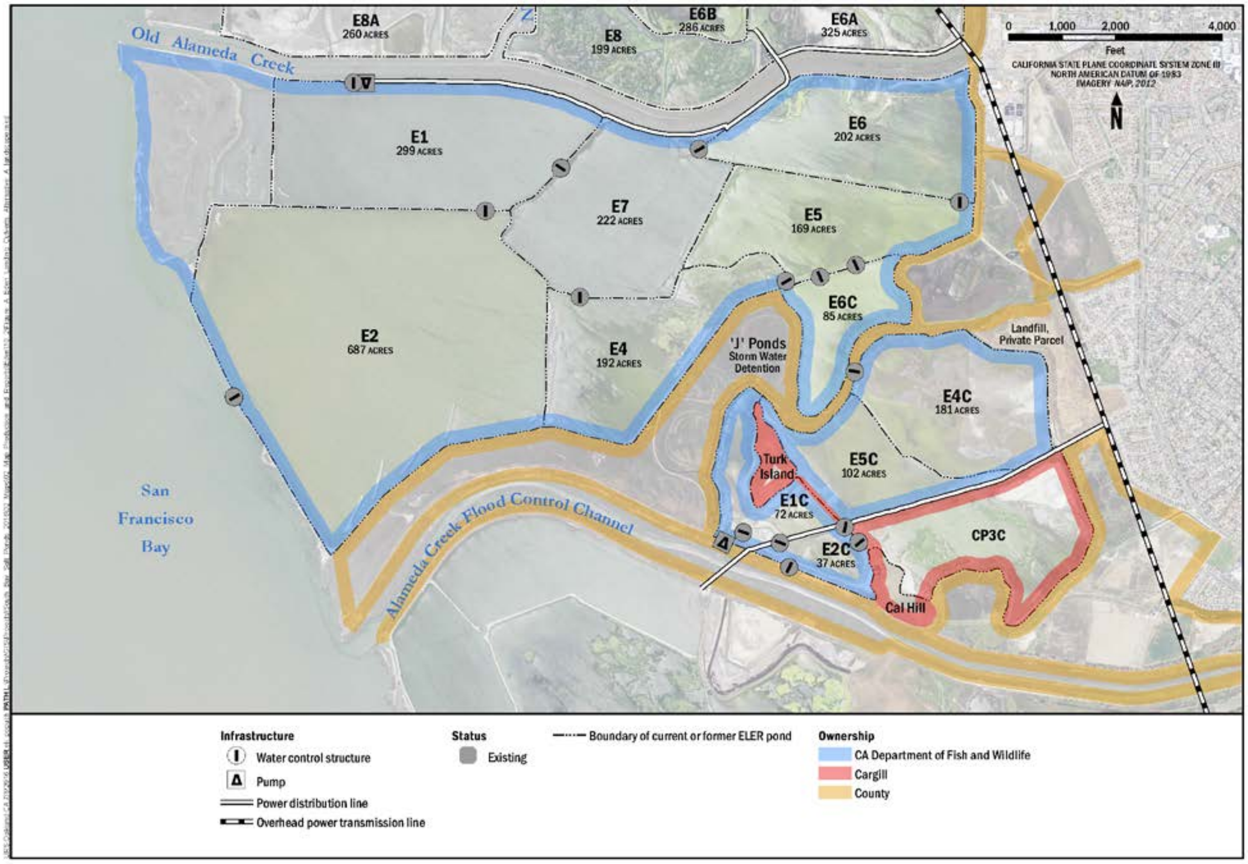

Figure 4.1. Existing Infrastructure

Table 4.1. Existing Water Control Structures Proposed Action

Location	Quantity	Size	Type	Action
E2 - Bay	2	48 in.	Intake/discharge gates	Demolish (backfill levee)
OAC - E1	4	48 in.	(2) Intake/discharge open pipes/combo gates	Demolish
			(2) Intake/discharge slide gates/flap gates	
OAC - E1	1	10,000 gpm	Pump (#1 Baumberg Intake)	
E1 - E2	1	48 in.	Slide gate	
E1 - E7	1	48 in.	Slide gate	
E7 - E4	1	48 in.	Slide gate	
E7 - E6	1	48 in.	Slide gate	
E4 - E5	1	48 in.	Combo gate	
E6 - E5	4	30 in.	Wood gates	Demolish (Alt. B) or Replace/repair (Alt. C & D)
E5 - E6C	2	36 in.	Combo gates	
E6C - E4C	2	30 in.	Siphons (not operable)	Demolish (backfill levee)
E2C - E5C	1	36 in.	Combo gate	
ACFCC - E1C	1	7,660 gpm	Pump (Cal Hill Intake) (not operable)	
ACFCC - E2C	2	48 in.	Intake/discharge combo gates	Replace/repair
E2C - CP3C	1	48 in.	Slide gate	
E2C - E2C donut	1	36 in.	Unknown (open)	Demolish
E1C - E2C donut	1 1	24 in. 10,000 gpm	Unknown (not operable) Pump (Call Hill Transfer) (not operable)	

4.1.2 Levee Raising

The design goals of levee raising include providing an equal or improved level of flood protection relative to existing conditions, providing support for Bay Trail construction, and providing support for high refuge habitat and adjacent habitat transition zones. Table 4.2 summarizes the location and length of raised levees for each alternative. Based on the hydrodynamic flood modeling summarized in Attachment 1, a raised levee elevation of 12 feet NAVD88 will provide equal or better flood protection, compared to existing conditions, thereby meeting the project flood protection objective. This is 5 feet above MHHW and provides a freeboard of about 1.5 to 2.5 feet above the maximum water surface elevation within the ponds during the design hydrologic events. Some levees will be raised also to 12 feet NAVD88 for construction of recreational trails and adjacent habitat transition zones, which are detailed in Section 4.1.9 and Section 4.1.5, respectively. Appendix A, Figures A-3, A-4, and A-5 contain plan views of these levee improvements.

Table 4.2. Proposed Raised Levees

Levee Raising Location	**Alternative B** Linear Feet	**Alternative C** Linear Feet	**Alternative D** Linear Feet	**Purpose**
Inland Ponds Landside Levee	6,000	-	6,000	Flood Protection
C-Pond Landside Levee	10,500	-	10,500	Flood Protection
Bay Trail Levee (E6C-ACFCC)	7,500	-	-	Bay Trail
Bay Levee	-	5,900	10,900	Habitat
Mid Complex Levee	-	12,900	12,900	Habitat
Total	24,000	18,800	40,300	

Design:

- Top elevation: Raised levees will have a minimum crest elevation of 12 feet NAVD88.
- Top width: Raised levees will have a minimum crest width of 12 feet.
- Side slope: The improved levees will have side slopes of 4:1 (H:V).

A typical cross-section of the proposed levee raising is shown in Figure 4.2.

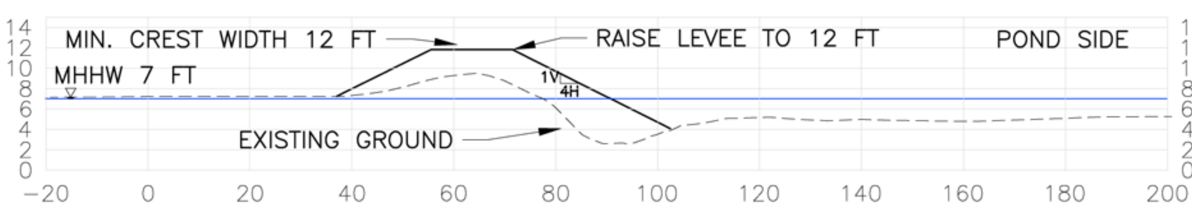

Figure 4.2. Proposed Levee Raising – Typical Section

Material for levee raising may be sourced on-site from levee lowering, levee breaching, pilot channel excavations, existing levee reshaping, and/or from off-site upland re-use materials. Levee lowering to MHHW may coincide with levee raising, without significant volumes of water entering the Bay and Inland Ponds (which will not be drained for construction).

Additional detail on the raised levees follows. Plan views are clipped from Figures A-3, A-4, and A-5 in Appendix A.

Inland Ponds Landside Levee

(Alternative B and D) Approximately 6,000 feet of perimeter levee raising, spanning from the northeast corner of Pond E6, to the south and west along Ponds E5 and E6C, and ending at the eastern corner of Pond E6C. The levees to be raised all border Alameda County property. Figure 4.3 shows the plan view (of Alt. B only), and Figure 4.4 shows profile with the existing levee (as of the 2010 LiDAR) with the proposed height increase to 12 feet NAVD88.

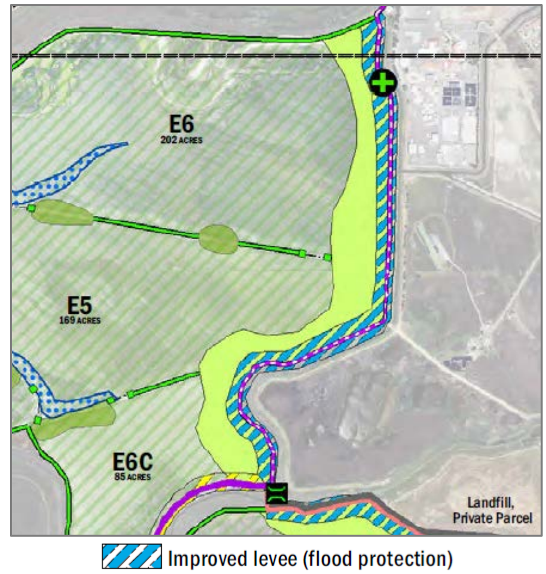

Figure 4.3. Plan of Inland Ponds Landside Levee (Alt. B)

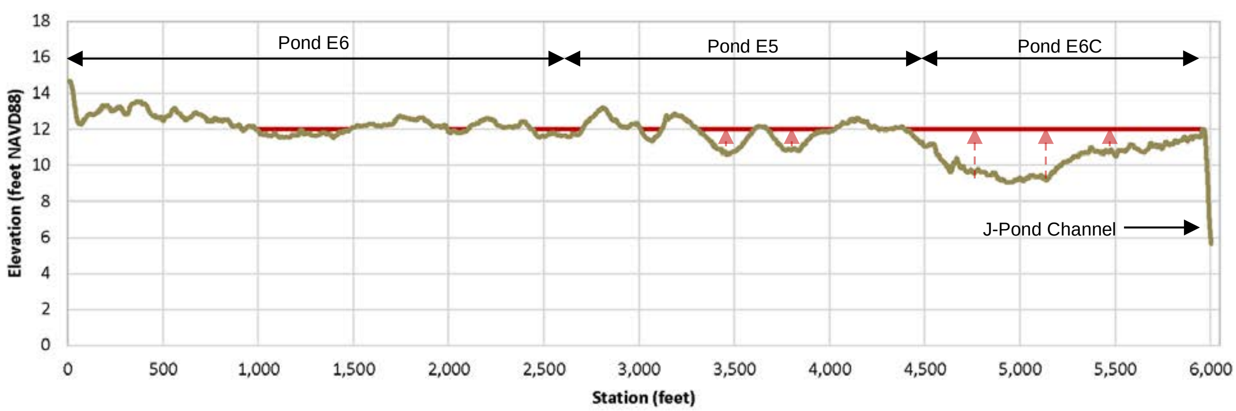

Figure 4.4. Raised Levee Profile of Inland Ponds Landside Levee

C-Ponds Landside Levee

(Alternative B and D) Approximately 10,500 feet of perimeter levee raising along the landside portion of the C-Ponds, spanning from the northern corner of Pond E4C (where the E6C levee raising ends), to the south and east around Pond E4C and then west and south along Pond CP3C ending at Cal Hill. Also includes the existing Cargill access levee to Turk Island. The eastern levee to be raised near Ponds E4C borders Alameda County property. The southern levees to be raised near Ponds E4C, E5C, and E2C border Cargill's Pond CP3C. Figure 4.4 shows the plan view (of Alt. B only) and Figure 4.6 shows the profile with the existing levee (as of the 2010 LiDAR) with the proposed height increase to 12 feet NAVD88.

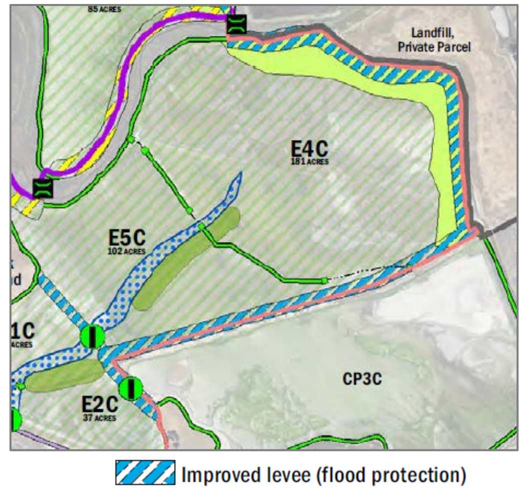

Figure 4.5. Plan of C-Ponds Landside Levee (Alt. B)

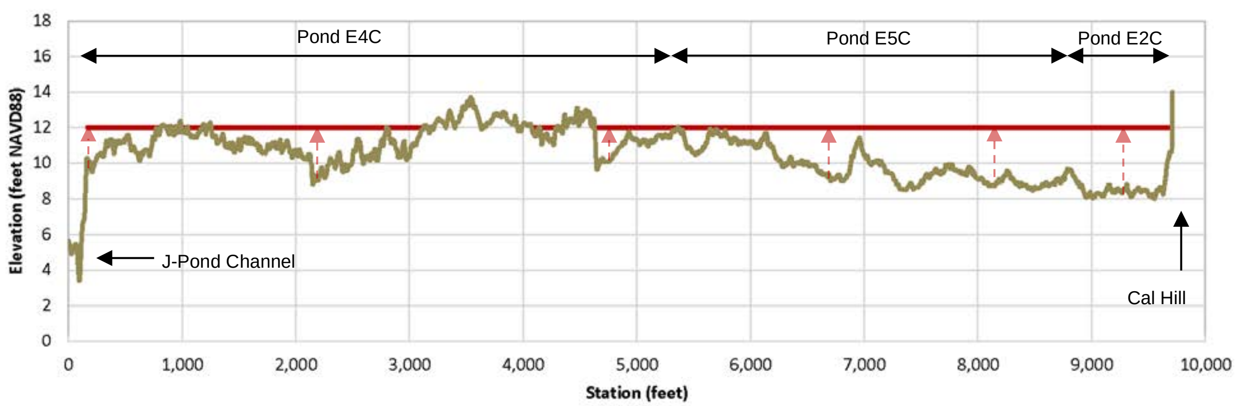

Figure 4.6. Raised Levee Profile of C-Ponds Landside Levee

<u>Bay Trail Levee (E6C – ACFCC)</u>

(Alternative B) Approximately 7,500 feet of perimeter levee raising along the southern E6C levee and northern E5C and E1C levees will provide a raised base levee for the Bay Trail; this levee improvement provides no flood protection. The proposed levee alignment falls all on CDFW property, except for a connecting bridge over Alameda County's J-Ponds. Figure 4.7 shows the plan view and Figure 4.8 shows the profile with the existing levee (as of the 2010 LiDAR) with the proposed height increase to 12 feet NAVD88.

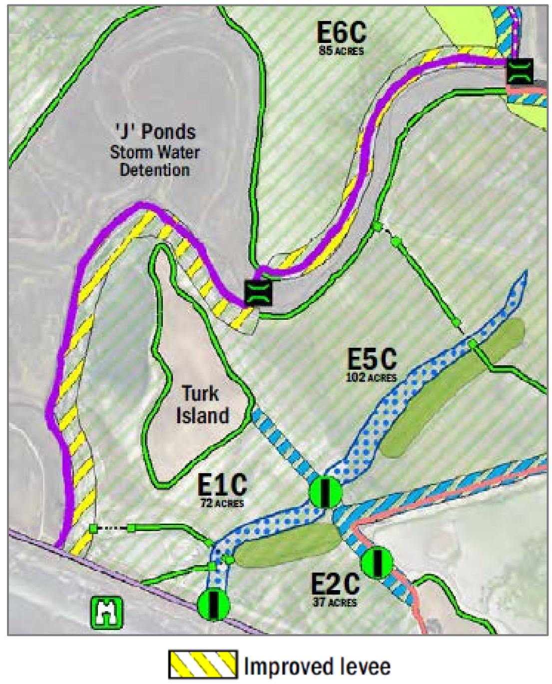

Figure 4.7. Plan of Bay Trail Levee (E6C – ACFCC) (Alt. B)

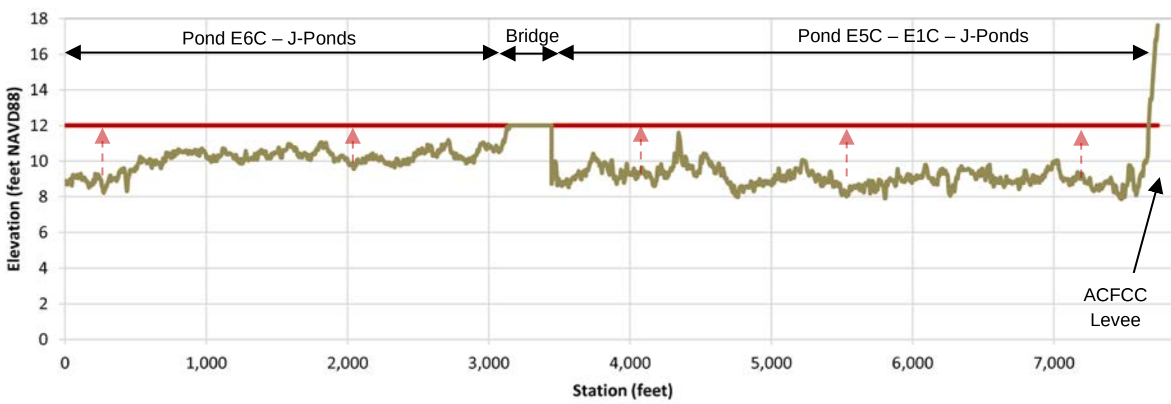

Figure 4.8. Raised Levee Profile of Bay Trail Levee (E6C – ACFCC)

<u>Bay Levee</u>

(Alternative C and D) Approximately 5,900 (Alt. C) and 10,900 (Alt. D) feet of perimeter levee raising along the western bay front levees of Ponds E1 and E2. The levees to be raised border the Cargill Mitigation Marsh, Southern Whale's Tale Marsh, and San Francisco Bay. Figure 4.9 shows the plan views and Figure 4.10 shows the existing levee (as of the 2010 LiDAR) with the proposed height increase to 12 feet NAVD88. The profile view shows that in Alternative C, little raising will be performed because the existing levee is near or above the 12-foot design elevation.

The Bay Levee will be raised for habitat enhancement, not flood protection. The Eden Landing Preliminary Alternatives Analysis (URS 2014a) proposed raising the levee located between the Bay and Ponds E1 and E2. Hydrodynamic modeling results described in Attachment 1 show that tide waters will enter southern Eden Landing through the OAC breaches and lowered levees, and therefore increasing the height of the Bay levee will not reduce the water surface elevation within the Bay and Inland Ponds. Raising this Bay levee may reduce wave overtopping, however the segments lower than 12 feet NAVD88 are protected behind 1,000 to 2,500 feet of fringing marsh (and the partial Cargill Mitigation Marsh western levee).

Figure 4.9. Plan of Bay Levee (Alt. C left, Alt. D right)

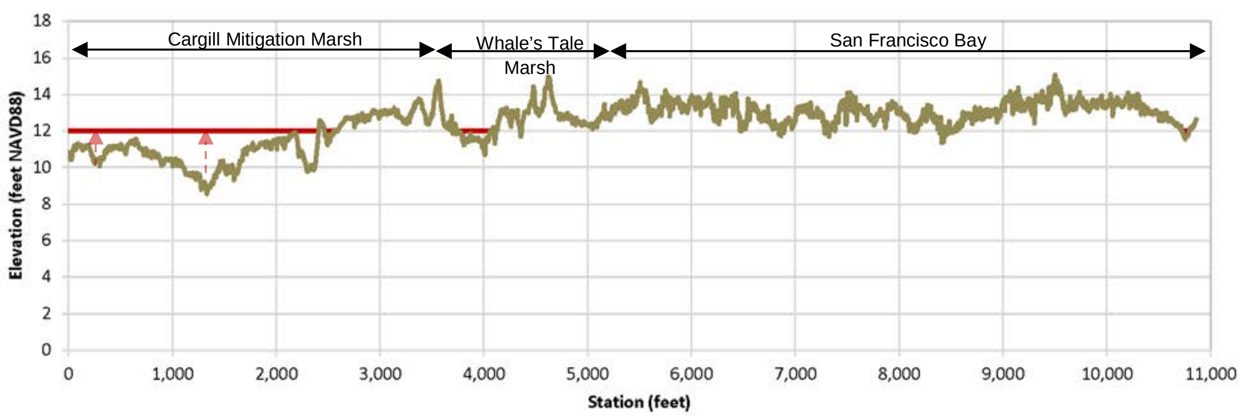

Figure 4.10. Raised Levee Profile of Bay Levee

Other approaches may also be taken for habitat enhancement, such as placing small tree trunks strategically in the ponds near or on the islands. In Alternative B, tree roots are proposed to be placed along the outer Bay levee to help create high tide refuge and help protect the levee from wave erosion. Tree "rootwads" are a natural slope stabilization technique often used in stream restoration design.

<u>Mid-Complex Levee</u>

(Alternative C and D) Approximately 12,900 feet of perimeter levee raising along a mid-complex levee spanning from the southwest corner of Pond E6, between Ponds E7, E5, and E4, across the Alameda County's "J" Ponds, connecting to the ACFCC levee near the southwest corner of Pond E1C. For Alternative C, the levee will be permanently raised. For Alternative D, the levee will be temporarily raised and a later Project Phase would breach and may also lower or remove sections of the levee to restore tidal influence to the Inland and C Ponds. Figure 4.12 shows the existing levee (as of the 2010 LiDAR) with the proposed height increase to 12 feet NAVD88.

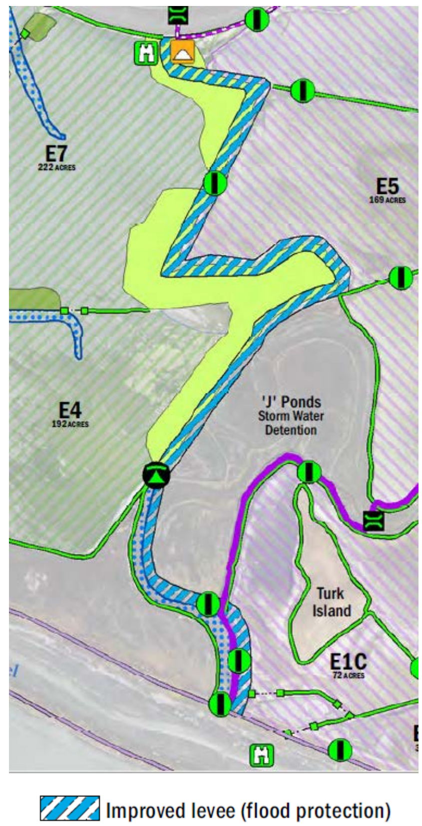

Figure 4.11. Plan of Mid-Complex Levee (Alt. C)

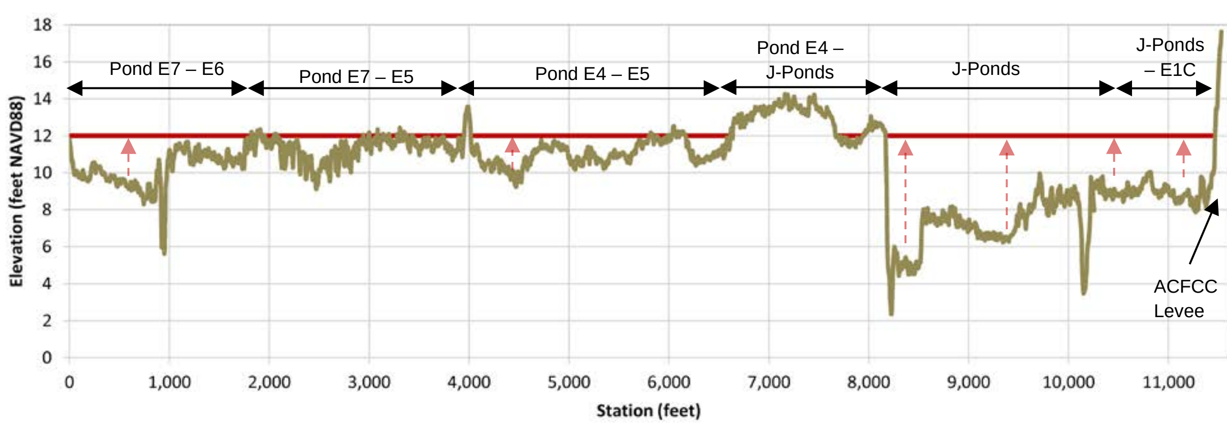

Figure 4.12. Raised Levee Profile of Mid Complex Levee

4.1.3 Levee Lowering

The design goals of levee lowering include providing an increased frequency of levee overtopping to help provide an equal or improved level of flood protection relative to existing conditions, as well as to promote increased hydraulic connectivity between channels and marshes. Table 4.3 and Figure 4.13 show the location and length of lowered levees for each alternative. Based on the hydrodynamic flood modeling summarized in Attachment 1, a lowered levee elevation to MHHW (7 feet NAVD88) will help provide equal or better flood protection by large ACFCC discharge events to overtop the lowered levees into the Bay Ponds and exit through the OAC to the Bay. This will in turn reduce flood levels traveling upstream through the J-Ponds and into inland Alameda County properties. With this approach, the restored ponds can support temporary detention of flood waters to benefit inland low-lying regions. As the ponds accrete over time and begin to support marsh habitat, the periodic tidal overtopping of the highest tides will create new breaches along these lowered levees and will increase hydraulic and habitat connectivity.

Table 4.3. Proposed Lowered Levees

Levee Lowering Location	Alternative B Linear Feet	Alternative C Linear Feet	Alternative D Linear Feet
OAC/E1 & E7 Levee	5,400	5,400	5,400
Fringing Marsh/E1&E2	3,800	3,800	-
ACFCC/E2 Levee	3,600	3,600	3,600
Total	12,800	12,800	9,000

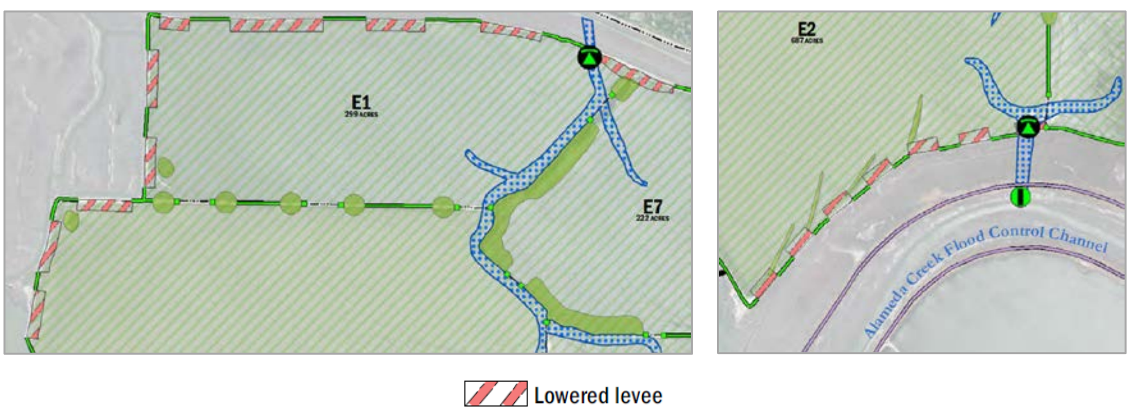

Figure 4.13. Plan of Lowered Levees (Alt. B)

Design:

- Top elevation: Lowered levees will be lowered to MHHW, 7 feet NAVD88.
- High Tide Refuge Habitat: Portions of lowered levees will remain at two feet above MHHW, or 9 feet NAVD88 to provide high tide refuge habitat.

A typical cross-section of the proposed levee lowering is shown in Figure 4.14.

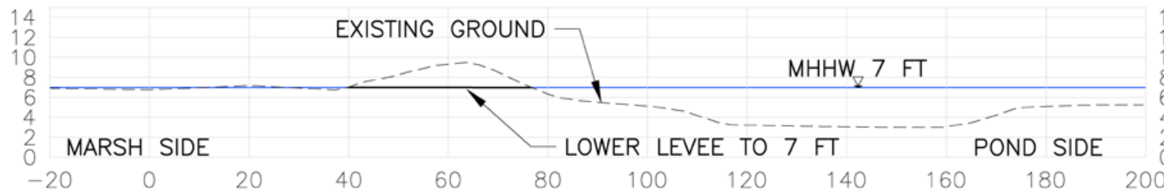

Figure 4.14. Proposed Levee Lowering – Typical Section

Material excavated from levee lowering will be reused onsite to raise levees and/or build habitat transition zones. Additional detail on the lowered levees follows.

<u>OAC – Pond E1 and E7 Levee</u>

(Alternatives B, C, and D) Along the 7,000-foot long northern levee of Pond E1 and E7 bordering the OAC, approximately 75% of the length (5,400 feet) will be lowered. The remaining 25% of the levee length will be left at existing elevations to provide high water refuge habitat at intervals along the levee alignment. Figure 4.15 shows the existing levee (as of the 2010 LiDAR) with the proposed levee lowering to MHHW (7 feet NAVD88).

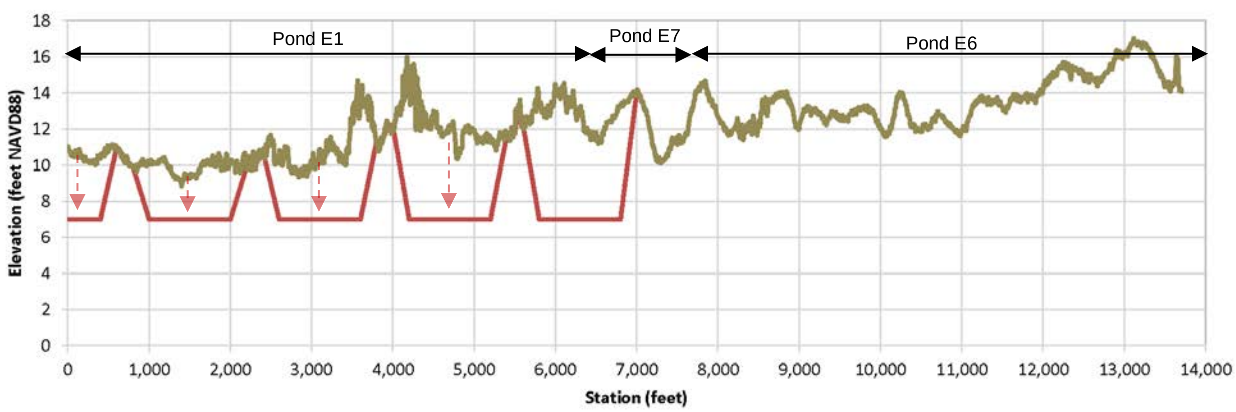

Figure 4.15. Lowered Levee Profile of OAC and Pond E1 and E7 Levees

<u>Fringing Marsh – Pond E1 & E2 Levee</u>

(Alternatives B and C) Along the 5,000-foot long western levee of Pond E1 and E2 bordering the Bay, approximately 75% of the length (3,800 feet) will be lowered. The remaining 25% of the levee length will be left as existing conditions to provide high water refuge habitat at intervals along the levee length. Figure 4.16 shows the existing levee (as of the 2010 LiDAR) with the proposed levee lowering to MHHW (7 feet NAVD88).

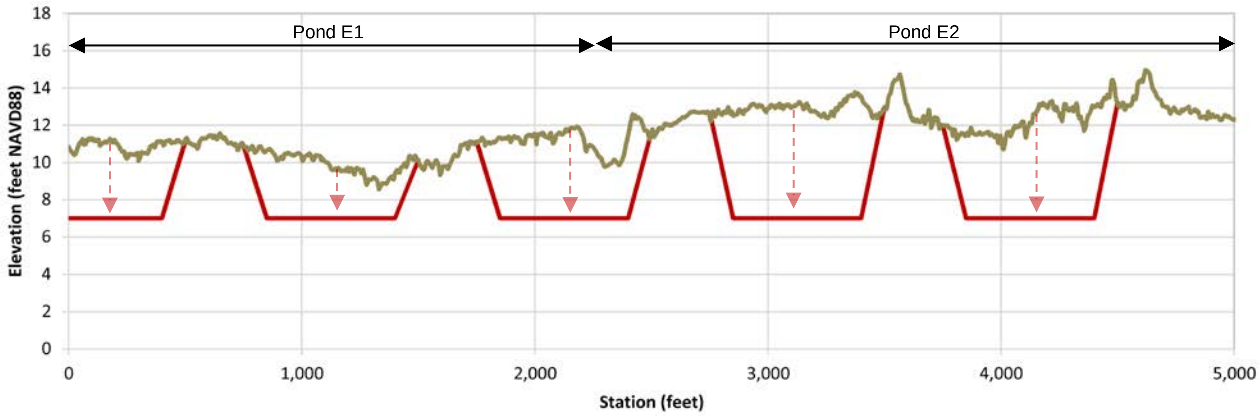

Figure 4.16. Lowered Levee Profile of Bay and Pond E2 and E1 Levee

<u>ACFCC – Pond E2 Levee</u>
(Alternatives B, C, and D) Along the 4,900-foot long southern levee of Pond E2 bordering Alameda property adjacent to the ACFCC, approximately 75% of the length (3,600 feet) will be lowered. The remaining 25% of the levee length will be left as existing conditions to provide high water refuge habitat at intervals along the levee length. Figure 4.17 shows the existing levee (as of the 2010 LiDAR) with the proposed levee lowering to MHHW (7 feet NAVD88).

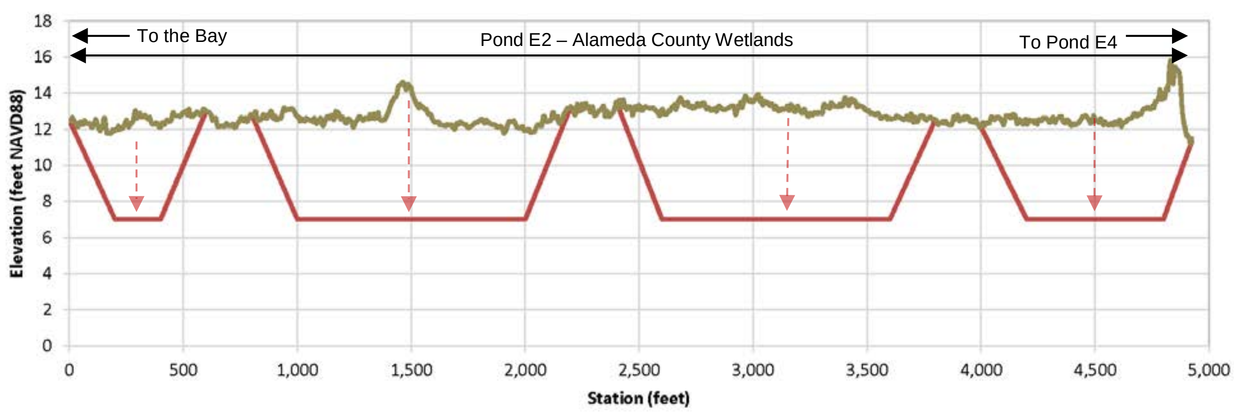

Figure 4.17. Lowered Levee Profile of Pond E2 and Alameda County Wetland Levee

4.1.4 Levee Breach

The design goal of levee breaching was to increase hydraulic connectivity between nearby sloughs and ponds. Levee breach locations were selected based on the historical slough locations and proposed pilot channel locations to maximize hydraulic connectivity between ponds. Breaches were classified as being either external or internal; external defined as a connection to an adjoining property not owned by CDFW, and internal defined as a connection between ponds (owned by CDFW). Breach locations, design details, and associated alternatives are summarized in Table 4.4 for external breaches and in Table 4.5 for internal breaches. Locations of the breaches can be seen in Appendix A Figures A-3, A-4, and A-5.

Table 4.4. External Levee Breach Design

Location	Width (ft.) (perpen. crest)	Length (ft.) (parallel crest)	Bottom Elev. (ft. NAVD88)	Slope	Purpose	Applicable Alternatives
OAC/E6	200	160	-4	3H:1V	Hydraulic connectivity	B
OAC/E1 (east)	150	380	-4			B, C and D
OAC/E1 (west)	150	30	0		Remove existing pump	B, C and D
Alameda County Wetlands/E2/E4	100	50	2.7 or higher		Fish passage	B
Alameda County Wetlands/E2	100	50	2.7 or higher			C

Table 4.5. Internal Levee Breach Design

Location	Width (ft.) (perpen. crest)	Length (ft.) (parallel crest)	Bottom Elev. (ft. NAVD88)	Slope	Purpose	Applicable Alternatives
E1/E2 (west)	50	120	-4	3H:1V	Hydraulic connectivity	B, C and D
E1/E2 (mid)	50	120	-4			B, C and D
E1/E2 (east)	50	120	-4			B, C and D
E1/E7	75	50	-4			B, C and D
E2/E7	75	50	5 (EG)			B, C and D
E7/E4	75	100	-4			B, C and D
E2/E4 (north)	50	50	-4			B, C and D
E2/E4 (south)	50	50	6 (EG)			B, C and D
E7/E6 (west)	25	25	5 (EG)			B
E7/E6 (east)	75	100	-4			B
E5/E7	75	110	-4			B
E4/E5	75	50	5 (EG)			B
E6/E5 (west)	50	50	0			B
E6/E5 (east)	50	50	0			B
E5/E6C	100	50	-4			B
E1C/E2C Donut	100	100	2.7			B, C and D
E2C Donut (west)	50	50	2.7			B, C and D
E2C Donut (east)	50	50	2.7			B, C and D
E4C/E5C (mid)	20	50	2.7			B and D
E4C/E5C (south)	20	50	2.7			B and D

Note: EG = Existing Ground

Levee breach design bottom elevations range from -4 feet to about 6 feet NAVD88. The elevation of -4 feet was chosen to align with the pilot channel depths, which were designed to allow for about one foot of water in the channels during the lowest spring tide (approximately -2.8 feet NAVD88) to prevent fish stranding. Levee breaches not connected to a pilot channel have design bottom elevations near existing grade of the ponds, or if they border a channel (as in the case of the Pond E6/E5 east and west breaches) an average elevation of 0 feet was proposed.

Levee breach widths (perpendicular to the levee crest) were based on existing topography to connect breach bottoms to pond bottoms or adjoining pilot channels. Levee breach lengths (parallel to the levee crest) were initially sized based on empirical hydraulic geometries of historic marshes in San Francisco Bay (PWA et al. 2004), and confirmed and modified as needed with MIKE21 model results (as described in Attachment 1). PWA et al.'s empirical relationships correlate equilibrium channel depth, top width, and cross-sectional area with tidal prism. As detailed in Appendix B, the potential diurnal tidal prism was calculated for each breach using the anticipated marsh area that will receive tide waters from each breach. Using the estimated tidal prism, the average channel cross-sectional area was estimated and informed the breach length when used in combination with the desired breach depth. Both the short term (immediately after the breach) and long term (future accreted marsh) tidal prisms were analyzed. The breach lengths were sized based on the channel depth assumptions, and will increase in length if the bottom channel elevation increases.

Breaches will not be armored and are expected to evolve naturally with erosion or deposition from incoming and outgoing tidal flows. The side slopes for these breaches are recommended for construction stability only. Breaches will be excavated with long reach excavators positioned on the existing levee crests. The material will be hauled to or directly placed onto locations identified to receive fill for levee raising, island or mound creation, or construction of habitat transition zones.

A typical cross-section of the proposed levee breach is shown in Figure 4.18.

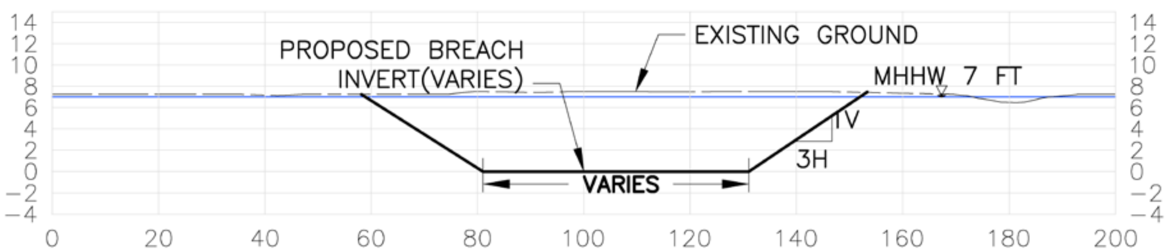

Figure 4.18. Proposed Levee Breach – Typical Section

4.1.5 Habitat Transition Zone

Habitat transition zones are areas with a wide transition in elevation from upland zones to tidal marsh zones. Low marsh, high marsh, tidal fringe, and upland habitats will develop over a habitat transition zone. The design goal of habitat transition zones is to provide areas varying in elevation to increase habitat diversity and complexity.

Table 4.6 summarizes the location and length of habitat transition zones for each alternative. Habitat transition zones will be constructed of material generated on-site from excavations of pilot channels, levee breaches, and lowered levees. Upland fill material may also be used if available from off-site construction projects, assuming it meets suitability requirements. In the case of Alternative B, material should first be utilized to construct the habitat transition zone in the Inland Ponds, as opposed to in the C-Ponds, because Pond E4C is relatively high and will be exposed to already muted tides.

Table 4.6. Proposed Habitat Transition Zones

Habitat Transition Zone Location	Alternative B Linear Feet	Alternative C Linear Feet	Alternative D Linear Feet
Inland Ponds Landside Levee	6,000	-	-
C-Pond Landside Levee	4,500	-	-
Mid Complex Levee	-	7,800	-
Bay Levee	-	-	10,900
Total	10,500	7,800	10,900

The preliminary design assumes a slope of 30:1 (H:V), which is the flattest slope that will be considered for construction, and thus the maximum fill volume and footprint for the habitat transition zones. Future designs may include slopes as steep as 10:1 (H:V), but these will require less fill material and have a smaller footprint. Habitat transition zones will be sized based on the amount of material available. Slopes varying from 10:1(H:V) to 30:1(H:V) will provide both a wide habitat transition zone as well as a gentle slope for dissipating wave energy and reducing erosion potential; all important design features for increasing sea level rise resiliency of the future marshes.

Design:

- Top elevation and slope: The top of habitat transition zone will begin at an elevation of 9.0 feet NAVD88 and extend down to pond bottom with slopes between 10:1(H:V) and 30:1(H:V).
- Slope protection: Hydroseeding with native seed mix and/or a planting schema will speed establishment of a range of vegetation, transiting from tidal marsh to upland vegetation.

Figure 4.19 shows a typical cross-section of the proposed habitat transition zone slopes along the proposed levee alignments.

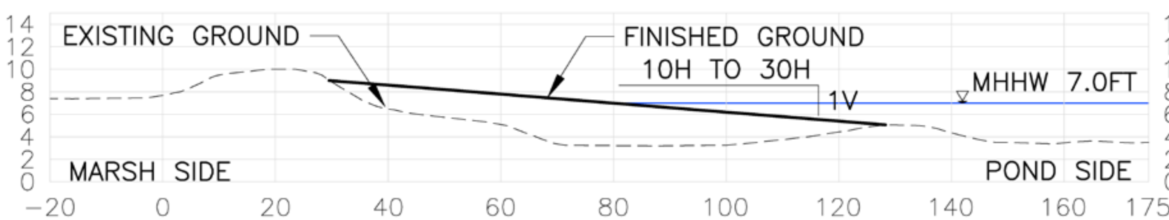

Figure 4.19. Proposed Habitat Transition Zone – Typical Section

4.1.6 Pilot Channel

The design goal of pilot channels is to facilitate draining and filling of the ponds. Without the channels, the low-lying pond depressions in the center of the ponds will not drain, slowing vegetation growth in the restored marsh. As depicted in Figure 3.2, about half of the project site historically drained towards the ACFCC or directly out to the Bay, which is currently not possible given existing property lines, levees and flood concerns. As an alternative, new main channel alignments will be constructed adjacent to existing levees in order to utilize the higher ground of the levees to support equipment access during construction, as well as to utilize the existing borrow ditch geometry to limit excavation. Channel "spurs" will offshoot the main channels into the deeper pond centers where necessary to reach pond depressions. These channel spurs will be minimized as they are more time-consuming (i.e. expensive) to construct.

Pilot channel locations, design details, and applicable alternatives are summarized in Table 4.7 and correspond to channels shown in Figures A-3, A-4 and A-5 found in Appendix A.

Table 4.7. Pilot Channel Design Details

Location	Top Channel Width (ft.)	Length (ft.)	Existing Elev. (ft. NAVD88)	Design Bottom Elev. (ft. NAVD88)	Design Slope	Applicable Alternatives
Bay Ponds Channel						
OAC island cut near E1 breach	15	250	7	0	1H:1V	B, C and D
E1 borrow ditch	30	2,500	6	-4		B, C and D
E2 borrow ditch	30	2,600	6	-4		B, C and D
E4 borrow ditch	30	1,400	6	-4		B, C and D
E1 spur	15	600	4.5	0		B, C and D
E2 spur	15	2,200	4	0		B, C and D
E7 spur	15	900	4.5	0		B, C and D
E4 spur	15	300	5	0		B, C and D
Inland Ponds Channel						
OAC island cut near E6 breach	15	250	7.5	0	1H:1V	B
E6 borrow ditch	30	2,000	5	-4		B
E7 borrow ditch	30	1,000	6	-4		B
E5 borrow ditch	30	3,400	6	-4		B
E6 spur	15	1,300	5	0		B
OAC island cut near E7 culvert	15	250	7.5	0		C and D
E6 borrow ditch (culvert route)	30	2,000	5	0		D
E5 borrow ditch (culvert route)	30	4,400	5.5	0		D
C-Ponds Channel						
E2C-E1C channel	30	1,600	5.5	2.7	1H:1V	B and D
E5C channel	30	2,000	5.5	2.7		B and D
E4C channel	30	700	5.5	2.7		B and D
Fish Passage Channel						
ACFCC to E2 and E4	15	3,100	7.5	0	1H:1V	B
ACFCC to E4 borrow ditch	15	3,100	7	2.7		C

The smaller spur channels, island cuts, and fish passage channels have design widths of 15 feet and slopes of 1:1 (H:V) with the assumption that future scouring will widen and create stable marsh slopes over time (although marsh channel slopes are relatively steep). The larger main channels have design widths of 30 feet and slopes of 1:1 (H:V), which can be constructed with a long reach excavator positioned on existing levees and reaching to the side of the levee. Excavated material will be deposited nearby to create island habitats.

In the Bay and Inland Ponds, a main channel bottom elevation of -4 feet NAVD88 was chosen to allow for about one foot of water in the channels during the lowest spring tide (approximately -2.8 feet NAVD88) to prevent fish stranding. During a MLLW tide (-1.1 feet NAVD88), about three feet of water will remain in the channels. Some sedimentation and scouring is anticipated to occur in and near the channels as they equilibrate, however, by excavating to a relatively low elevation, natural channel morphology will not be slowed by hard sills. (Hard sills created by the weight of historic levees were encountered in the northern Eden Landing Phase 1 ponds).

In the C-Ponds, a main channel bottom elevation of 2.7 feet NAVD88 was chosen to match the existing culvert invert elevation located between the ACFCC and Pond E2C. In the Inland Ponds, a main channel bottom elevation of 0 feet NAVD88 was chosen in Alternative D to align with the proposed culvert invert elevations in those ponds.

The OAC channel is comprised of a large northern stream and a smaller southern stream separated by a middle island of existing marsh. As part of Alternatives B, C and D, three different "island cuts" are proposed in the existing marsh within the OAC to connect the flow through the proposed external breaches and culverts into the larger and deeper northern stream of the OAC. If not constructed, the scouring power of the restored tidal prism will scour the southern stream, as opposed to the northern stream that is the main conveyance for flood flows. Scouring of the southern stream may cause accretion in the northern stream, which is undesired. The island cuts are narrow and intended to begin the erosion process towards a stable channel equilibrium that would develop over time.

A typical cross-section of the proposed pilot channel is shown in Figure 4.20.

Figure 4.20. Proposed Pilot Channel – Typical Section

4.1.7 Island Habitat

The design goal of the island habitats is to provide high tide refuge habitat and a means to beneficially reuse excavated material onsite. Island habitats will be constructed throughout the pond complex where existing levees will remain, separated by new levee breaches. Material excavated from the levee breaches and nearby pilot channels will be used to improve the remnant levees (island habitat) in footprint and height. The islands will be built to an elevation above MHHW to minimize exposure to tidal waters. Given the islands will be constructed from remnant levees and adjacent pilot channels, the islands will be linear in nature and the majority will be located significant distances from recreational trails to avoid habitat disturbance.

The island in Ponds E5C and E4C will be located in the middle of the pond adjacent to the pilot channel, as these ponds are relatively higher than others in the pond complex and the pond bottoms are believed accessible with heavy equipment. All other islands will be constructed from existing levees.

A select group of islands will be treated to create nesting habitat for western snowy plover, California least tern, or other bird species. The top surface of the islands will be treated with a 12-inch thick sand layer underlain by a 6-inch thick crushed rock to minimize weed establishment. The sand layer will include oyster shells or other materials to provide a primarily unvegetated, diverse landscape that is typically preferred by nesting birds.

Design:

- Top elevation: The islands will have a minimum crest elevation of 9 feet NAVD88, not including sand and rock substrate placed for habitat on top of the levee crest.
- Side slope: The nesting island will have side slopes no steeper than 7:1 (H:V) to the pond bottom.

A typical cross-section of the island habitats is shown in Figure 4.21.

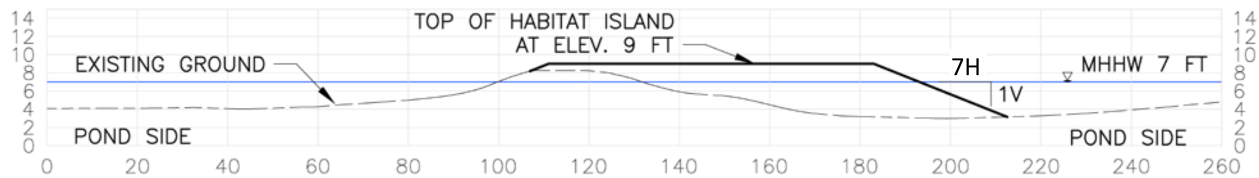

Figure 4.21 Island Habitat – Typical Section

4.1.8 Water Control Structures

The design goal of new water control structures is to facilitate the controlled movement of water between the ponds. Redundancy is desired in the proposed culvert system to provide reliability. The water control structures will have combination gates at both the inlets and outlets for maximum flexibility in water level control. A combination gate can be operated as a slide gate to allow flow in both directions, or may act as a tide gate in both directions when closed.

The design details of the proposed water control structures (new and modifications to existing) are shown in Table 4.8.

Table 4.8. Water Control Structure Design Details

Location	(Number), Size, Type	Length (ft.)	Existing Invert Elev. (ft. NAVD88)	Design Invert Elev. (ft. NAVD88)	Purpose	Applicable Alternatives
ACFCC/E2C (existing)	(2) 48 in. dia. HPDE/CMP	170	2.7	-	Hydraulic connectivity (Alt. B) or Pond management (Alt. C and D)	B, C and D
ACFCC/E2C	(2) 48 in. dia. HPDE/CMP	170	-	2.7		
E1C/E5C (south)	(2) 48 in. dia. HPDE/CMP	60	-	2.7		
E1C/E5C (north)	(1) 48 in. dia. HPDE/CMP	50	-	2.7		C and D
E2C/CP3C (existing)	(1) 48 in. dia. HPDE/CMP	60	Unknown	-		B and D
OAC/E6	(2) 48 in. dia. HPDE/CMP	150	-	0		C and D
E6/E5 (west)[1]	(1) 48 in. dia. HPDE/CMP	40	-	0		
E6/E5 (east)[1] (existing)	(1) 48 in. dia. HPDE/CMP	40	-	0		
E5/E6C (west)[2] (existing)	(1) 36 in. dia. HDPE/CMP	60	Unknown	0		
E5/E6C (east)[2] (existing)	(1) 36 in. dia. HDPE/CMP	60	Unknown	0		
ACFCC/E2&E4 via Alameda County Wetlands	(1) 6 ft. x 6 ft. concrete box or (3) 48 in. diam. HDPE/CMP	200	-	2.7	Fish passage	B
E7/E5	(1) 48 in. dia. HPDE/CMP	50	-	0	Culvert redundancy	C
ACFCC/Alameda County Wetlands	(1) 6 ft. x 6 ft. concrete box or (3) 48 in. diam. HDPE/CMP	200	-	2.7	Fish passage	
Alameda County Wetlands/E1C	(1) 48 in. dia. HPDE/CMP	30	-	2.7	Fish passage/pond management	
Alameda County Wetlands/J-Ponds	(1) 48 in. dia. HPDE/CMP	50	-	2.7	Detention basin management	

Note 1: E6/E5 (west) and (east) could be combined into a single set of culverts to reduce costs as opposed to two separate culverts.

Note 2: E5/E6C (west) and (east) could be combined into a single set of culverts to reduce costs as opposed to two separate culverts.

Water control structures will include prefabricated box culverts or circular high density polyethylene (HDPE) or corrugated metal pipe (CMP) installed through levees with either headwalls or T-shaped bridge structures to operate gate valves. For the larger water control structures, a concrete box culvert may be used to mitigate corrosion concerns typically expected in estuarine water. Alternatively, solid wall HDPE pipes may be employed as they provide a longer service life (greater than 50 years) but are typically more expensive.

A culvert, as opposed to a bridged beach, was proposed to join Ponds E1C and E5C (Cargill-owned levee) because a culvert is believed to be more cost effective than a bridge able to support maintenance vehicle access. Some of the culverts that require coordination with either Cargill or the ACFCWCD may be phased in at a later time in the project to allow for stakeholder involvement and agreement.

Additional Design Details:

- Cover: Concrete box culverts will have a minimum of 1.0 foot of cover. HDPE and CMP will require more cover than that of concrete box culverts and will be based on the diameter of the pipe and future cover analysis calculations.
- Fish Passage: Culverts intended for fish passage will consider adult and juvenile life stages and associated low and high passage flow criteria in future design phases. Because these culverts are in both a tidal and riverine system environment, different culvert heights will be considered to limit the time the culvert is flowing full. A natural culvert bottom will also be considered to encourage fish passage into the Bay Ponds from ACFCC.
- Seepage Control: Culverts will be designed to prevent through seepage along the pipe trench alignment. Engineered seepage prevention collars may be required.
- Floatation: Culverts (pipe material and wall thickness) will be designed to prevent floatation when fully inundated. Engineered concrete collars on the pipe may be required.

4.1.9 Recreational Trails

The design goal of recreational trails is to meet the recreation objectives of the project. Table 4.9 includes the trail locations and lengths. Each action alternative includes continuing the Bay Trail from its existing extent in the northern Eden Landing Ponds to the southeast corner of Pond E6C; from there three routes are proposed to connect the trail to the ACFCC levee. Plan views of the proposed trail routes are shown in Appendix A Figures A-3, A-4, and A-5.

Table 4.9. Trail Details

<table>
<tr><th>Location</th><th>Length (ft.) (parallel crest)</th><th>Purpose</th><th>Applicable Alternatives</th></tr>
<tr><td>N. Eden Landing Ponds to E6C</td><td>16,000</td><td rowspan="7">Public Access / Recreation</td><td>B, C and D</td></tr>
<tr><td>E6C to ACFCC</td><td></td><td></td></tr>
<tr><td>Route 1: CDFW Property only</td><td>7,400</td><td rowspan="3">B, C and D</td></tr>
<tr><td>Route 2: CDFW & Cargill Property</td><td>10,500</td></tr>
<tr><td>Route 3: CDFW & Alameda County Property</td><td>11,900</td></tr>
<tr><td>Alvarado Salt Works Loop</td><td>13,500</td><td>C</td></tr>
<tr><td>S. ACFCC levee connection</td><td>NA (bridge)</td><td>C</td></tr>
</table>

The trail though the Northern Eden Landing Ponds to Pond E6 includes crossing the existing tide gate structure located along the OAC. Handrails and appropriate access features would be included in the design to modify this existing, operating tide gate structure for pedestrian access.

Design:

- Width: trails designed to be part of the Bay Trail will follow Bay Trail design guidelines and may be at least 12 feet wide with a three-foot shoulder on either side, totaling to 18 feet. Trails not designated as part of the Bay Trail will be a minimum of 10 feet wide with a one-foot should on either side, totaling to 12 feet.

- Surfacing: trails will be built on improved or existing levees. Erosion or uneven surfaces on existing levees will be regraded for ADA compliance. Surfacing materials may be compacted gravel, decomposed granite, and/or native soil with stabilizing agents.
- Bridges: all bridges will be passable by pedestrians, and depending on bridge length and location may also be passable by maintenance or emergency vehicles. Maintenance and emergency vehicles currently have access to all levees via existing access routes.

4.1.10 Bridges

The design goal of bridges is to meet the recreation objectives of the project. Table 4.10 details bridge locations and lengths. Plan views of the proposed bridges are shown in Appendix A Figures A-3, A-4, and A-5.

Table 4.10. Bridge Details

Location	Length (ft.)	Purpose	Applicable Alternatives
Across J-Ponds from E6C to E4C	250	Public Access / Recreation	B, C and D
Across J-Ponds from E6C to E5C	310		B, C and D
Across OAC to Alvarado Salt Works	500		C
Across ACFCC at Cal Hill	600		C

Design Details:

- Bridge Loading: all bridges will be passable by pedestrians and bicycles. The two shorter bridges across the J-Ponds will also be accessible by maintenance and emergency vehicles. The two longer bridges across the OAC and ACFCC already have existing nearby vehicle access (i.e. the OAC tide gate structure and Union City Blvd. over ACFCC).
- Bridge Support: Given the long spans, bridges may be supported by numerous driven piles in the channels.
- Bridge Bottom Elevation: bridges spanning the OAC and ACFCC will allow for the 100-year flood event to pass underneath the bridges with sufficient freeboard. Floating structures (such as maintenance dredging and Coast Guard equipment) must also pass under, or a portion of the bridge removed for passage past, the bridge at MHHW tide. Bridges spanning the J-Ponds will be constructed to allow for Alameda County equipment access under the bridge.
- Abutment Scour: bridge abutments will be protected against scour.

Figure 4.22 depicts a typical light-duty bridge suitable for pedestrians and bicycles.

Figure 4.22 Representative Light-duty Bridge with Abutment Armoring
Source: Questa 2011

4.1.11 Interpretive Signage and Benches

Interpretive signage and benches will support the recreation objective of the project. One interpretive sign and bench may be placed near the proposed viewing platform near the intersection of the C-Ponds and the ACFCC levee (Alternatives B, C, and D). The interpretive sign will be similar to that shown in Figure 4.23. Benches will be approximately 7 or 8 feet long with coated steel supports and wood slat finished surfaces, similar to that shown in Figure 4.23.

Figure 4.23 Representative Interpretive Sign and Bench (located at northern Eden Landing Ponds)

4.1.12 Viewing Platform

Viewing platforms will provide a scenic lookout area to support the recreation objective of the project. A viewing platform will be comprised of asphalt or similar surfacing material as the proposed recreational trails and may be built near the intersection of the C-Ponds and the ACFCC levee (Alternatives B, C, and D) as well as near the Alvarado Salt Works (Alternative C). The viewing platforms will be constructed on or near levee crests and may vary in size to accommodate the existing space. Access to the platforms will be ADA accessible. A typical viewing platform is shown in Figure 4.24.

Figure 4.24 Proposed Viewing Platform

4.1.13 Union Sanitary District Connection

Union Sanitary District (USD) provides wastewater collection, treatment, and disposal services to Fremont, Newark and Union City. USD's wastewater treatment plant is located immediately east of Pond E6. Given the close proximity to the plant, southern Eden Landing may be a suitable location for wet-weather detention storage or a treated freshwater discharge. The SBSP Restoration Project team and USD are currently discussing such options and applicable permits. Alternative B contains an approximate location of a USD connection to Pond E6.

4.2 Construction Implementation

Construction will be implemented by procuring the services of a general contractor with experience in performing restoration activities, levee improvements, and working within and near tidal waters and bay mud. Site access information, along with a preliminary analysis of the schedule and cost estimate to complete the construction activities, is discussed below.

4.2.1 Access

Primary access to southern Eden Landing is near the Union Sanitary District Headquarters at the end of Horner Street, which can be reached from Dyer/Whipple Road or Alvarado-Niles exits off I-880, and Union City Blvd. Alternative access to the southern portion of southern Eden Landing is at the end of Westport Way via Carmel Way (near Sea Breeze Park) off Union City Blvd. Access routes are shown on Figure 4.25. Access throughout the pond complex is via former salt pond levee maintenance roads. Public foot and road access is permitted within some locations within the northern pond complex and along the ACFCC levees currently.

Construction vehicles shall avoid crossing any structures if the vehicle exceeds the weight-bearing capacity. If this is not possible, engineer-approved precautions shall be taken to avoid damaging the structures.

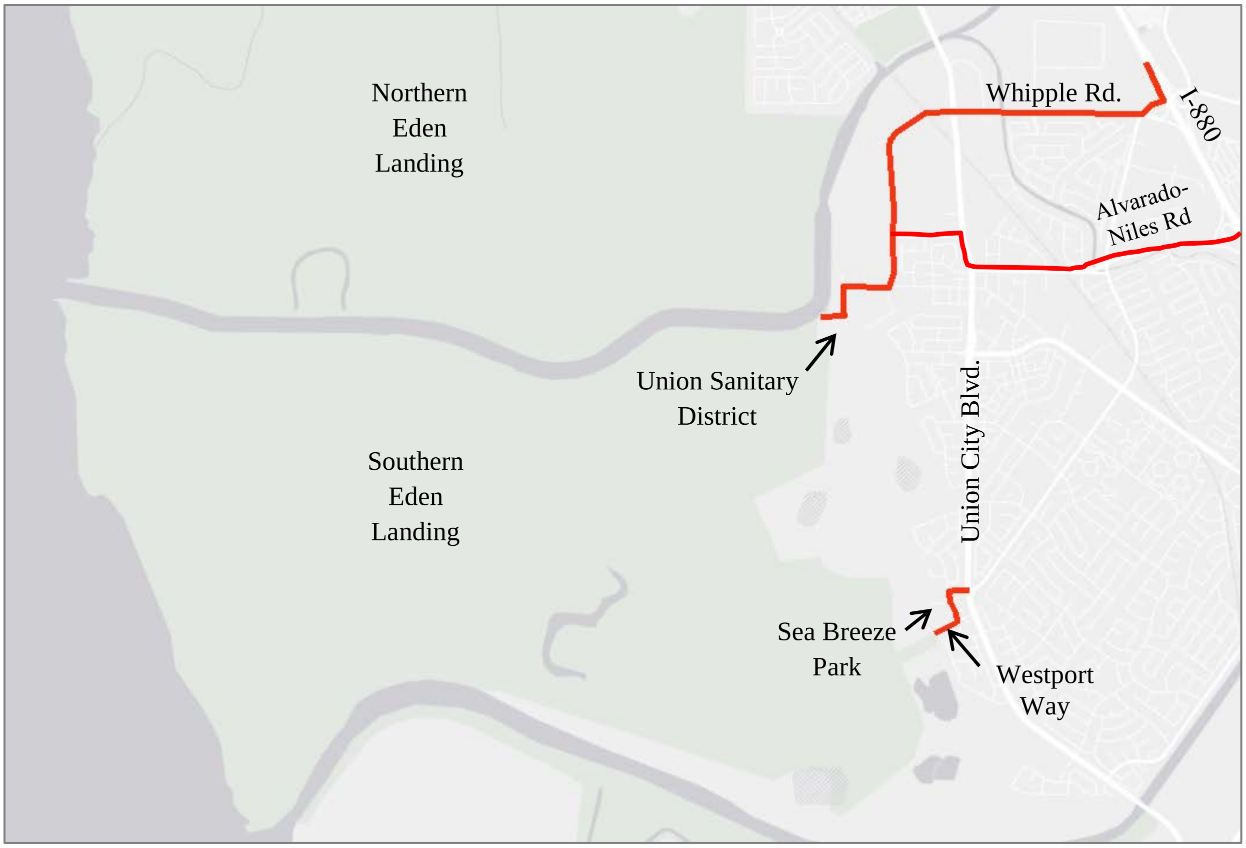

Figure 4.25 Site Access

4.2.2 Earthwork Volumes

Based on the preliminary design, estimated volumes of earthwork proposed for the Eden Landing alternatives are detailed in Table 4.11. Quantities were measured using AutoCAD Civil3D software based on terrain models of the existing and proposed ground surfaces. A bulking factor of 30% was included in both cut and fill volumes, as well as a 20% contingency.

Because the levees are comprised of dry, compacted material, material excavated from levee lowering and external breaches is most suitable for construction of raised levees. Wet bay mud generated from pilot channel excavation will be used to construct the habitat islands. Excavation of internal levee breaches will also be used to construct habitat islands to minimize hauling small amounts of material far distances around the site. Habitat transition zones will be constructed with any excess excavation from levee breaches and lowered levees, and will be supplemented with imported material if needed.

Table 4.11 shows that in Alternative B, approximately 155,000 CY of dry material will be excavated, of which 91,000 CY will be placed on levees to raise them. The remaining 64,000 CY will help build habitat transition zones and trails, although an additional 92,000 CY of material will need to be imported to construct the Alternative B habitat transition zones. Lastly, approximately 240,000 CY of wet material will be excavated and used to create habitat islands throughout the complex in this Alternative.

Table 4.11. Preliminary Earthwork Volumes

Dry Material Excavation and Placement	Alternative B		Alternative C		Alternative D	
	Cut (CY)	**Fill (CY)**	**Cut (CY)**	**Fill (CY)**	**Cut (CY)**	**Fill (CY)**
Levee Raising						
Inland Ponds Landside Levee	-	9,000	-	-	-	9,000
C-Pond Landside Levee	-	44,000	-	-	-	44,000
Bay Trail Levee	-	38,000	-	-	-	-
Bay Levee	-	-	-	2,000	-	9,000
Mid Complex Levee	-	-	-	81,000	-	81,000
Levee Lowering						
OAC/E1 & E7 Levee	-28,000	-	-28,000	-	-28,000	-
Fringing Marsh/E1&E2	-17,000	-	-17,000	-	-	-
ACFCC/E2 Levee	-25,000	-	-25,000	-	-25,000	-
Levee Breaches						
External	-85,000	-	-42,000	-	-41,000	-
Total	-155,000	91,000	-112,000	83,000	-94,000	143,000
Net Dry Material		**-64,000**		**-29,000**		**49,000**
Wet Material Excavation and Placement						
Pilot Channels						
Bay Ponds	-80,000	-	-80,000	-	-80,000	-
Inland Ponds	-71,000	-	-2,000	-	-39,000	-
C-Ponds	-13,000	-	-	-	-13,000	-
Fish Passage Channel	-18,000	-	-1,000	-	-	-
Levee Breaches						
Internal	-58,000	-	-37,000	-	-38,000	-
Habitat Islands						
Throughout Complex		240,000		120,000		170,000
Total	-240,000	240,000	-120,000	120,000	-170,000	170,000
Net		**0**		**0**		**0**
Imported Upland Fill Placement						
Habitat Transition Zones						
Inland Ponds Landside Levee	-	101,000	-	-	-	-
C-Ponds Landside Levee	-	46,000	-	-	-	-
Mid Complex Levee	-	-	-	75,000	-	-
Bay Levee	-	-	-	-	-	96,000
Trails						
Imported Trail Base	-	9,000	-	13,000	-	9,000
Total	0	156,000	0	88,000	0	105,000
Excess Dry Material Excavation		-64,000		-29,000		49,000
Net Fill Import		**92,000**		**59,000**		**154,000**

Note: Levee raise volumes assume a conservative levee crest width of 16 feet, as opposed to a minimum 12 feet.

4.2.3 Construction Methods and Equipment

Probable construction equipment includes:

- Long reach excavator(s) and drag-line excavator (working off crane mats in soft areas)
- Amphibious excavator(s) (for channel excavation)
- End dump trucks (for onsite and offsite hauling)
- Low-ground pressure (LGP) trucks (for onsite hauling)
- LGP dozer(s) (for material pushing around site)
- LGP loader(s) (for material loading into trucks)
- LGP backhoe (for trenching)
- Motor grader (for levee road leveling and upkeep)
- Temporary matting (wood or plastic for equipment support)
- Water truck(s) (dust control, moisture conditioning)
- Compactor(s) (material compaction)
- HDPE pipe fuser (culvert construction)
- Crane(s) (equipment/material loading/unloading)
- Auger drill (bridge and/or water control structure foundation piles)

This equipment list does not include smaller items such as fuel service, maintenance service, personal vehicles, small tools and equipment.

Currently, the Bay and Inland Ponds are hydraulically separated from the C-Ponds. Almost all construction at the C-Ponds may therefore be phased separately than the Bay and Inland Ponds (with levee raising in the C-Ponds being the exception because it requires excavated material from levee lowering in the Bay Ponds). Assuming construction is performed in the Bay, Inland, and C-Ponds concurrently (un-phased throughout the site) the sequence of construction tasks for Alternative B may include the following:

- <u>Pre-construction Pond Management</u>: Lower pond water levels to lowest possible levels for improved site access.
- <u>Mobilization</u>: develop submittals, staging areas, and other facilities. Mobilize equipment to the site via ground transportation.
- <u>Site Preparation</u>: Where necessary, clear and grub work areas, scarify slopes, and repair/raise low access roads in preparation of work.
- <u>Demolition</u>: Demolish existing structures and backfill as identified.
- <u>USD Connection:</u> Construct, if included in project.
- <u>Bridges:</u> Construct pedestrian bridges. Construction methods may include cofferdams, foundation piles, cast in-place concrete abutments, and placement of riprap scour protection.
- <u>Water Control Structures:</u> Excavate trenches and temporarily store material. Install HDPE or CMP pipe using flatbed trucks for delivery, loaders for lowering pipe in place, and HDPE pipe fuser to connect pipe sections (if necessary). Install valves.

- Internal Breaches, Channels & Habitat Islands: Excavate internal breaches and channels. Place material nearby to create habitat islands. Dozers would move material laterally as necessary to construct habitat islands with excavated material.
- OAC Island Cuts: Construct limited temporary roads (with mats and material) as necessary to excavate island cuts in existing OAC marsh. Load material on trucks and place onsite as habitat islands/habitat transition zones.
- Habitat Transition Zones: Utilize excess onsite material as it becomes available, or import material from offsite locations to place and grade for construction of habitat transition zones. Scarify slopes prior to placement. Shape material with a dozer.
- Lower & Raise Levees: Working from the levee top, excavate material, load onto trucks, transport onsite and place at levee raising locations. If excess material is available, use material to build habitat transition zones.
- External Breaches & Raise Levees: Excavate external breaches with long reach excavators. Haul material onsite to complete levee raises. Import material to raise levees as needed.
- Trails and Viewing Platforms: Grade and compact proposed trail pathways. Import, place and compact trail base material. Geotextile fabric may be laid out, gravel compacted in-place, and quarry fines compacted on top to create an accessible surface. Create viewing platforms at-grade off-set from the main trail pathway; or if elevated, drill platform foundations and assemble onsite using small power tools.
- Signage and Benches: Install trails, signage, and benches on identified levees.
- Demobilization: Demobilize equipment via ground transportation.

A similar task construction sequence may be performed if Alternatives C and D are selected; however with the construction of a mid-complex levee, the contractor may choose to phase tasks between the Bay Ponds (planned to be tidal habitat) and the Inland and C-Ponds (planned to be managed ponds). For instance, if the Inland and/or C-Ponds are desired managed pond habitat for species, their project features may be constructed after completion of the features within the Bay Ponds (including the mid-complex levee). Some sequence constraints in these options, such as constructing the habitat transition zones before lowering access levees (Alternative D).

It is assumed that the bottom of the Bay and Inland Ponds will not support LGP equipment without temporary access road construction. It is also assumed that the bottom of the C-Ponds, with the exception of possibly Pond E2C, will support LGP equipment for the construction of channels within the pond bottoms. It is also assumed that fill will be imported as a rate that ensures an efficient construction operation. All fill is assumed to be imported from a dirt broker at no cost to the project.

The final equipment and sequencing will be developed by the selected contractor based on the contractor’s detailed work plan.

4.2.4 Schedule

The construction schedule will be driven by the volume of earthwork, construction work windows, weather conditions, and contractor means and methods.

4.2.4.1 Construction Work Windows

Construction activities will occur within permitted work windows to avoid impacts to special-status and other sensitive species. The dates provided were developed based on the Eden Landing Pond E12/13 Restoration Preliminary Design (PWA 2009) and the Alviso-Island Ponds A19, A20, and A21 Preliminary Design Memorandum (URS 2014b). Permits for this project may have different construction limitations.

In-channel construction will likely be limited between April 15 to October 15 when water levels are lowest. Considerations include:

- Steelhead could be present from December 15 to April 30. In-channel work between April 15 and April 30 should have an approved biological monitor present and should be done at low tides whenever possible.
- Longfin smelt and sturgeon could be present year-round. In-channel work should have an approved biological monitor present and should be conducted at low tide if possible.

Construction activities in bird nesting areas could be limited during the following periods listed for each species:

- March 1 to September 15 for western snowy plover
- February 1 to September 1 for terns, avocets, and stilts
- February 1 to September 1 or earlier (as allowed) for California Ridgway's rail

Negative results of pre-construction surveys and monitoring efforts could lengthen the permitted construction periods. Work in the spring and summer (March - August) is not prohibited, but approved buffer zones could be implemented to allow work to continue during nesting seasons.

4.2.4.2 Construction Schedule

Construction is expected to begin in 2018. Assuming a construction window of September 1 through March 1, a preliminary estimate of the overall duration of construction is shown in Table 4.12.

Table 4.12. Preliminary Project Construction Durations

Alternative	Duration (months) *
Alternative Eden B	29
Alternative Eden C	27
Alternative Eden D	27

*Duration is from initiation of mobilization to final demobilization and includes sequential, seasonal down time.

The construction durations for habitat transition zone creation will be primarily controlled by the availability of upland fill material that can be imported to the project site. Durations assume that sufficient fill material is available to allow for continuous operation during the construction windows, but that the quantity available will only allow for one habitat transition zone construction crew at a time. Habitat transition zone construction durations range from 7, 3.5, to 5 months (five 8-hour working days per week, with 4.35 weeks/month) for Alternatives B, C, and D (assuming single crews), which is a significant portion of the project duration. These durations also assume upland material is hauled onsite at the rate of possible placement, although road capacity will likely restrict delivery of material, possibly doubling the time required to build the habitat transition zones. Based on experiences at Inner Bair Island, if fill material will be provided by an independent dirt broker at no cost to the project, it is recommended that the above durations be increased if used for permitting or scheduling.

Other construction elements were allowed to occur concurrently with multiple crews provided that they made reasonable sense. The estimate is based on the assumption that some heavy construction activities may be permitted to occur during the nesting habitat window under the watch of a biological monitor.

4.2.5 Preliminary Cost Estimate

Table 4.13, Table 4.14, and Table 4.15 contain preliminary rough order of magnitude construction cost estimates for the three Eden Landing action alternatives. Each estimate depends on distinct features that may or may not be included in the final preferred alternative. Unit costs were developed based on a combination of similar AECOM project experience, unit construction costs from a contractor experienced in salt marsh restoration construction, the R.S. Means estimate guide, and vendor quotes.

Item #	Line Item	Quantity	Unit	Unit Cost	Amount
1	Mobilization & Demobilization				$1,881,300
1.1	Mobilization & Demobilization	1	LS	15%	$1,881,300
2	Site Preparation				$413,400
2.1	Clear & Grub	39	ACRE	$4,000	$156,000
2.2	Demolition Water Control Structures	16	EACH	$8,900	$142,400
2.3	Demolition Electrical Lines	1	LS	$115,000	$115,000
3	Earthwork				$6,728,000
3.1	Levee Raising (haul, fill)	91,000	CY	$17	$1,547,000
3.2	Levee Lowering (cut)	56,000	CY	$3	$168,000
3.3	Levee Breaches - External (cut)	68,000	CY	$7	$476,000
3.4	Levee Breaches - Internal (cut, haul, fill)	47,000	CY	$13	$611,000
3.5	Channels & Islands (cut, fill)	110,000	CY	$9	$990,000
3.6	Channel spurs (access road, cut, haul, fill)	36,000	CY	$27	$972,000
3.7	Habitat Transition Zones (haul, fill)	147,000	CY	$12	$1,764,000
3.8	Hydroseeding	20	ACRE	$10,000	$200,000
4	Structures				$4,450,000
4.1	Water Control Structures	-	-	-	-
4.1.1	ACFCC/E2C (add to existing; two 48" pipes, 170 lf with headwalls & gates)	1	EACH	$670,000	$670,000
4.1.2	ACFCC/E2&E4 via Alameda County Wetlands (6'x6' concrete box, 200 lf with headwalls & gates)	1	EACH	$630,000	$630,000
4.1.3	E2C/CP3C (replace existing one 48" pipe, 75 lf, with gates)	1	EACH	$375,000	$375,000
4.1.4	E1C/E5C (south) (one 48" pipe, 75 lf, with gates)	1	EACH	$375,000	$375,000
4.2	Bridges (~300 ft long)	2	EACH	$1,600,000	$3,200,000
4.3	Bridges (~500 ft long)	0	EACH	$2,100,000	$0
5	Public Access Features				$950,300
5.1	Recreational Trails	311,200	SF	$3	$933,600
5.2	Interpretive Signage	1	EACH	$3,900	$3,900
5.3	Benches	1	EACH	$6,800	$6,800
5.4	Viewing Platform	1,000	SF	$6	$6,000
	Subtotal				$15,343,000
	Design & Unit Cost Contingency			25%	$3,835,800
	Total Direct Construction Cost				$19,178,800
	Construction Contingency			30%	$5,753,700
	Total				**$24,932,500**

Table 4.13. Preliminary Cost Estimate for Eden Landing – Alternative B

Item #	Line Item	Quantity	Unit	Unit Cost	Amount
1	Mobilization & Demobilization				$2,554,100
1.1	Mobilization & Demobilization	1	LS	15%	$2,554,100
2	Site Preparation				$353,800
2.1	Clear & Grub	33	ACRE	$4,000	$132,000
2.2	Demolition Water Control Structures	12	EACH	$8,900	$106,800
2.3	Demolition Electrical Lines	1	LS	$115,000	$115,000
3	Earthwork				$4,145,000
3.1	Levee Raising (haul, fill)	82,000	CY	$17	$1,394,000
3.2	Levee Lowering (cut)	56,000	CY	$3	$168,000
3.3	Levee Breaches - External (cut)	34,000	CY	$7	$238,000
3.4	Levee Breaches - Internal (cut, haul, fill)	29,000	CY	$13	$377,000
3.5	Channels & Islands (cut, fill)	48,000	CY	$9	$432,000
3.6	Channel spurs (access road, cut, haul, fill)	18,000	CY	$27	$486,000
3.7	Habitat Transition Zones (haul, fill)	75,000	CY	$12	$900,000
3.8	Hydroseeding	15	ACRE	$10,000	$150,000
4	Structures				$11,075,000
4.1	Water Control Structures	-	-	-	-
4.1.1	ACFCC/E2C (add to existing; two 48" pipes, 170 lf with headwalls & gates)	1	EACH	$670,000	$670,000
4.1.2	ACFCC/Alameda County Wetlands (6'x6' concrete box, 200 lf with headwalls & gates)	1	EACH	$630,000	$630,000
4.1.3	OAC/E6 (two 48" pipes, 150 lf with gates)	1	EACH	$430,000	$430,000
4.1.4	E1C/E5C (south) (one 48" pipe, 60 lf with gates)	1	EACH	$370,000	$370,000
4.1.5	E1C/E5C (north) (one 48" pipe, 50 lf with gates)	1	EACH	$365,000	$365,000
4.1.6	Wetlands/E1C (one 48" pipe, 30 lf with gates)	1	EACH	$355,000	$355,000
4.1.7	Wetlands/J-Ponds (one 48" pipe, 50 lf with gates)	1	EACH	$365,000	$365,000
4.1.8	E6/E5 (west) (one 48" pipe, 40 lf with gates)	1	EACH	$360,000	$360,000
4.1.9	E6/E5 (east, replace existing) (one 48" pipe, 40 lf with gates)	1	EACH	$360,000	$360,000
4.1.10	E5/E6C (west, repair gates only)	1	EACH	$100,000	$100,000
4.1.11	E5/E6C (east, repair gates only)	1	EACH	$100,000	$100,000
4.1.12	E7/E5 (one 48" pipe, 50 lf with gates)	1	EACH	$370,000	$370,000
4.2	Bridges (~300 ft long)	2	EACH	$1,600,000	$3,200,000
4.3	Bridges (~500 ft long)	2	EACH	$2,100,000	$4,200,000
5	Public Access Features				$1,453,000
5.1	Recreational Trails	473,200	SF	$3	$1,419,600
5.2	Interpretive Signage	2	EACH	$3,900	$7,800
5.3	Benches	2	EACH	$6,800	$13,600
5.4	Viewing Platform	2,000	SF	$6	$12,000
	Subtotal				$20,500,900
	Design & Unit Cost Contingency			25%	$5,125,300
	Total Direct Construction Cost				$25,626,200
	Construction Contingency			30%	$7,687,900
	Total				**$33,314,100**

Table 4.14. Preliminary Cost Estimate for Eden Landing – Alternative C

Item #	Line Item	Quantity	Unit	Unit Cost	Amount
1	Mobilization & Demobilization				$1,955,700
1.1	Mobilization & Demobilization	1	LS	15%	$1,955,700
2	Site Preparation				$450,700
2.1	Clear & Grub	55	ACRE	$4,000	$220,000
2.2	Demolition Water Control Structures	13	EACH	$8,900	$115,700
2.3	Demolition Electrical Lines	1	LS	$115,000	$115,000
3	Earthwork				$5,867,000
3.1	Levee Raising (haul, fill)	143,000	CY	$17	$2,431,000
3.2	Levee Lowering (cut)	42,000	CY	$3	$126,000
3.3	Levee Breaches - External (cut)	33,000	CY	$7	$231,000
3.4	Levee Breaches - Internal (cut, haul, fill)	30,000	CY	$13	$390,000
3.5	Channels & Islands (cut, fill)	89,000	CY	$9	$801,000
3.6	Channel spurs (access road, cut, haul, fill)	17,000	CY	$27	$486,000
3.7	Habitat Transition Zones (haul, fill)	96,000	CY	$12	$1,152,000
3.8	Hydroseeding	25	ACRE	$10,000	$250,000
4	Structures				$5,770,000
4.1	Water Control Structures	-	-	-	-
4.1.1	ACFCC/E2C (add to existing; two 48" pipes, 170 lf with headwalls & gates)	1	EACH	$670,000	$670,000
4.1.2	E2C/CP3C (replace existing one 48" pipe, 75 lf, with gates)	1	EACH	$375,000	$375,000
4.1.3	OAC/E6 (two 48" pipes, 150 lf with gates)	1	EACH	$670,000	$670,000
4.1.4	E1C/E5C (south) (one 48" pipe, 60 lf with gates)	1	EACH	$370,000	$370,000
4.1.5	E1C/E5C (north) (one 48" pipe, 50 lf with gates)	1	EACH	$365,000	$365,000
4.1.6	E6/E5 (west) (one 48" pipe, 40 lf with gates)	1	EACH	$360,000	$360,000
4.1.7	E6/E5 (east, replace existing) (one 48" pipe, 40 lf with gates)	1	EACH	$360,000	$360,000
4.1.8	E5/E6C (west, repair gates only)	1	EACH	$100,000	$100,000
4.1.9	E5/E6C (east, repair gates only)	1	EACH	$100,000	$100,000
4.2	Bridges (~300 ft long)	2	EACH	$1,600,000	$3,200,000
4.3	Bridges (~500 ft long)	0	EACH	$2,100,000	$0
5	Public Access Features				$950,300
5.1	Recreational Trails	311,200	SF	$3	$933,600
5.2	Interpretive Signage	1	EACH	$3,900	$3,900
5.3	Benches	1	EACH	$6,800	$6,800
5.4	Viewing Platform	1,000	SF	$6	$6,000
	Subtotal				$15,913,700
	Design & Unit Cost Contingency			25%	$3,978,500
	Total Direct Construction Cost				$19,892,200
	Construction Contingency			30%	$5,967,700
	Total				**$25,859,900**

Table 4.15. Preliminary Cost Estimate for Eden Landing – Alternative D

Note: LS = lump sum; CY = cubic yards; apparent errors in table totals due to rounding.

The following assumptions were made in developing this preliminary cost estimate.

- Pond bottoms of the Bay and Inland Ponds will be wet during construction and will not support low ground pressure equipment without matting and road construction out into the ponds. Pond bottoms of the C-Ponds will be dry during construction and have the ability to support low ground pressure equipment.
- Building temporary roads out into the ponds to excavate channels requires construction sequencing considerations because fill material will have to be brought into the site, and efficient management of this fill material could reduce costs.
- Import fill is assumed to be provided to the projects by a dirt broker at no cost to the project and in a quantity that does not limit typical equipment production rates.
- Significant culvert costs include T-shaped bridge structures (on both sides) to operate gates, sheet piling, dewatering, trenching, HDPE piping, and combination gates on either side of the pipe. (HDPE pipe is assumed in this estimate as opposed to CMP.)
- Significant concrete box culvert costs include concrete headwalls (both sides), sheet piling, dewatering, trenching, cast-in-place concrete, and combination gates on either side of the culvert.
- Approximately half of the disturbed acreage from levee raising and cutting is assumed to be hydroseeded, as areas exposed to tidal waters are anticipated to be naturally seeded once tidal exchange is returned to the ponds.
- Each Alternative contains optional Trail Routes 1, 2, and 3. An average distance of Trail Routes 1, 2, and 3 (approximately 10,000 linear feet) was used in cost estimates.
- The estimate includes a design and unit cost contingency of 25 percent to cover changes to the design assumptions and components and uncertainty in material unit costs.
- The estimate includes a construction contingency of 30 percent to cover changes to the project costs during construction.
- The contingencies do not include costs for engineering design, environmental documentation, permits, or contract and construction administration.

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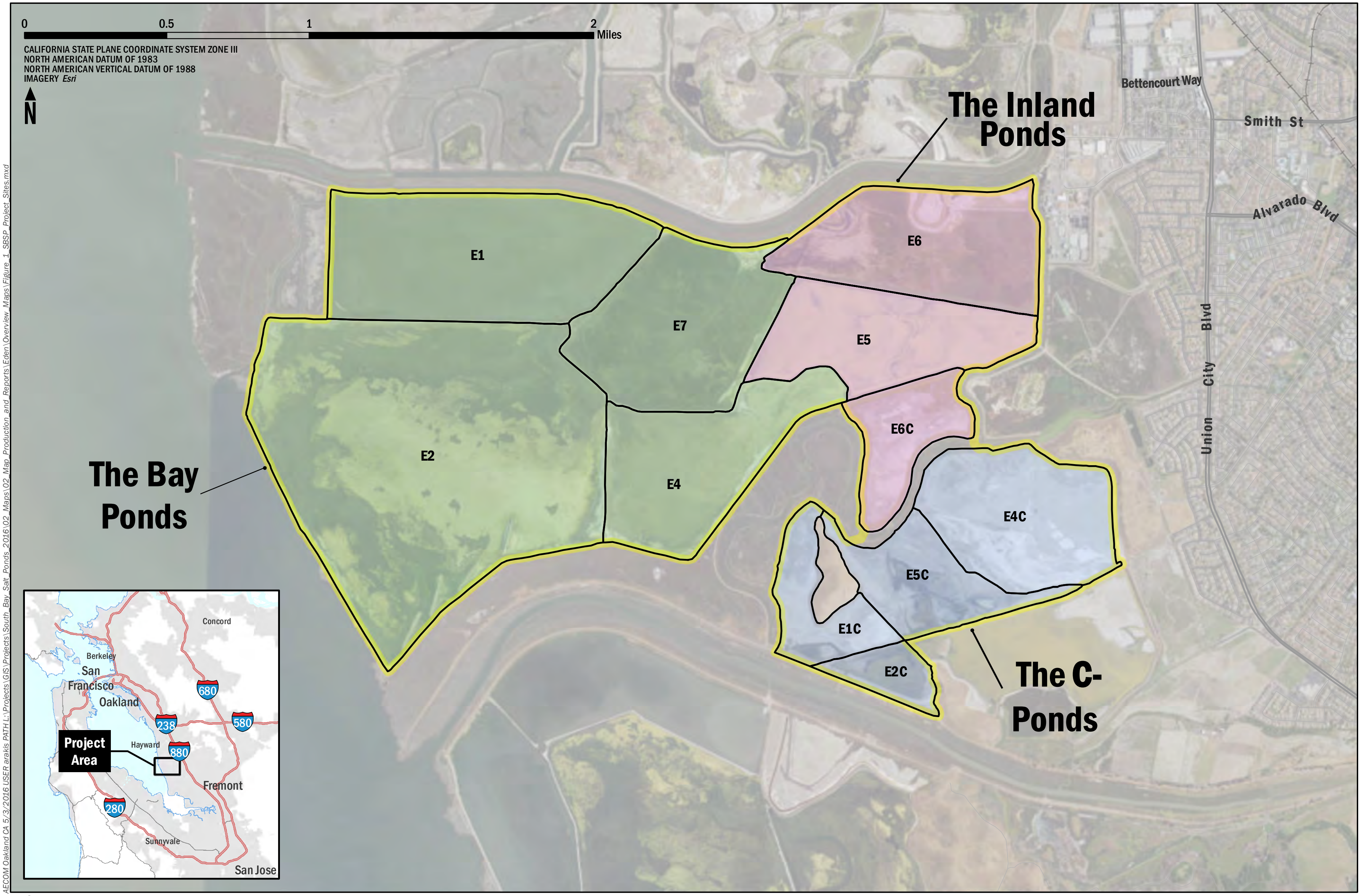
Appendix A

Eden Landing Figures



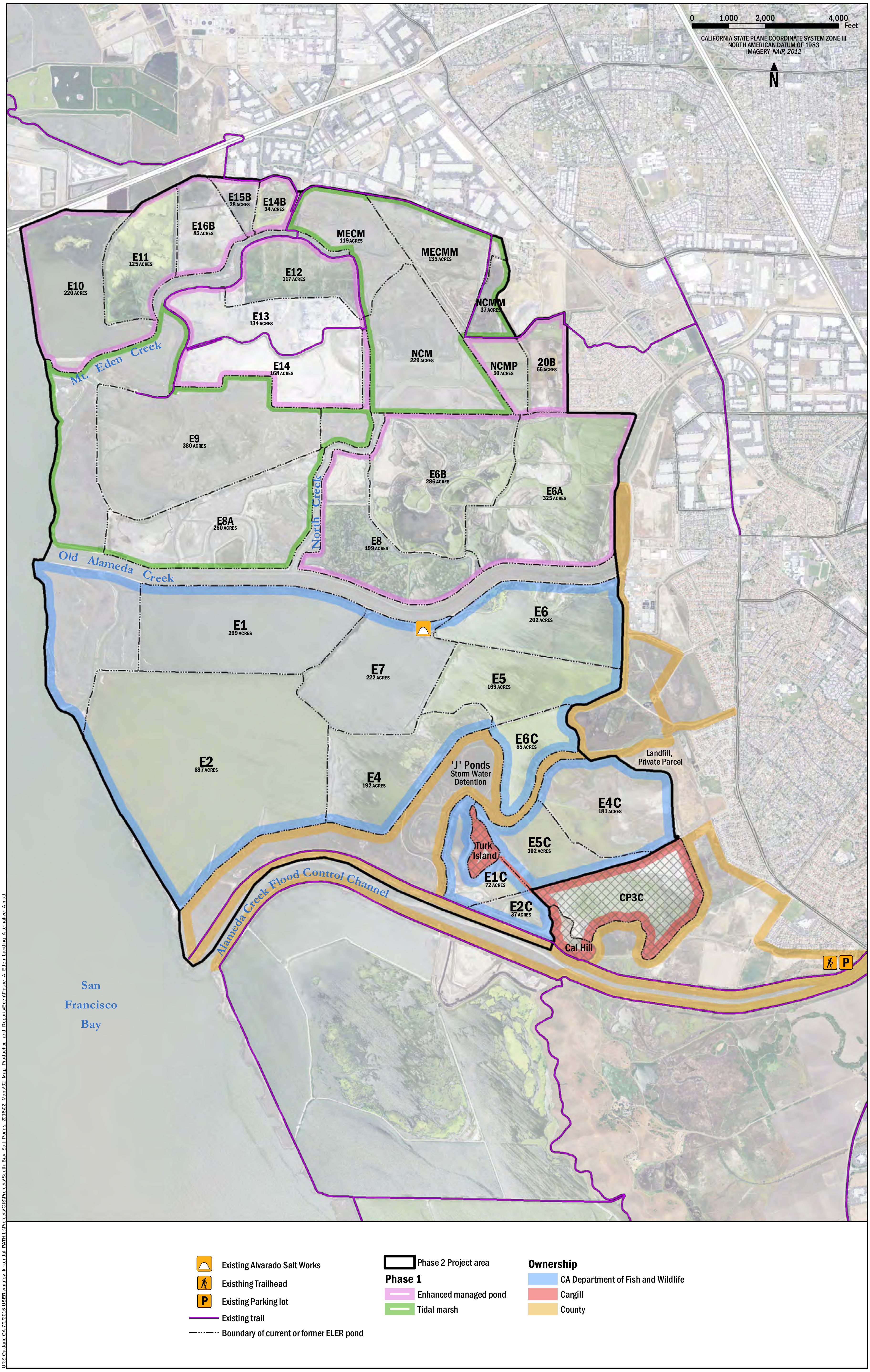
LEGEND

- Phase 2 Eden Landing Project Area
- The Bay Ponds
- The C Ponds
- The Inland Ponds

AECOM

South Bay Salt Pond Restoration Project
Eden Landing Phase 2: Project Area

Figure A-1
Eden Landing Phase 2: Project Area



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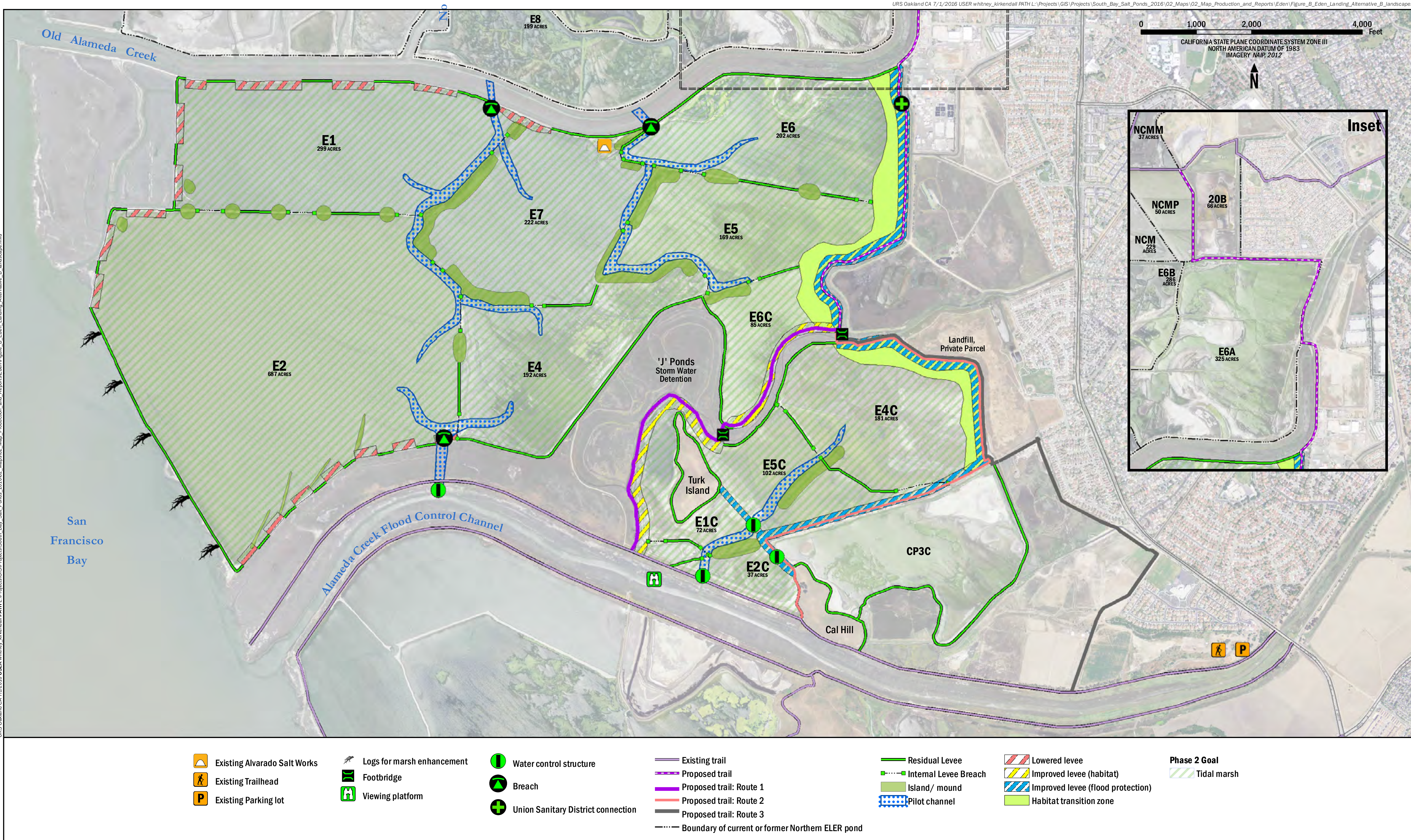
AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden A



AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden B

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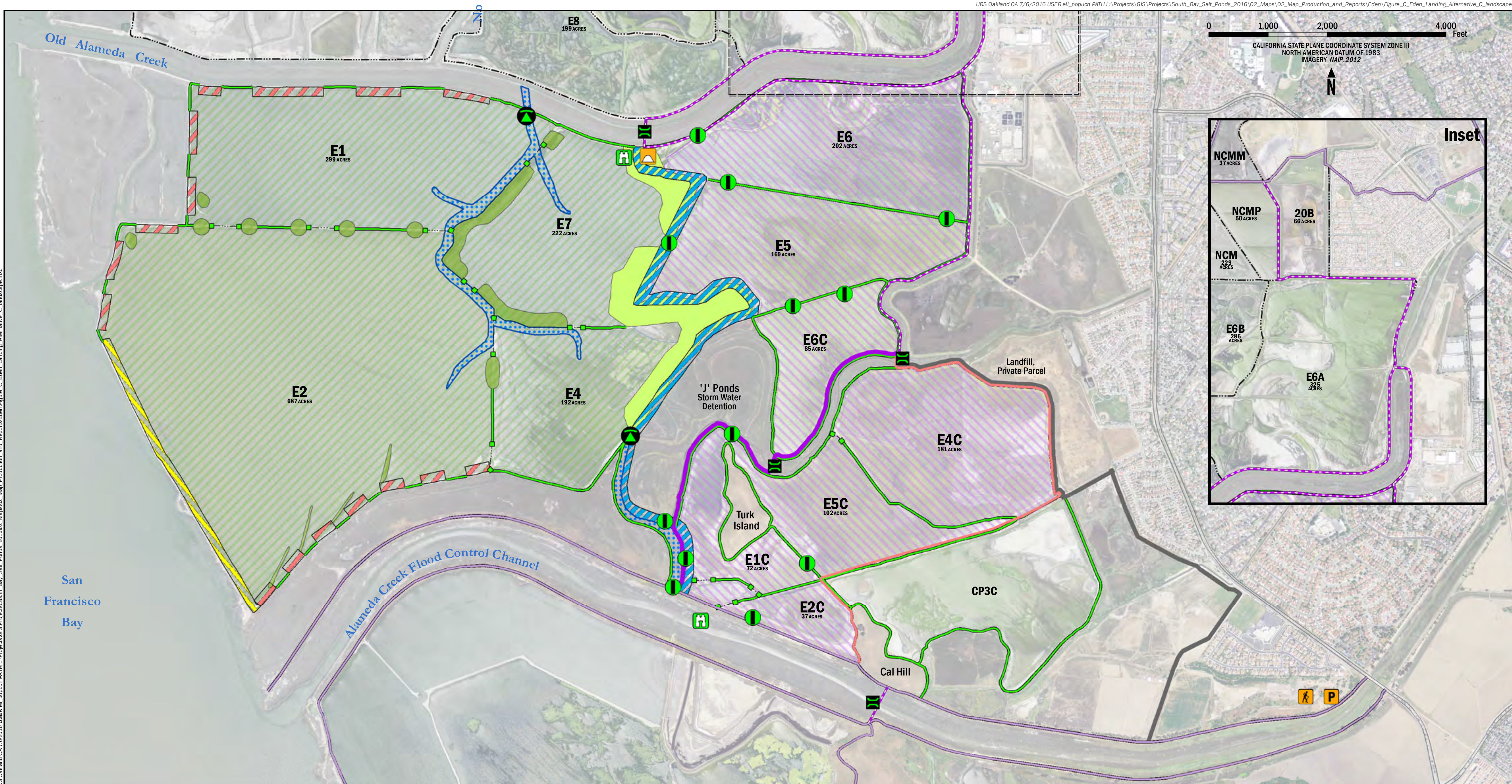
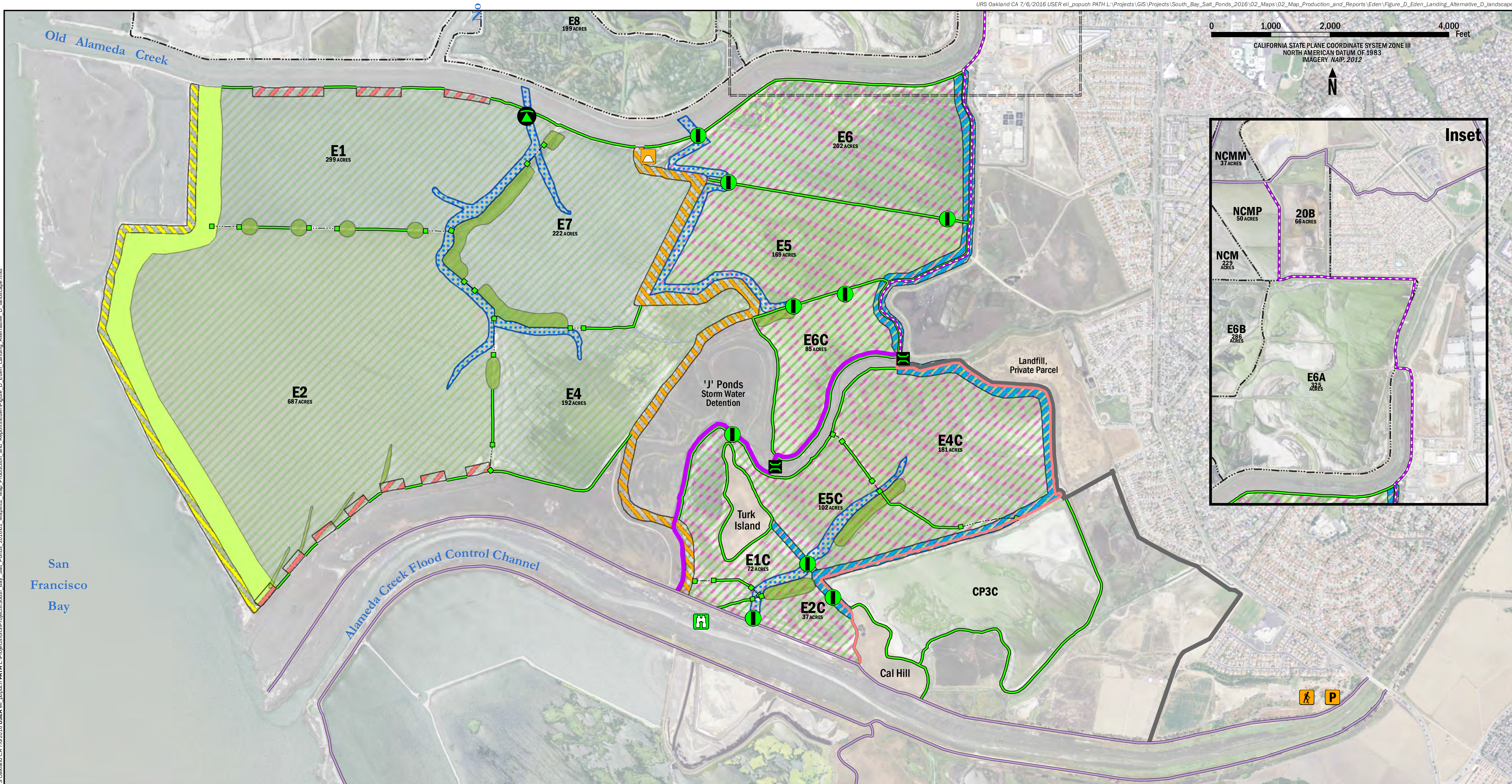


Existing Alvarado Salt Works
Existing Trailhead
Existing Parking lot
Footbridge
Viewing platform
Water control structure
Breach
Existing trail
Proposed trail
Proposed trail: Route 1
Proposed trail: Route 2
Proposed trail: Route 3
Boundary of current or former ELER pond
Residual Levee
Internal Levee Breach
Island/ mound
Pilot channel
Lowered levee
Improved levee (flood protection)
Improved levee (habitat)
Habitat transition zone
Phase 2 Goal
Managed Pond, Permanent
Tidal marsh

AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden C



Existing Alvarado Salt Works	Viewing platform	Existing trail	Residual Levee	Lowered levee	Phase 2 Goal
Existing Trailhead	Water control structure	Proposed trail	Internal Levee Breach	Improved levee (flood protection)	Managed Pond, then tidal marsh
Existing Parking lot	Breach	Proposed trail: Route 1	Habitat transition zone	Improved levee (habitat)	Tidal marsh
		Proposed trail: Route 2	Island/ mound	Temporary levee	
		Proposed trail: Route 3	Pilot channel		
		Boundary of current or former ELER pond			

AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden D

Infrastructure

- Water control structure
- Pump
- Power distribution line
- Overhead power transmission line

Status

- Existing

Boundary of current or former ELER pond

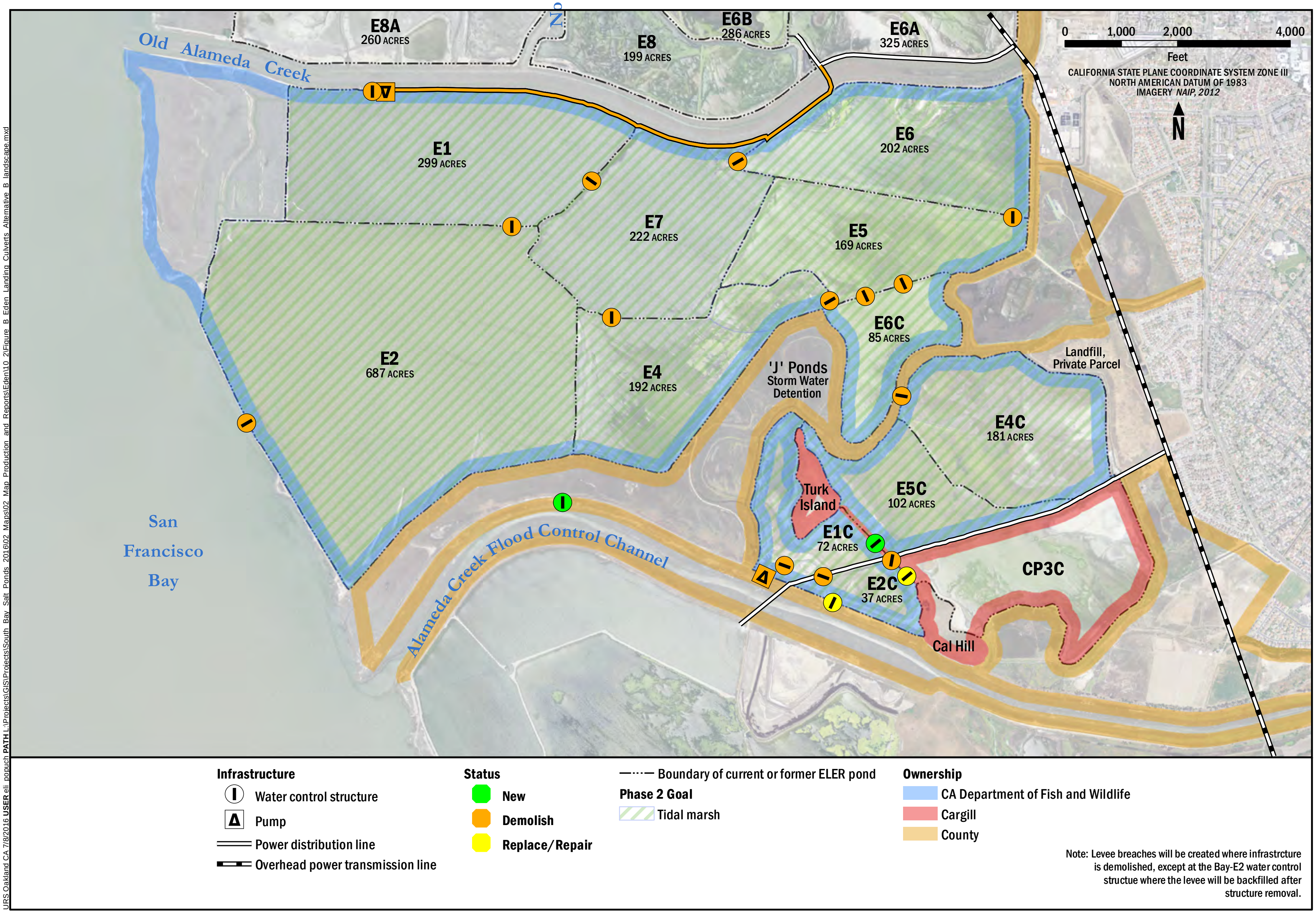
Ownership

- CA Department of Fish and Wildlife
- Cargill
- County

AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative A



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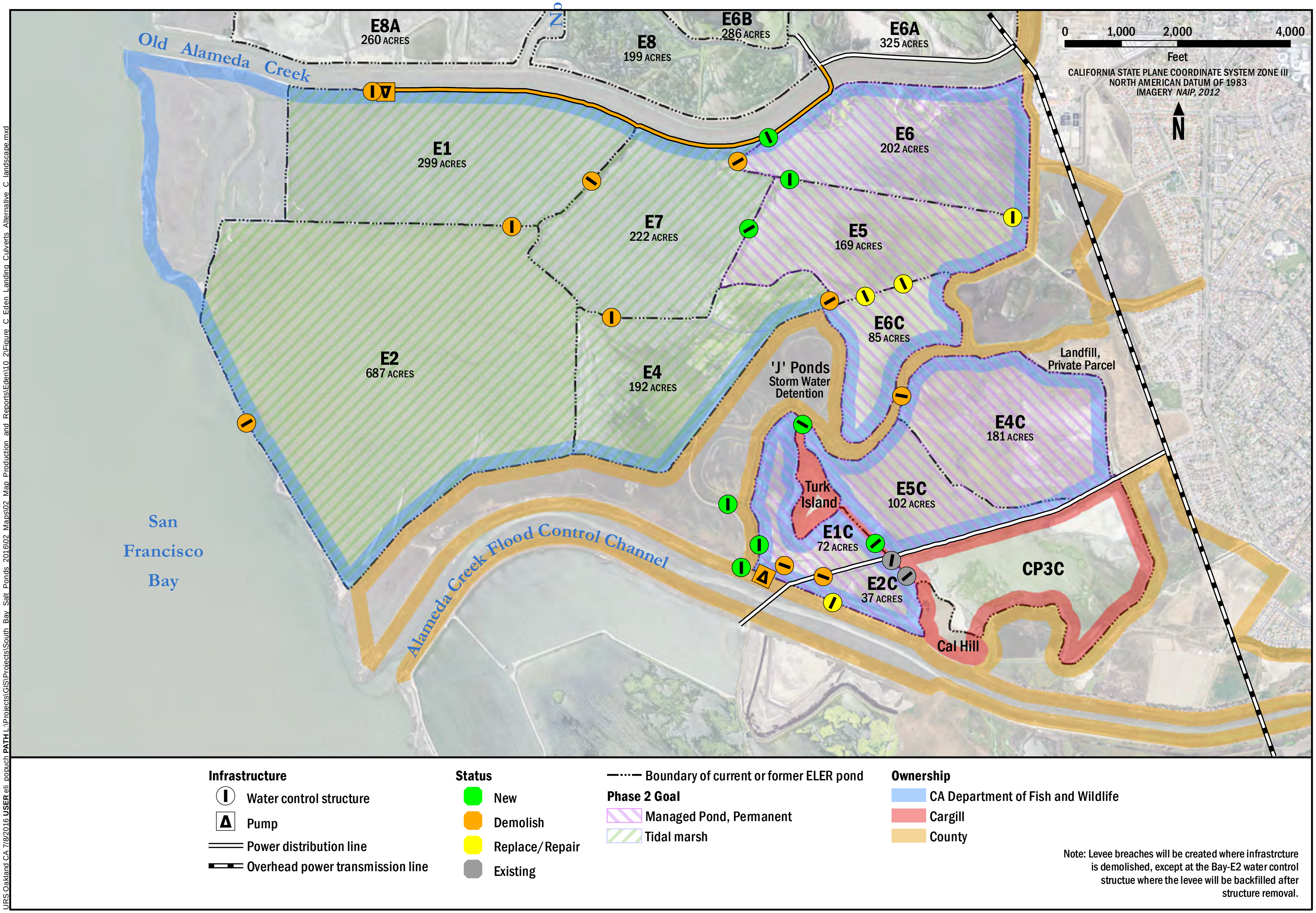
AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

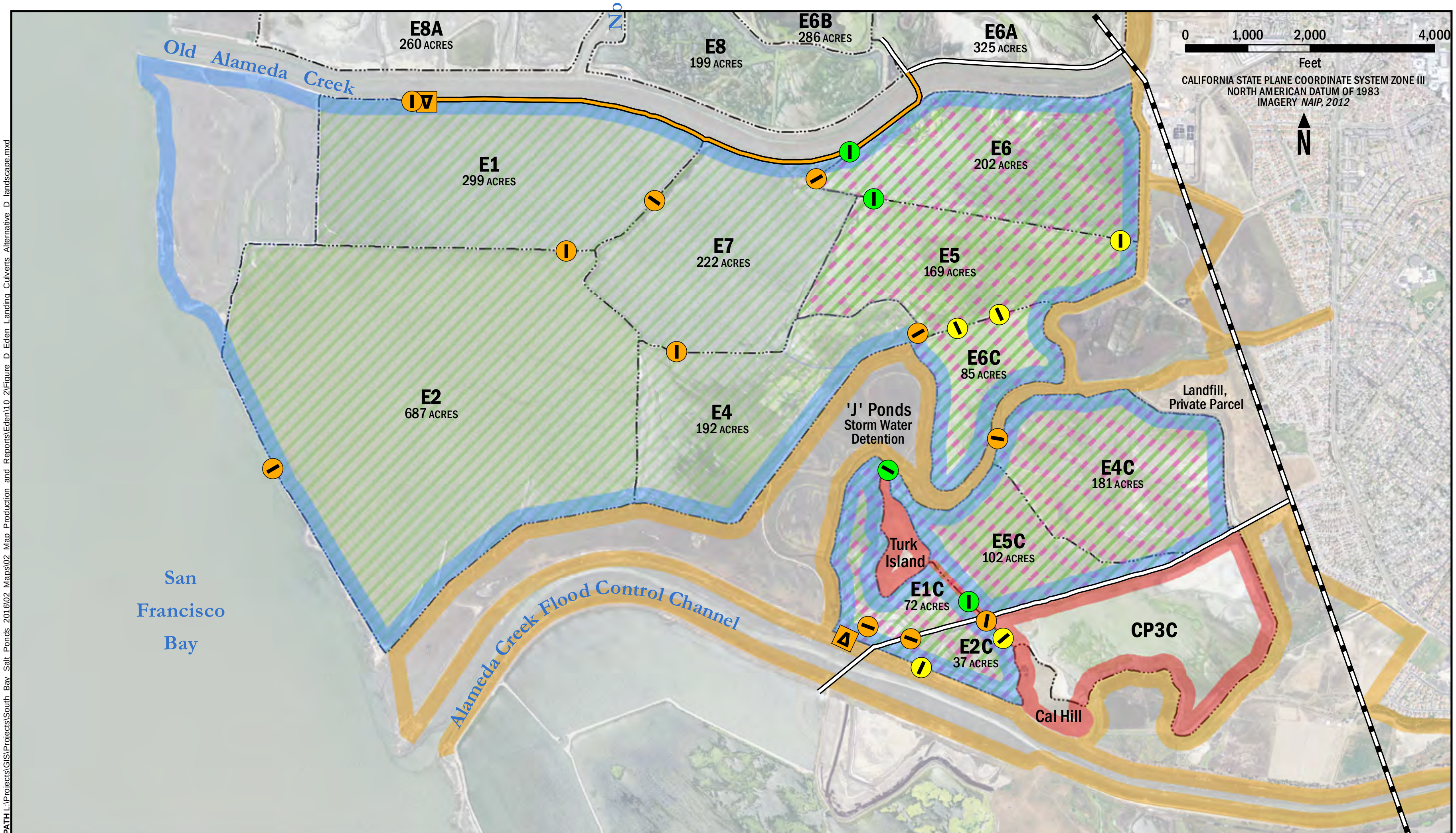
Infrastructure Alternative B



AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative C



Infrastructure

- Water control structure
- Pump
- Power distribution line
- Overhead power transmission line

Status

- New
- Demolish
- Replace/Repair

Boundary of current or former ELER pond

Phase 2 Goal

- Managed Pond, then tidal marsh
- Tidal marsh

Ownership

- CA Department of Fish and Wildlife
- Cargill
- County

Note: Levee breaches will be created where infrastructure is demolished, except at the Bay-E2 water control structue where the levee will be backfilled after structure removal. New and replaced/repaired water control structures in the Island Ponds will be demolished when the ponds are phased into tidal marsh.

AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative D

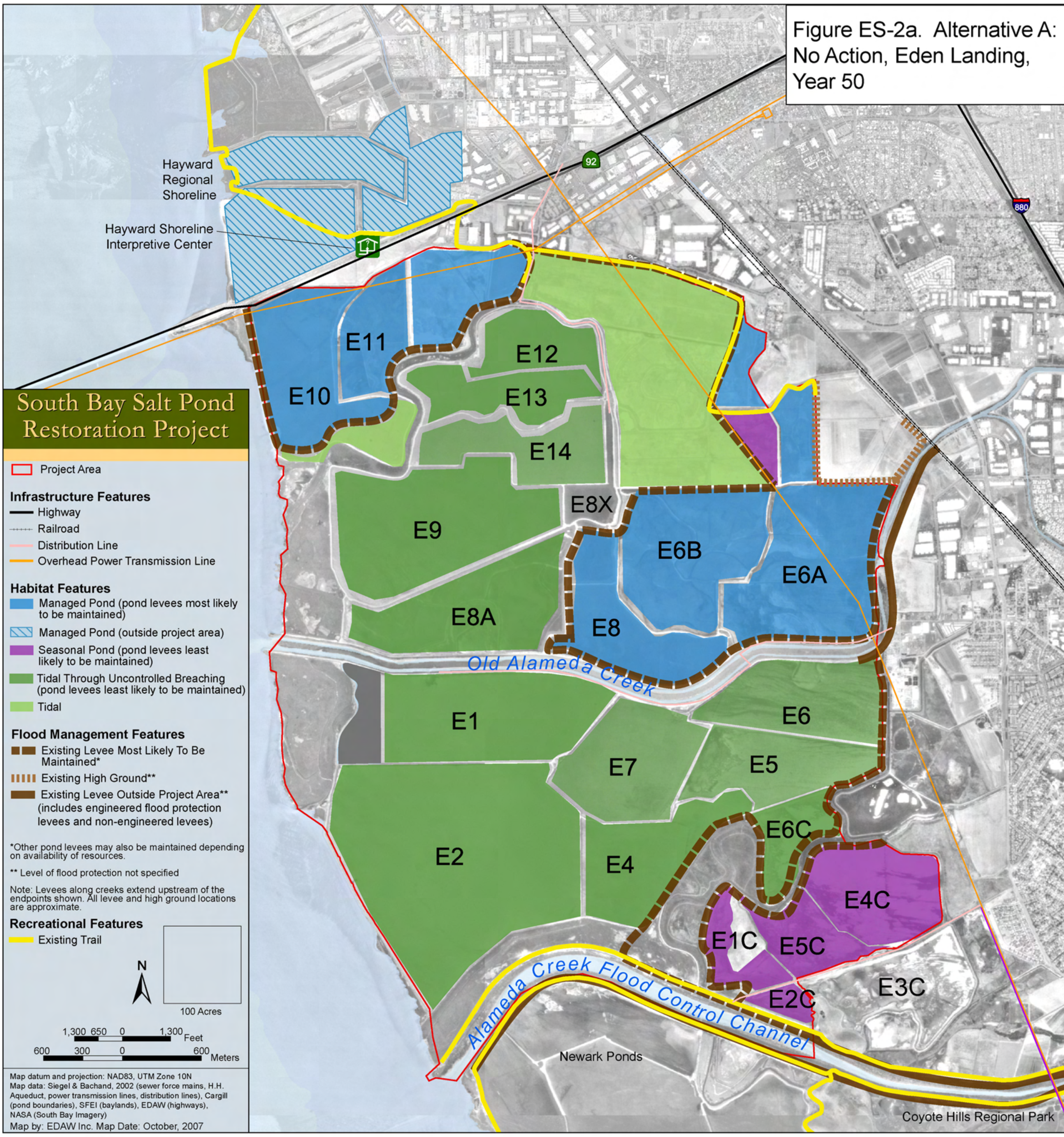


Figure A-6. Programmatic EIS/R Alternative A: No Action

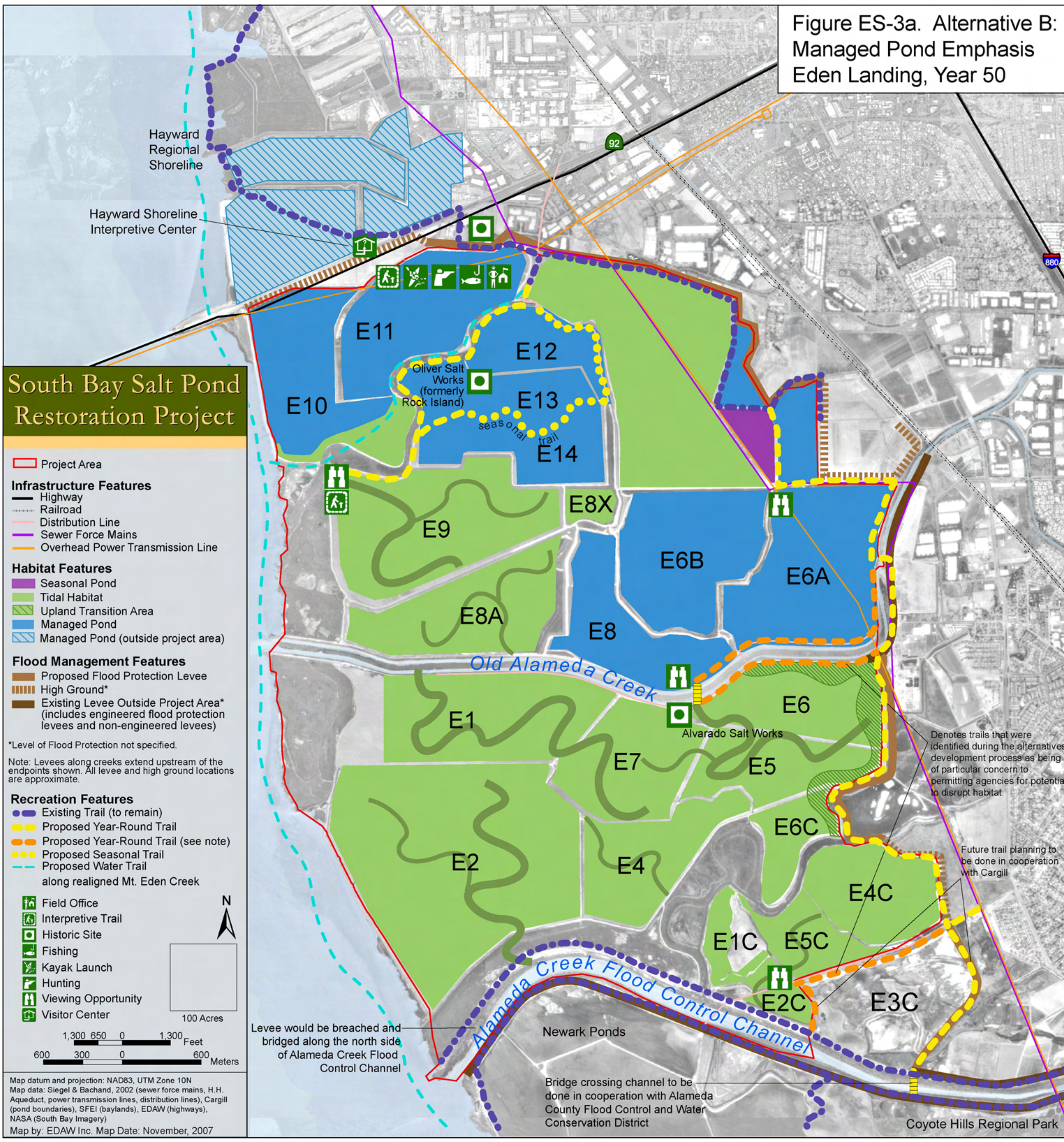


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Figure A-7. Programmatic EIS/R Alternative B: Managed Pond Emphasis

Figure A-8. Programmatic EIS/R Alternative C: Tidal Habitat Emphasis

Appendix B

Levee Breach Design

Table A.1. External Breach Design: Empirical Relationships

Location	Pond Area (acres)	Avg. Pond Bottom Elev. (ft. NAVD88)	Potential Diurnal Tidal Prism (ac-ft)	Avg. Channel Cross-sectional Area (ft^2)	Bottom Elev. (ft. NAVD88)	Channel Top Width or Breach Length (ft.) (parallel crest)	Applicable Alternatives
OAC/E1 (west)	Note 1				0	30	B, C and D
OAC/E1 (east)	1,375 (E1, E2, E4, E7)	4.9 (E1) 4.8 (E2) 5.6 (E4) 5.2 (E7)	1,000	2,750	-4	380	B, C and D
OAC/E6	445 (E5, E6, E6C)	5.1 (E5, E6) 5.5 (E6C)	280	1,200	-4	160	B
Alameda County Wetlands/E2/E4	Note 2				2.7 or higher	50	B
Alameda County Wetlands/E4	Note 2				2.7 or higher	50	C

Note 1: Not applicable. Breach included due to structure removal and not designed with empirical relationships.

Note 2: Not applicable. Breach included to provide fish passage downstream of a culvert. Not designed with empirical relationships.

Table A.2. Internal Breach Design: Empirical Relationships

Location	Pond Area (acres)	Avg. Pond Bottom Elev. (ft. NAVD88)	Potential Diurnal Tidal Prism (ac-ft)	Avg. Channel Cross-sectional Area (ft^2)	Bottom Elev. (ft. NAVD88)	Channel Top Width or Breach Length (ft.) (parallel crest)	Applicable Alternatives
E1/E2 (west)	680 (E2)	4.8 (E2)	180	900	-4	120	B, C and D
E1/E2 (mid)			180	900	-4	120	B, C and D
E1/E2 (east)			180	900	-4	120	B, C and D
E1/E7	Note 1				-4	50	B, C and D
E2/E7	Note 1				5 (EG)	50	B, C and D
E7/E4	190 (E4)	5.6 (E4)	120	700	-4	100	B, C and D
E2/E4 (north)	Note 1				-4	50	B, C and D
E2/E4 (south)	Note 1				6 (EG)	50	B, C and D
E7/E6 (west)	Note 1				5 (EG)	25	B
E7/E6 (east)	200 (E6)	5.1 (E6)	130	730	-4	100	B
E5/E7	245 (E5, E6C)	5.1 (E6) 5.5 (E6C)	150	780	-4	110	B
E4/E5	Note 1				5 (EG)	50	B
E6/E5 (west)	Note 1				0	50	B
E6/E5 (east)	Note 1				5 (EG)	50	B
E5/E6C	80 (E6C)	5.5 (E6C)	20	230	-4	50	B
E1C/E2C Donut	Note 2				2.4	100	B, C and D
E2C Donut (west)	Note 2				2.4	50	B, C and D
E2C Donut (east)						50	B, C and D
E4C/E5C (mid)	95 (E5C)	6.1 (E5C)	60	410	2.7	50	B and D
E4C/E5C (south)					2.7	50	B and D

Note 1: Not applicable. Breach included to promote water exchange between ponds and not designed with empirical relationships.

Note 2: Not applicable. Culvert causes muted tides; therefore, breaches not designed with empirical relationships.

ATTACHMENT 1. SOUTHERN EDEN LANDING RESTORATION PRELIMINARY DESIGN: 1D AND 2D HYDRODYNAMIC MODELING

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South Bay Salt Pond Restoration Project

MEMORANDUM

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

FROM: AECOM

DATE: July 2016

RE: **Attachment 1. Southern Eden Landing Restoration Preliminary Design: 1D and 2D Hydrodynamic Modeling**

1. INTRODUCTION

This memorandum documents the one- and two-dimensional hydrodynamic modeling performed in support of the Southern Eden Landing Restoration Preliminary Design (AECOM 2016a). The preliminary design is of the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 actions at the southern half of the Eden Landing Ecological Reserve (ELER). For the purposes of this document, these ponds are referred to as the southern Eden Landing Ponds.

The southern Eden Landing Ponds includes 11 ponds that are described in three groups in this memorandum, 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 1.1:

- The Bay Ponds: Ponds E1, E2, E4, and E7 are the four relatively large ponds closest to San Francisco Bay, bordered to the north by the Old Alameda Creek (OAC) and to the south by

Alameda County-owned property including the Alameda County Wetlands and the Alameda County Flood Control Channel (ACFCC).

- The Inland Ponds: Ponds E5, E6, and E6C are somewhat smaller ponds in the northeast portion of the complex. They are bordered to the north by OAC, to the east by the Union Sanitary District Waste Water Treatment Plant and Cargill owned property (used by the Southern Alameda County Radio Controllers Aircraft Club), and to the south by an Alameda County-owned freshwater outflow channel and diked marsh areas known collectively as the "J-Ponds".
- The Southern Ponds or C-Ponds: Referred to by both names, Ponds E1C, E2C, E4C, and E5C are in the southeastern portion of the complex. They are separated from the Inland Ponds and the Bay Ponds by the J-Ponds.

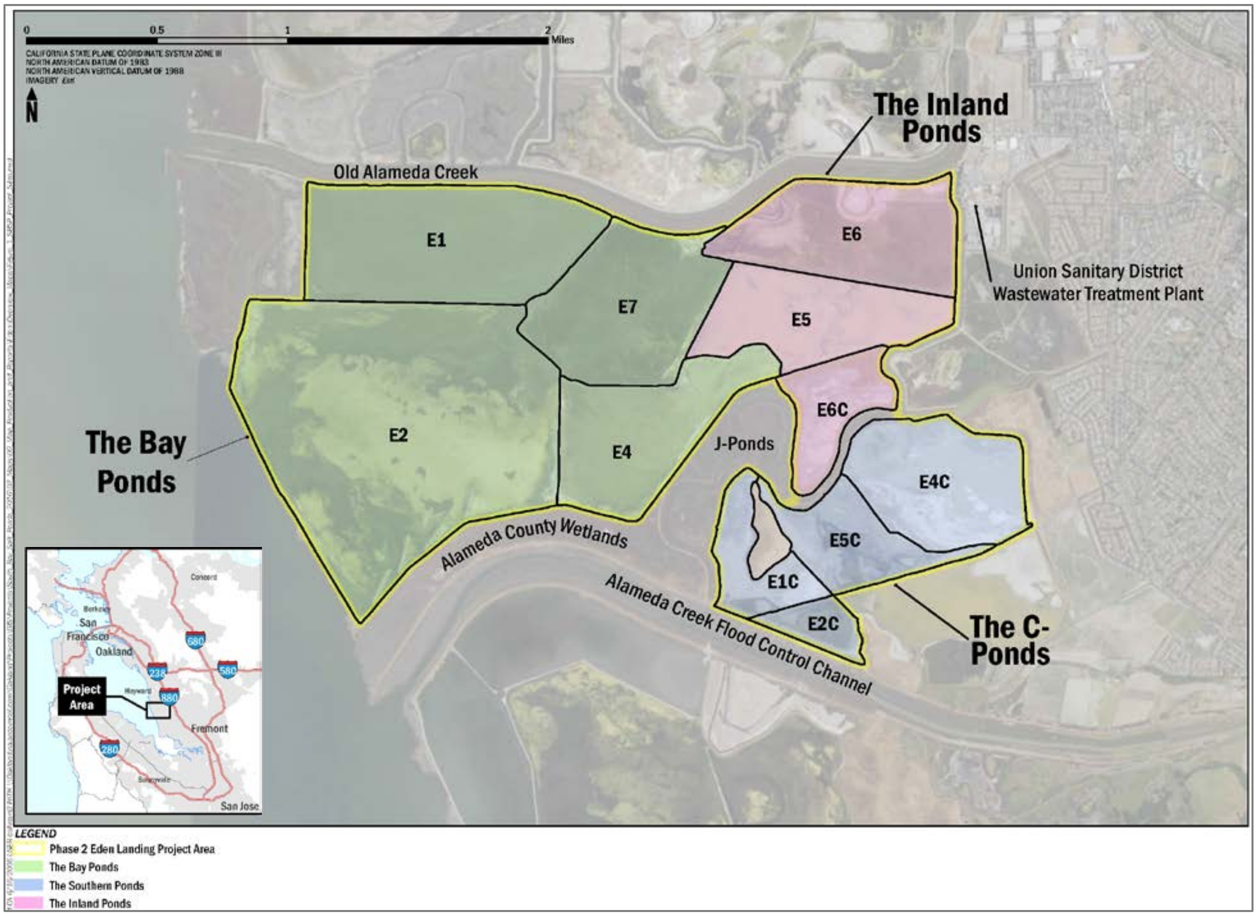

Figure 1.1. Project Vicinity Map

The Phase 2 southern Eden Landing alternatives include one no-action (Alternative Eden A) and three action project alternatives (Alternatives Eden B, C and D) as graphically depicted in Appendix A on Figures A-2, A-3, A-4, and A-5. Each of these alternatives also includes new infrastructure and repair of existing structures as shown in Figures A-6, A-7, A-8, and A-9. Figure 1.2 below shows no-action infrastructure alternative map (Figure A-6) which details existing infrastructure (culverts, pumps, and electrical lines) within southern Eden Landing. Table 1.1 summarizes these existing culverts and pumps and the proposed action. Proposed actions include demolishing or repairing/replacing structures. Demolished materials will be salvaged for re-use elsewhere, or disposed or recycled off-site.

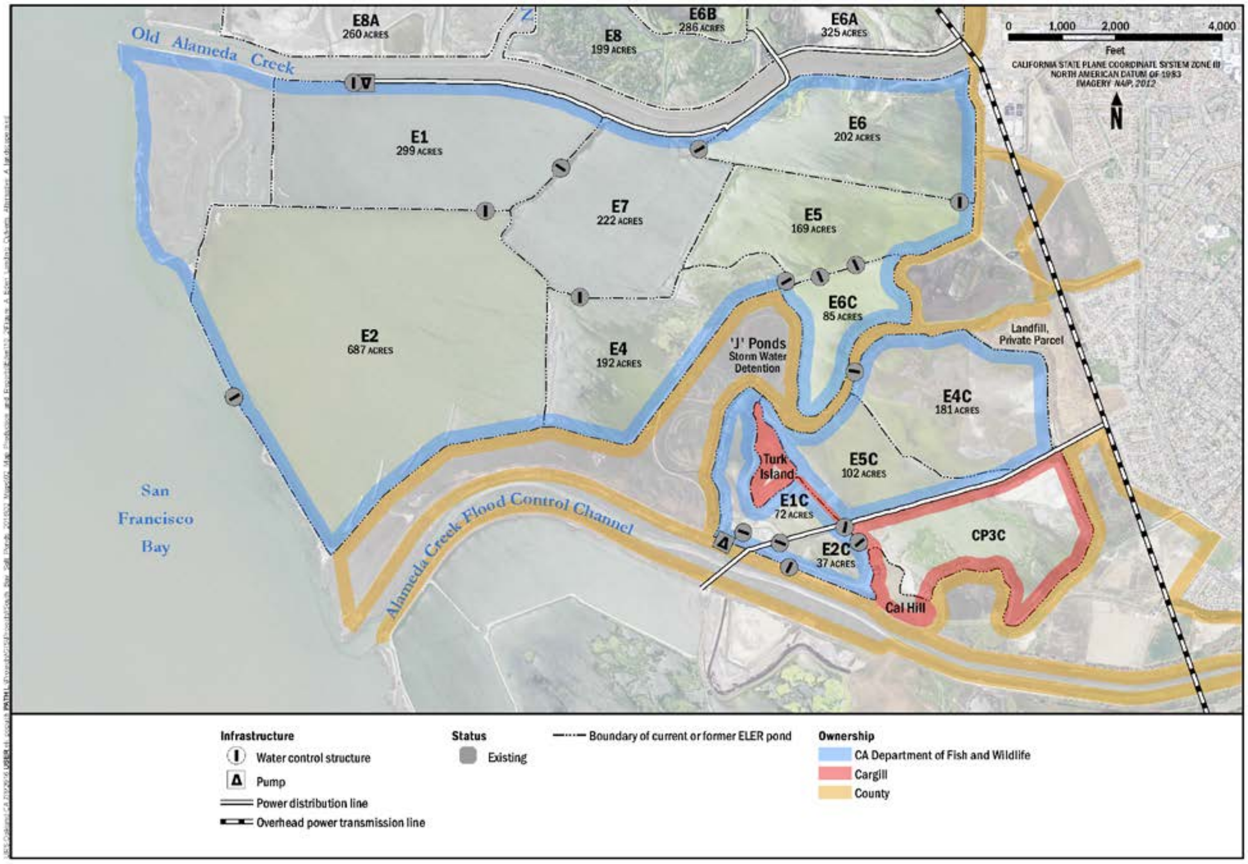

Figure 1.2. Existing Infrastructure

Table 1.1. Existing Water Control Structures

Location	Quantity	Size	Type	Action
E2 - Bay	2	48 in.	Intake/discharge gates	Demolish (backfill levee)
OAC - E1	4	48 in.	(2) Intake/discharge open pipes/combo gates	Demolish
			(2) Intake/discharge slide gates/flap gates	
OAC - E1	1	10,000 gpm	Pump (#1 Baumberg Intake)	
E1 - E2	1	48 in.	Slide gate	
E1 - E7	1	48 in.	Slide gate	
E7 - E4	1	48 in.	Slide gate	
E7 - E6	1	48 in.	Slide gate	
E4 - E5	1	48 in.	Combo gate	
E6 - E5	4	30 in.	Wood gates	Demolish (Alt. B) or Replace/repair (Alt. C & D)
E5 - E6C	2	36 in.	Combo gates	
E6C - E4C	2	30 in.	Siphons (not operable)	Demolish (backfill levee)
E2C - E5C	1	36 in.	Combo gate	
ACFCC - E1C	1	7,660 gpm	Pump (Cal Hill Intake) (not operable)	
ACFCC - E2C	2	48 in.	Intake/discharge combo gates	Replace/repair
E2C - CP3C	1	48 in.	Slide gate	
E2C - E2C donut	1	36 in.	Unknown (open)	Demolish
E1C - E2C donut	1 1	24 in. 10,000 gpm	Unknown (not operable) Pump (Cal Hill Transfer) (not operable)	

2. METHODOLOGY

AECOM developed a two-dimensional hydrodynamic model using MIKE21 to refine the design of restoration features including levee breach and pilot channel dimensions, levee raising and lowering heights and locations, and culvert locations and numbers. A one-dimensional hydraulic model using HEC-RAS was also developed to efficiently analyze culvert sizes for the C-Ponds and Inland Ponds, as HEC-RAS has a more robust culvert routine and the model runtime is minutes instead of hours with MIKE21. Analyses were performed on the three project action alternatives (Alternatives Eden B, C and D). These alternatives are graphically depicted in Appendix A on Figures A-3, A-4, and A-5.

The following sections include a description of the model methodology (model type, domain, restoration feature design criteria, modeling scenarios, and inputs). Because there were no available flow or pond water surface elevation data, neither of the models were calibrated.

2.1 Model Types

MIKE21 FM Model
AECOM used MIKE21 Flexible Mesh Flow Model version 2016 (MIKE21 FM) for this study. MIKE21 FM simulates changes in water levels and velocities in response to tides, wind, and freshwater inflows. It solves the time-dependent, vertically integrated equations of continuity and conservation of momentum in two horizontal dimensions. The equations are solved using a cell-centered finite volume method. Water levels and flows are resolved using a spatial domain comprised of triangles and/or quadrilateral elements. Inputs include topography and bathymetry, structure geometry, bed resistance, structures, and hydrographic boundary conditions (e.g. tides and river discharge). Outputs include water surface elevation, total water depth, velocities, and discharge through structures.

HEC-RAS Model
USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) was used to develop a model of the Eden Landing managed pond system. Existing and potential culverts were modeled to measure their effectiveness at filling the ponds during typical management activities and flood conditions. As mentioned above, HEC-RAS is the preferred model for culvert design as model runtimes are on the scale of minutes instead of hours with MIKE21, and HEC-RAS allows for more comprehensive culvert design. Inputs include topography and bathymetry, bed resistance, structures, and hydrographic boundary conditions (e.g. tides and river discharge). Outputs include water surface elevation and discharge velocities through structures.

2.2 Site Topography and Project Datum

Table 2.1 lists the three sources of topographic and bathymetric data used in this modeling analysis and the associated preliminary design.

Table 2.1. Topographic and Bathymetric Data

Data Source	Year Collected	Horizontal Datum	Vertical Datum	Projection
USGS 2010 SBSP Project LiDAR	2010	NAD83	NAVD88	UTM-10 10N
USGS 2005 SBSP Project Bathymetry	2003-2004	NAD83	NAVD88	CA State Plane III
USGS 2007 South San Francisco Bay Bathymetry	2005	NAD83	NAVD88	UTM-10 10N

The available site topography is high-accuracy LiDAR from the 2010 USGS San Francisco Coastal LiDAR project (San Francisco, Marin, Solano, Contra Costa, Alameda, San Mateo, Santa Clara counties, California). The LiDAR data was collected between June 11, 2010 and July 11, 2010.

USGS (2005) also conducted a bathymetric survey of the SBSP Project pond complexes between August 2003 and March 2004 using a shallow-water sounding system to measure water depths with a precision of 1 cm. The system was comprised of a single beam echosounder, a differential global positioning system (DGPS) unit, and a laptop computer on a shallow-draft kayak with a trolling motor. Sample depths were converted to elevation based on water surface elevations recorded every 15-20 minutes at the ponds. Transects were made at 100 meter intervals.

The below water elevations in the Bay adjacent to the project site were obtained from 2005 Hydrographic Survey of South San Francisco Bay, California by USGS, published in 2007. These data consisted of xyz data collected using a single beam acoustic sampler.

The digital elevation point files used in the hydrodynamic model were generated by merging the three sets of data using the horizontal spatial reference system of NAD83, CA State Plane III meters and vertical datum NAVD88, meters.

The data from the bathymetric survey of the SBSP pond complexes and the bathymetric survey of the South Bay were inserted into areas with no LiDAR coverage (to prevent overlapping points between the datasets). To reduce the number of LiDAR points for use in CADD and the hydrodynamic model, the LiDAR datasets were down sampled using a “model key point” algorithm. “Model key points” are points selected to represent local topography and are not removed during a point thinning process. This algorithm thins the ground class within a user-specified vertical tolerance. Areas which exhibit a greater variation in the terrain have more model key points than in areas with a smaller variation in terrain (for example a parking lot). The vertical tolerance parameter required for the algorithm mandates that a triangulated irregular network (TIN) surface generated from the model key points would be within the user-specified distance of a TIN surface generated from the original ground points. The algorithm vertical tolerance parameter was set to 6 inches (0.15 meters) for this study.

In general, the project site is comprised of fairly flat pond bottoms separated by levees. Many of the levees have borrow ditches directly adjacent to them. Figure 2.1 depicts the distribution of pond bottom elevations of the three groups of ponds, most of which are between MSL and MHW. About half of the pond bottoms are 1 ½ to 2 feet or more below MHW and less than 10% are higher than MHW. The C-Ponds are the highest group of ponds, followed by the Inland and Bay Ponds.

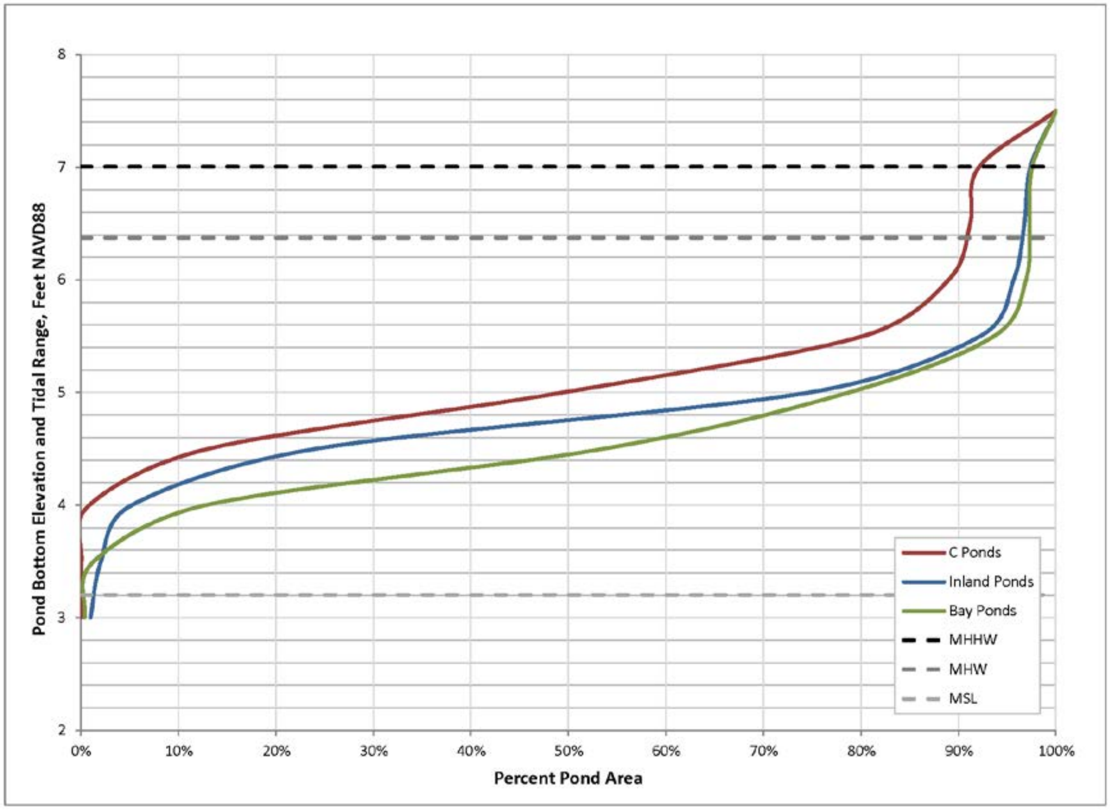

Figure 2.1. Average Pond Group Bottom Elevations

2.3 MIKE21 Model Domain

As mentioned in the previous section, the topographic and bathymetric data used to develop the model domain included three separate data sources. The final elevation grid used as input to the MIKE21 FM model is shown in Figure 2.2. (Please note, all MIKE21 model plan views are shown in metric coordinate systems and units, as the model runs most efficiently in metric.)

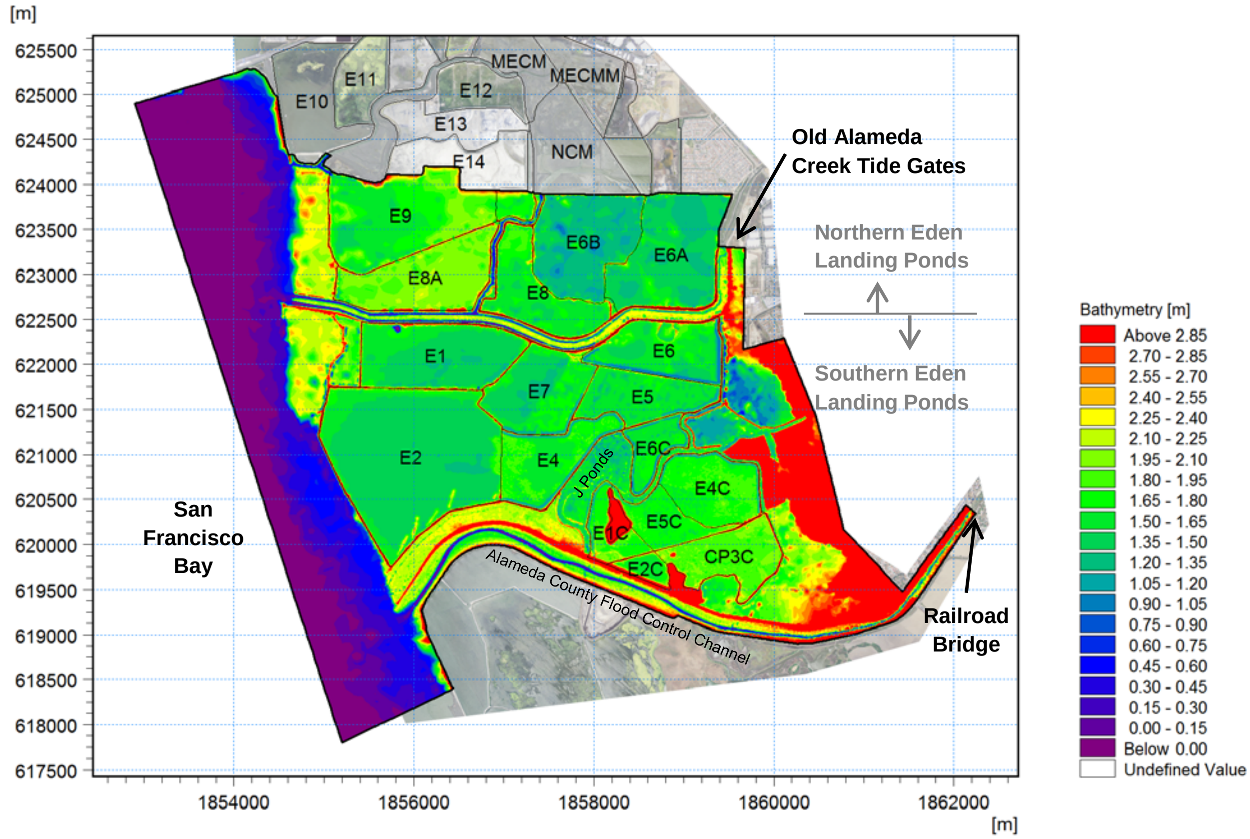

Figure 2.2. Model Elevation Grid (m NAVD88)

The model extent is as shown in Figure 2.2; bounded by the Bay to the west, the northern Eden Landing Ponds to the north, Alameda County property to the east, and ACFCC to the south. Along the OAC, the model extends to the tide gates located approximately 3.5 miles (18,500 feet) upstream from the Bay. Along the ACFCC, the model extends to the point of tidal influence approximately 4.7 miles (25,000 feet) upstream to the railroad bridge. The eastern boundary was determined with iterative modeling, which indicated that all modeled flood waters were contained by relatively high ground to the east. Of the northern Eden Landing Ponds, the three southwestern ponds (E8A, E9, and E8X) were included in the model extent because they were breached in September 2011 (SCC, 2012). The three southeastern managed ponds (E8, E6B, and E6A) were also included in the model, as they are overtopped during the 100-year flood event and therefore provide some storage capacity for the system.

The southern levee of the ACFCC was chosen as the southern extent of the model; however, it is likely overtopped during the 100-year flood event, allowing water to flow into Cargill's currently-operating salt ponds to the south. This is because, although the southern ACFCC levee is slightly higher than the northern levee near the Bay (by approximately 1 foot), the momentum of the flow will direct the water against the northern levee first, potentially overtopping and breaching it. Therefore, the southern model extent assumption is considered a realistic, conservative approach for determining flood levels in the project area.

The spatial domain of the MIKE21 FM model is represented by a system of triangular sections called a mesh, which is composed of nodes and elements. A "node" is a point in space that has both horizontal coordinates and vertical elevation assigned to it. An "element" is a triangular or quadrilateral area bounded by three or four nodes, varied throughout the mesh, which allows the area of interest to be modeled at variable resolution.

For construction of the MIKE21 FM mesh, the node points from the LiDAR were imported into the MIKE21 FM Mesh Generator utility. The Mesh Generator develops the unstructured grid that is used as the model domain. The elevations of each mesh element were interpolated from the LiDAR point cloud.

The final mesh is shown in Figure 2.3. Denser areas indicate finer mesh. In general the mesh elements range in size from 100 to 5,000 m^2 (approximately 15 to 100 meters tall and wide triangular elements). Smaller elements down to 10 m^2 are located on many of the narrow levee crests. In general, the most impacted ponds (C-Ponds), creeks, and County lands have refined element sizes of 200 m^2. The larger, flatter ponds have element sizes of 1,250 m^2. Time was taken to construct the mesh such that the critical topographic features, such as levee crests and borrow ditches, were accurately captured in the model with connected paths of at least one element.

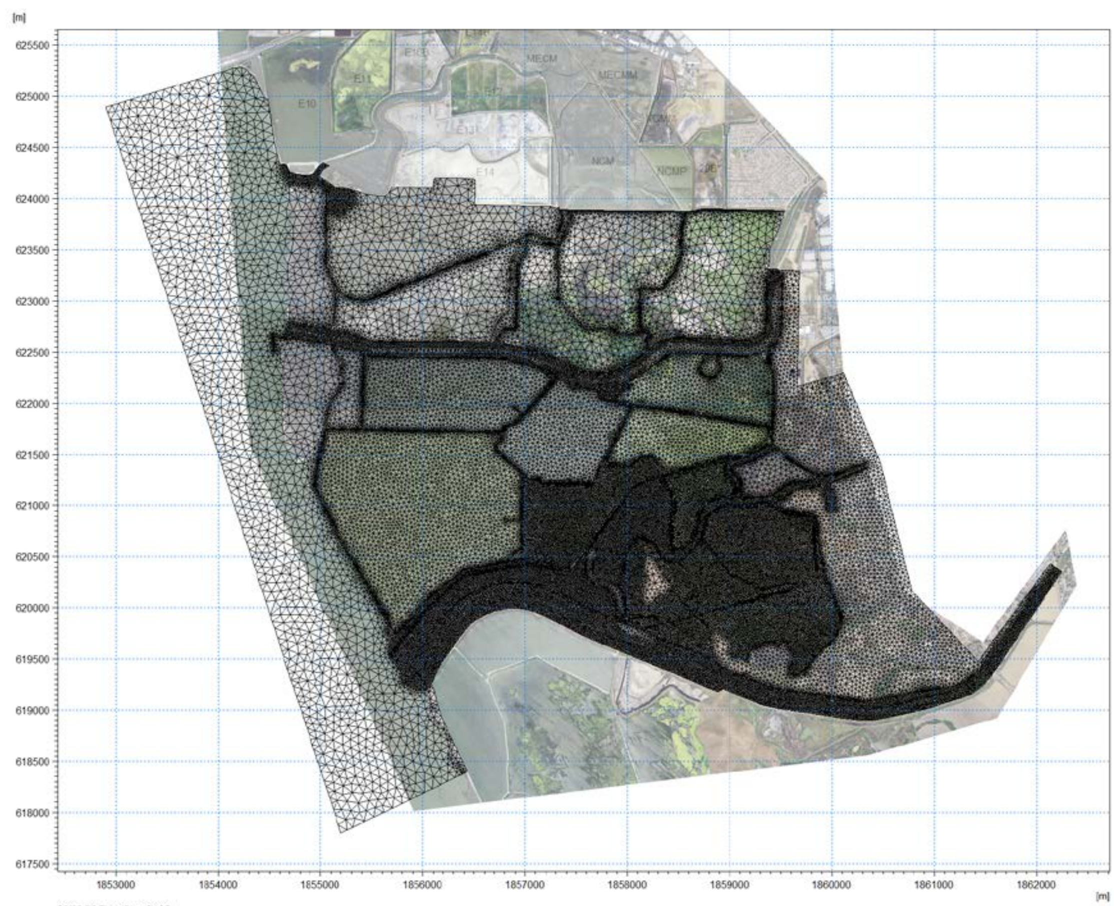

Figure 2.3. Model Mesh

Several modifications to the mesh and elevation grid were made in the Mesh Generator to improve the accuracy of the modeling results. These modifications include:

- The Northern Eden Landing Ponds were breached in September 2011 (SCC, 2012). The 2010 LiDAR data was modified to include levee breaches based on aerial imagery. Levee breach bottom elevations were estimated at about 5 feet NAVD88, similar to the surrounding pond bottom elevations.
- Borrow ditches and small channels visible in aerial imagery were included in the mesh to a greater detail than what was captured with the 100-meter bathymetry transects. Since limited bathymetry was available in these smaller ditches and channels, AECOM used nearby elevations that captured channel depths, and applied those elevations along the visible length of the channels (as determined by historic aerial images).
- Bathymetry was not available for the OAC or ACFCC, however, only the deepest portions of the channels were not captured with the 2010 LiDAR. As described in the results section, the OAC proved to be a major constriction in flow during the restoration scenarios. Because the OAC is comprised of a larger north and smaller south stream, separated by a marsh island in the middle, the smaller south stream was modified to resemble the larger north stream during some model runs. The southern stream in the OAC is anticipated to quickly, naturally increase in size and depth with the restoration project, and therefore this modification is believed to accurately represent the future conditions after restoration.

2.4 Modeling Configurations

Three general layout configurations were modeled to analyze how the different alternative configurations would function given certain boundary conditions. The features within each of these configurations were refined during the modeling analysis, resulting in the final restoration alternatives and modeling configurations as listed below. The habitat transition zones and habitat islands were not included in the analysis since they do not significantly affect the hydrodynamics. Specifics of the design of all of these alternatives can be found in the Preliminary Design Memo (AECOM 2016a).

1. Alternative A (Appendix A, Figure A-2): Existing conditions with all existing culverts closed (see Table 1.1). Given the limited conveyance of the culverts and the short duration of the peak flood (several hours), having the culverts open or closed has limited impact on flood levels; however the slightly more conservative "closed" scenario (resulting in a greater level of flood protection) was chosen of the two options.
2. Alternative B (Appendix A, Figure A-3): Full tidal restoration of the southern Eden Landing Ponds with improvements to the landside levee. The proposed fish passage channel from the ACFCC to Ponds E2 and E4 was not included in this configuration (it was originally included in a different alternative); it was however included in the Alternative C & D configuration described below. Given the relative limited conveyance through the proposed ACFCC culvert in this fish passage channel, (especially during 100-year fluvial and tidal events when levees are overtopped), the inclusion or exclusion of this fish passage channel has minimal, if any, effect on model results.

3. Alternative C & D (Appendix A, Figure A-4 and A-5): Construction of a mid-complex levee, allowing tidal restoration of the Bay Ponds and management of the Inland and C-Ponds. The future phased tidal restoration of the Inland and C-Ponds in Alternative D was assumed to be similar to Alternative B, and was therefore not modeled separately. This Alternative C & D configuration included Alternative B's fish passage culvert and channel from ACFCC to Ponds E2 and E4. Either of the fish passage channels could have been selected for use in the model, as both have limited relative conveyance through the proposed ACFCC culverts as described above.

2.5 Design Criteria of Restoration Features

The modeling objective was to inform the design of restoration features. The prominent design criteria of the restoration features were:

1. Tidal Propagation: Restoration features were designed to create adequate filling and draining of the ponds during tidal cycles. Adequate filling was defined as when the vast majority pond surface was flooded (greater than 6") during a flood tide. Adequate draining was defined as when the vast majority of the pond surface was dry (less than 6" based on model accuracy and data) during an ebb tide.
2. Flood Control: Restoration features were designed to provide at a minimum the same level of tidal and fluvial flood protection as exists under current conditions.

Additional criteria were also taken into consideration, such as limiting adverse erosion or accretion of nearby features such as existing marsh, levees and channels.

2.6 Hydrologic Scenarios

Design criteria were applied to the restoration features during two hydrologic scenarios: a typical tide scenario with no riverine discharge, and a flood scenario with a combination of 10- and 100-year riverine and tidal events. Both are described in detail below.

Tide Scenario: This hydrologic scenario included three weeks of a typical summer tide from May 4, 2015 7:00 AM to June 2, 2015 7:00 AM with no channel discharge. The first week was a "warmup" week for model equilibration, followed by two to three weeks as needed. The ponds initially were started with a water surface elevation of 2.5 feet in the ponds (about half a foot below MSL). The initial water surface elevation in the ponds was chosen to be near MSL, but because the model had a week of warmup, the initial water surface elevation had a minor impact on the modeling results. Figure 2.4 shows the time series of water levels in relation to the local tidal datums obtained from the Redwood City tide gauge (NOAA gauge 9414523), located roughly 7 miles (11 kilometers) west of Eden Landing.

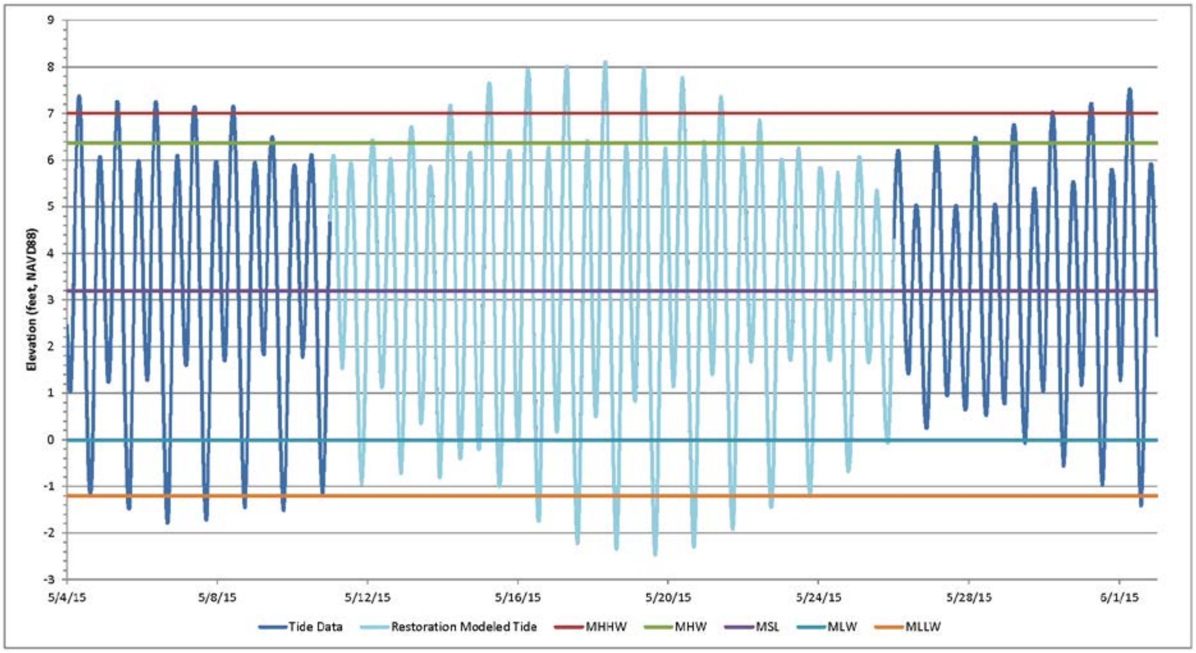

Figure 2.4. Typical Tide used as Input for Model Scenarios (Maximum Elevation 8.1 feet)

The 6 minute daily tide data from the Redwood City gauge were obtained from National Oceanic Atmospheric Administration's Tides and Currents website (NOAA 2016) and converted to NAVD88 using NOAA conversions listed in AECOM 2016. Table 2.2 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. Sources of conversions from tidal to geodetic (NAVD88) datum are listed in Table 2.2.

Table 2.2. Tidal Statistics for the 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 2016	NOAA 2016

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

Flood Scenario: This scenario included the following two combinations of flood events:

1. 100-year tide with 10-year riverine discharge from the OAC and ACFCC (coinciding tide and discharge peaks)
2. 10-year tide with 100-year riverine discharge from the OAC and ACFCC (coinciding tide and discharge peaks)

This is more conservative than recommended in the Alameda County Hydrology and Hydraulics Manual (2003) where for primary facilities the highest of the following scenarios is to be used:

- The FEMA 100-year water surface elevation; or
- The 5-year recurrence peak discharge combined with a 100-year tide elevation in the Bay; or
- The 15-year recurrence peak discharge with a MHHW elevation in the Bay.

These flood scenarios included seven days of a 10- and 100-year tide from May 15, 2015 7:00 AM to May 21, 2015 7:00 AM. Figure 2.5 and Figure 2.6 show the time series of the 10- and 100-year tide levels in relation to the local tidal datums. The 10- and 100-year tides were generated by shifting the typical tide shown in Figure 2.4 (maximum elevation of 8.1 feet) up to the extreme elevations of 9.4 feet and 10.7 feet NAVD88 (AECOM 2016b), respectively.

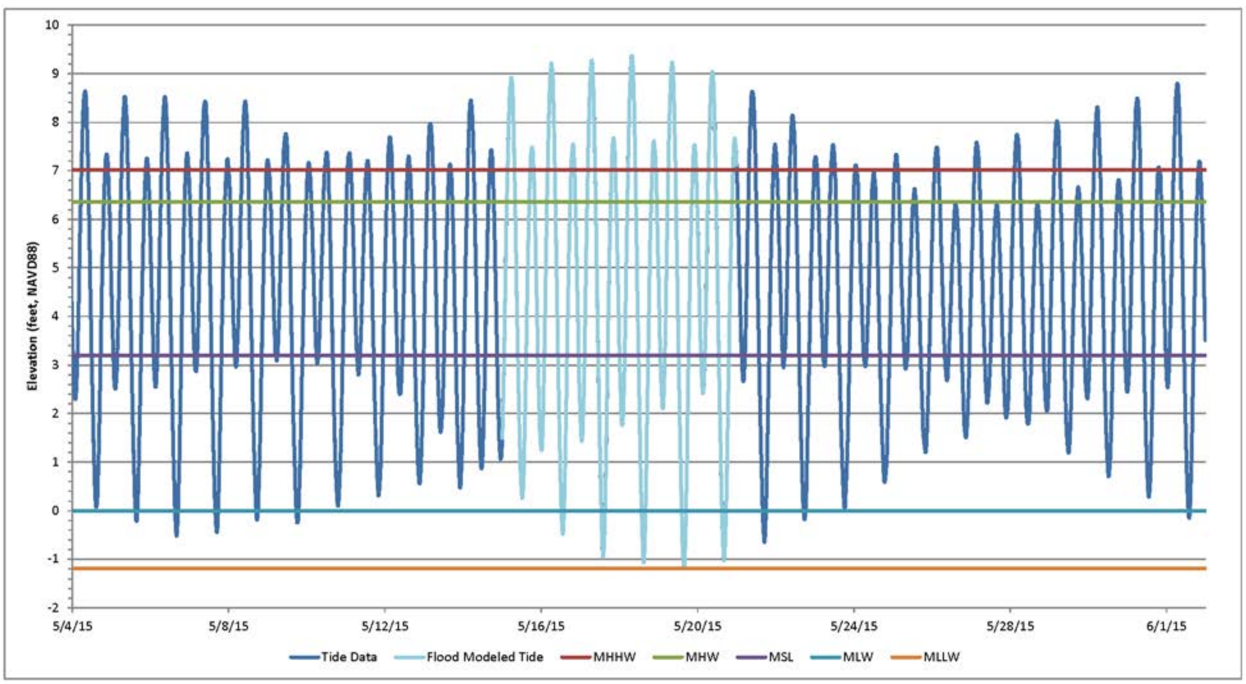

Figure 2.5. 10-year Tide (Extreme Elevation 9.4 feet)

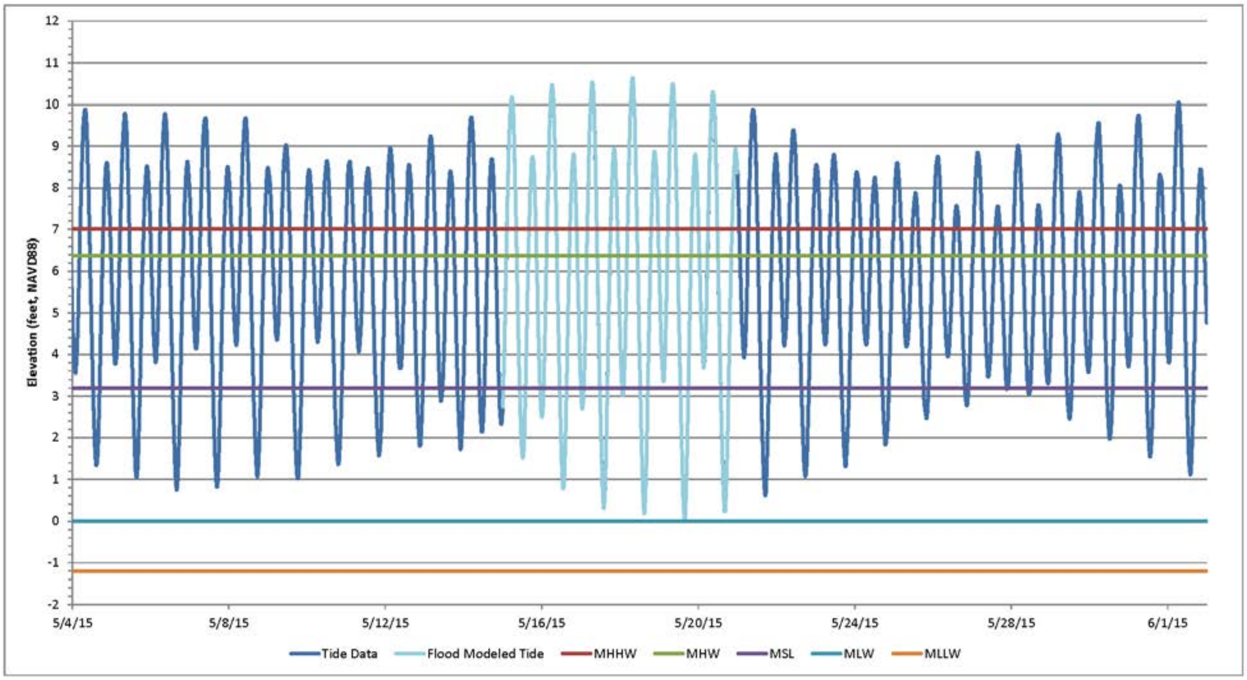

Figure 2.6. 100-year Tide (Extreme Elevation 10.7 feet)

The hydrographs for the 10- and 100-year discharge events from OAC and ACFCC are shown in Figure 2.7. The hydrographs were obtained from DHI (2015). To confirm that the hydrographs represent reasonable approximations to the 10- and 100-year events, HEC-SSP V2.0 was used to analyze 56 years of peak flow data collected in the ACFCC at Union City (USGS # 11180700, located 0.2 mi upstream of Interstate 880 crossing). The analysis resulted in a 100-year peak flow of 30,410 cfs and a 10-year flow of 14,116 cfs, which are consistent with the hydrographs in DHI (2015). Sufficient data were not available for the OAC so the DHI (2015) values were assumed to also be sufficiently accurate for preliminary design.

All flood scenarios had an initial water surface elevation of 6.5 feet NAVD88 throughout the model mesh, conservatively assuming the ponds were starting “full” about a half of a foot below MHHW. This is conservative for all alternatives because the available flood storage in the ponds is minimized. (The internal water level in the pond has no impact on the whether the external levees are overtopped during a flood event; the initial water surface elevation does however have an impact on if the internal levees are overtopped.) If this elevation were to be decreased to MSL, the maximum water surface elevation reached within the ponds (and used to design the levee heights) may decrease. At the 6.5 feet NAVD88 elevation, portions of the low-lying areas east of the complex also began with ponded water; however the *difference* in water surface elevation between existing and restored conditions was used as the indicator of meeting or exceeding existing flood control in this area, not the total water surface elevation. For this reason, these flood criteria results were not sensitive to the initial water surface elevation.

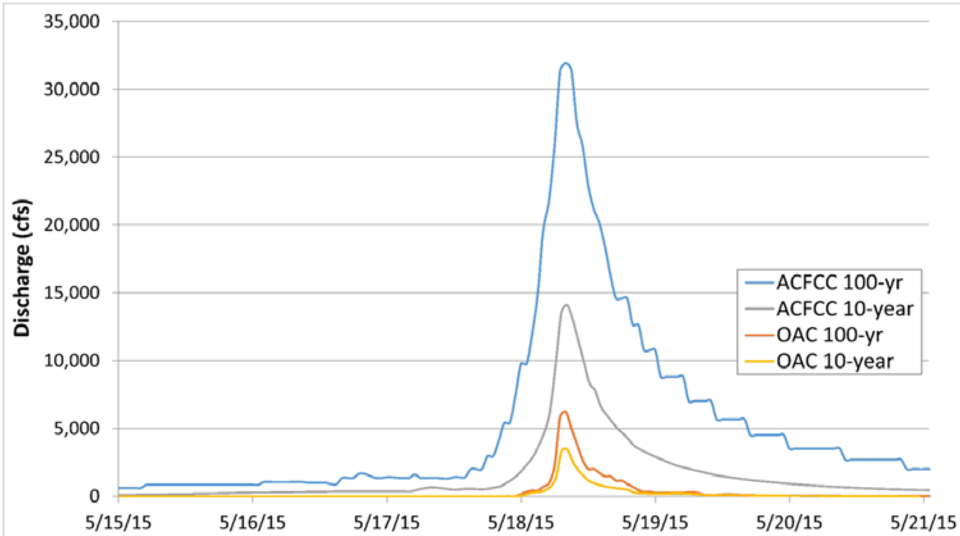

Figure 2.7. 10- and 100-year Discharge Event Hydrographs of ACFCC and OAC

2.7 Bed Resistance

In MIKE21 FM, the bed resistance is specified using a Manning number "M", which is the inverse of the more commonly used Manning's n. Typically the roughness coefficient is used as a calibration parameter, and the lower the Manning's number the higher the roughness. Figure 2.8 shows the chosen Manning's numbers based on vegetation observed or lack thereof in available imagery.

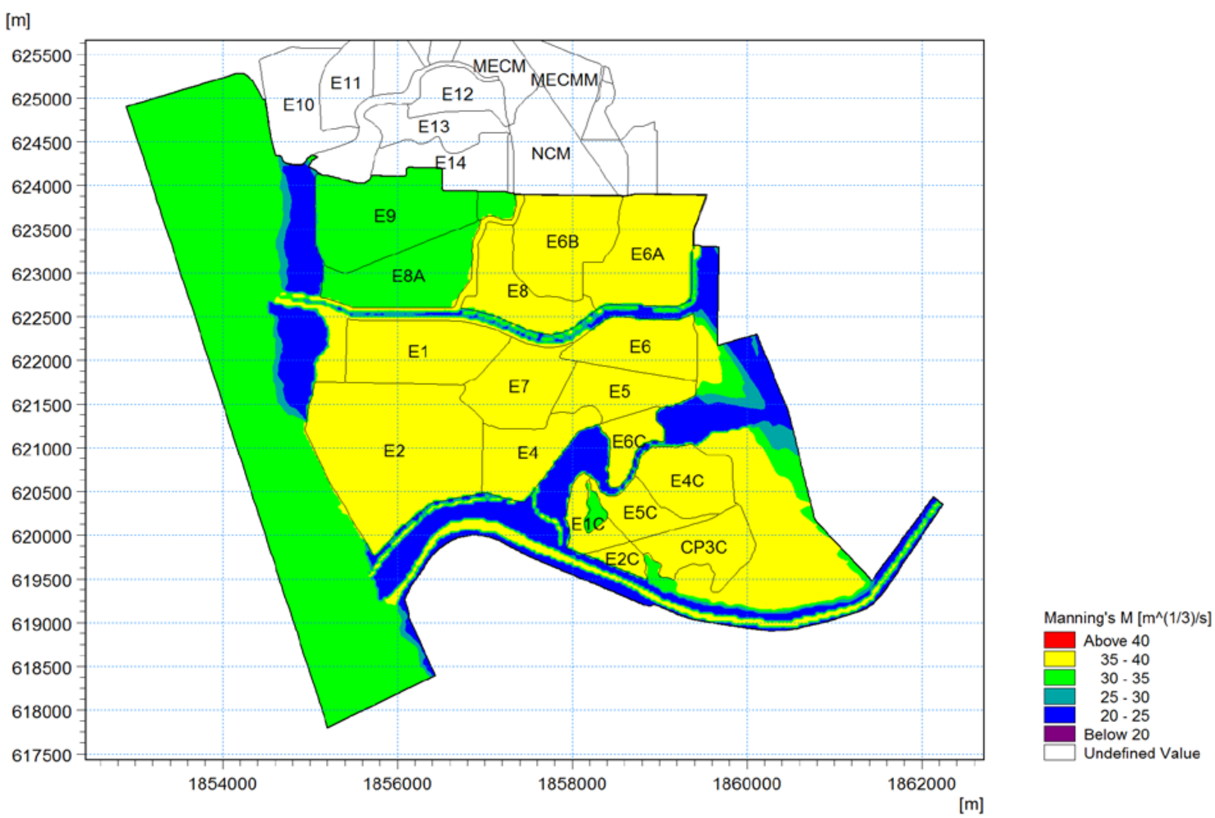

Figure 2.8. Bed Resistance

2.8 Approach

Various locations and quantities of levee breaches, pilot channels, culverts, and levee raising and lowering were modeled to refine the design features. The Preliminary Design Memo (AECOM 2016a) contains details on initial design choices for feature dimensions and locations. For instance, initial levee breach sizes were sized based on empirical hydraulic geometries of historic marshes in San Francisco Bay (PWA et al. 2004), and initial pilot channels were sized and located based on equipment capabilities and cost considerations.

In general, tidal filling and draining criteria were first met with the addition of levee breaches and pilot channels, then flooding criteria were applied to the features and levee raising and lowering design details were determined. The greatest water surface elevation resulting from the two Flood Scenario combinations was used to design the restoration features.

All of the southern Eden Landing Ponds are within areas inundated by the 1% annual chance flood on FEMA's Flood Insurance Rate Maps (FIRMs) due to coastal flooding sources from extreme high tide (as opposed to riverine sources) (see Figure 2.9). None of the existing levees are accredited to meet Federal standards to reduce risk from a 100-year flood. The 1% annual chance Still Water Level (SWL), or flood level not including the effects of waves or tsunamis but including storm surge and astronomical tide, of the ponds is 10 feet NAVD88. FEMA is currently updating its maps, and preliminary results indicate the 1% SWL will increase to 11 and 12 feet within southern Eden Landing pending additional considerations proposed by Alameda County. Because the uncertified levees in and around the pond complex do not influence the 1% SWL in FEMA's typical approach, breaching the existing ponds does not change FEMA's current FIRMs depicting 1% SWL.

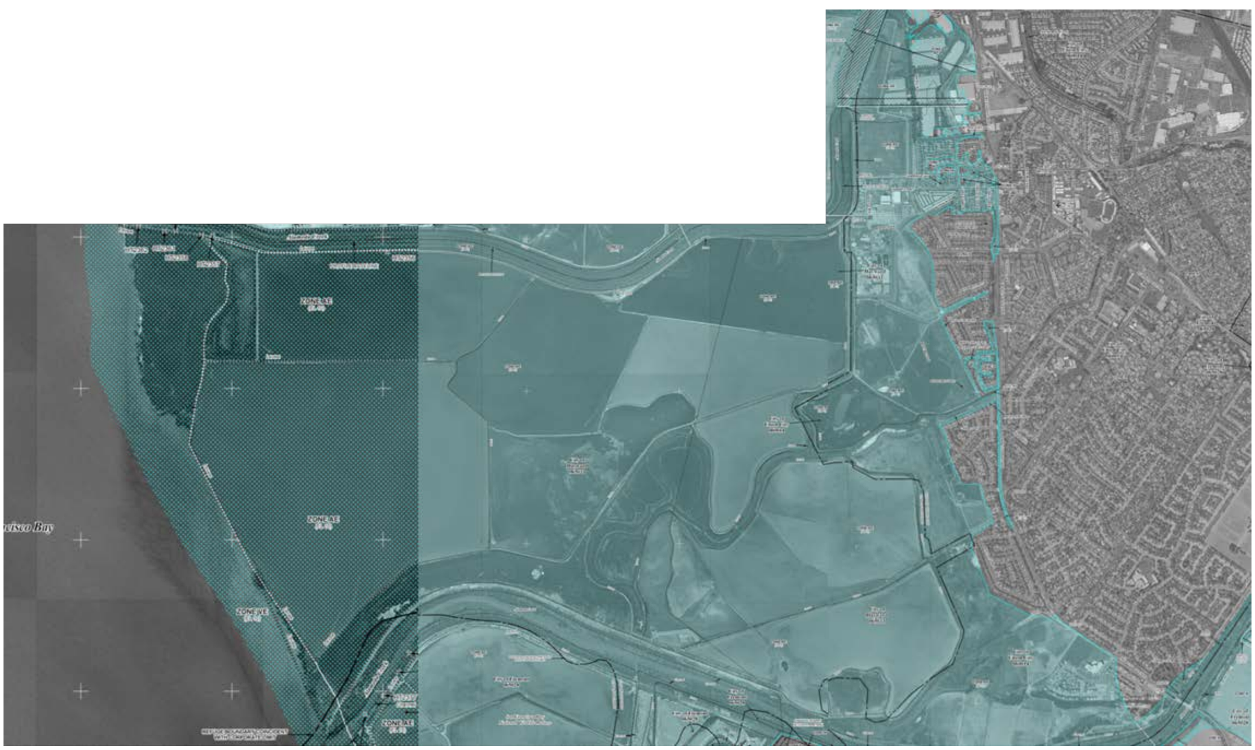

Figure 2.9. Existing FEMA Flood Insurance Rate Map Extent (Effective 2009, pending update)

FEMA also calculates the Total Water Level (TWL), which includes the effects of waves (wave setup and runup) on top of the SWL. All of the levee improvements and habitat transition zones proposed in the restoration design could lower FEMA's calculated TWL, as the TWL does take into consideration berms or levees that knock down waves or reduce fetch lengths.

The Federal levees surrounding the ACFCC are accredited levees, and therefore may need to be unclassified as an "accredited" levee in order to install breaches. Because this process is likely to conflict with the Phase 2 restoration timeline, the restoration design was constrained to installing only gated culverts in the ACFCC Federal levees. Although not ideal for the full tidal restoration alternative for the C-Ponds, additional culverts will improve tidal exchange and maintain or improve the existing flood protection. Restoration Alternatives B and D also included a culvert through the ACFCC Federal levee to allow fish passage from the ACFCC into the Bay Ponds.

Lastly, during model development Dr. David Schoellhamer from the USGS performed an external review of the model and modeling approach. His comments are listed in Appendix B and were incorporated into subsequent versions of the model and analysis.

3. MODEL RESULTS

The following is a summary of the MIKE21 and HEC-RAS modeling results.

3.1 MIKE21 Tide Scenario Results

The extent of tidal waters and total water depth within Alternative B (full tidal restoration) configuration is shown in Figure 3.1 and Figure 3.2 (on the following page) during the spring and neap tides, respectively. During the peak of the spring tide, the majority of the ponds contain ponded water except for the areas of highest elevation. The ponds may not drain completely at low tides during the peak spring tide and may contain ponded water for several days. When the peak tides recede the ponds do not fill as high and they drain more fully. During the neap tide, the majority of the ponds are drained with patches of water remaining in the ponds due to the uneven nature of the pond bottoms. These patches of ponded water are anticipated to shrink in size over time as small channels form in the pond bottoms; the model does not include geomorphic changes such as these.

Figure 3.3 (on the following pages) shows the water surface elevations in the Bay Ponds and channels of the Inland Ponds, which fill up to about 5.6 feet. The ponds receive water from the muted tide in the OAC, also shown in the figure. The majority of the pond bottoms of the Inland Ponds are only flooded during peak tidal elevations, however deeper channels transport water around the ponds. Figure 3.4 shows the water surface elevations in the C-Ponds, which fill up to about 6.3 feet (in E2C). The C-Ponds receive water from the slightly muted tide in ACFCC, also shown in the figure. In general, the ponds become more muted the farther the distance from the connection to ACFCC.

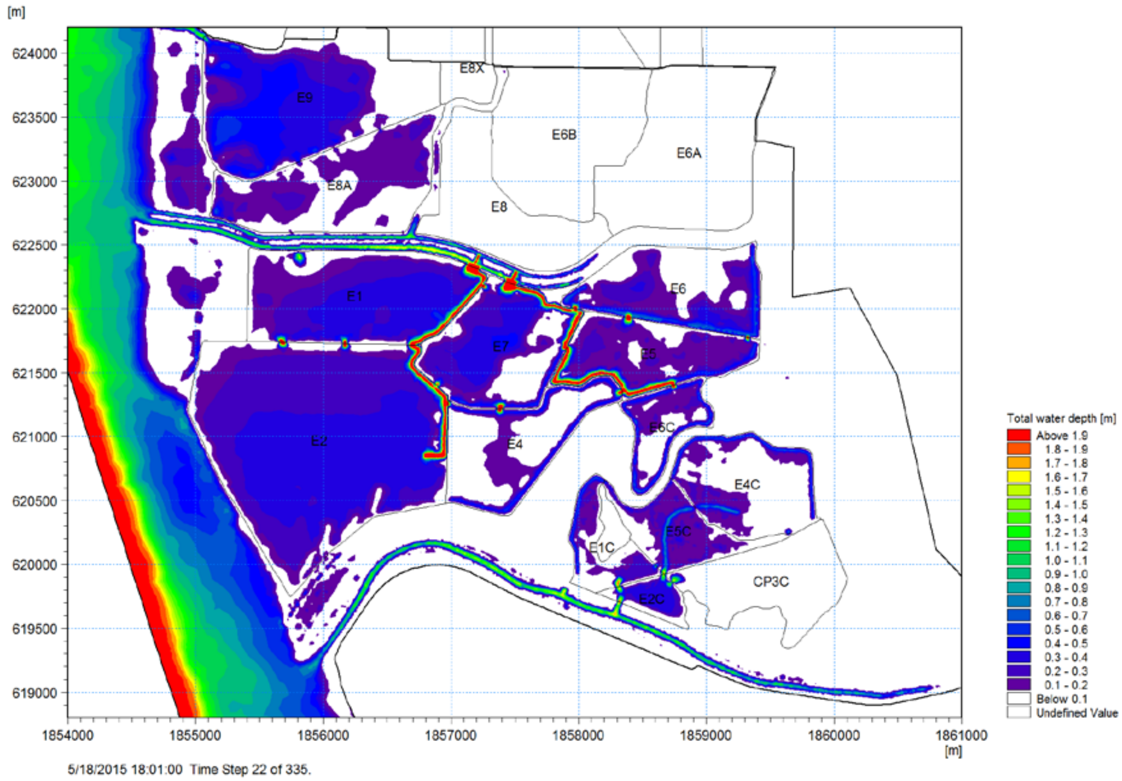

Figure 3.1. Alternative B Total Water Depth during Spring Tide

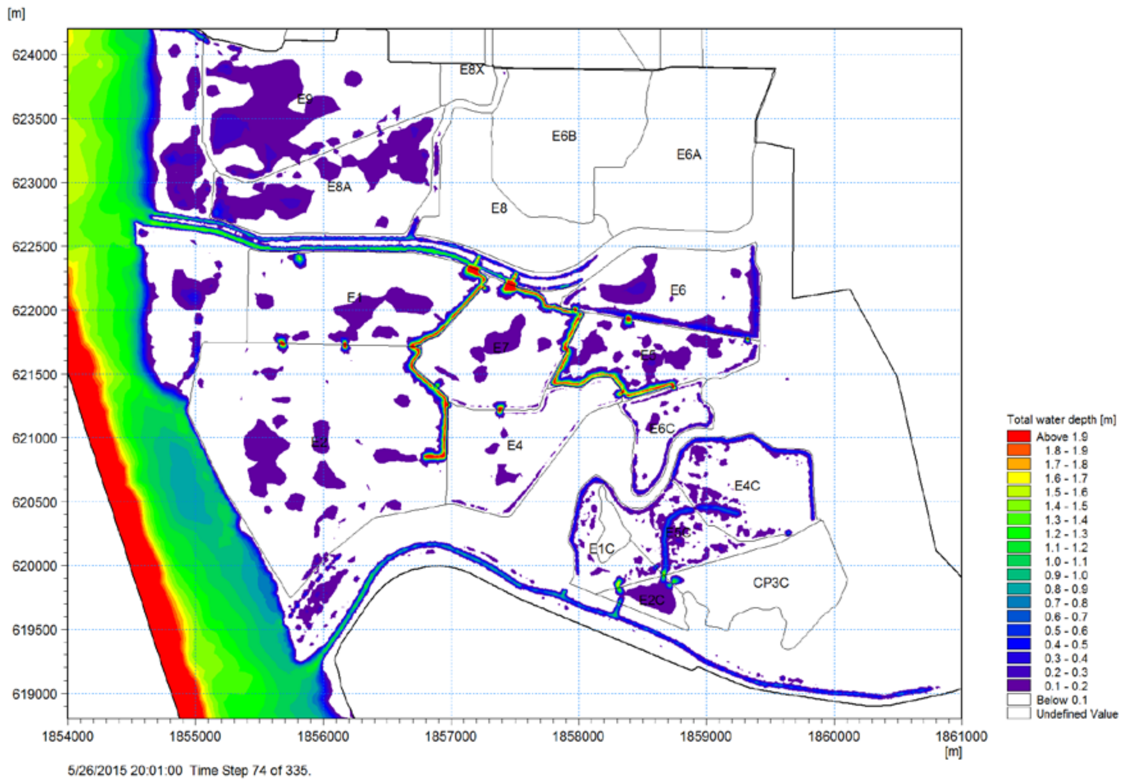

Figure 3.2. Alternative B Total Water Depth during Neap Tide

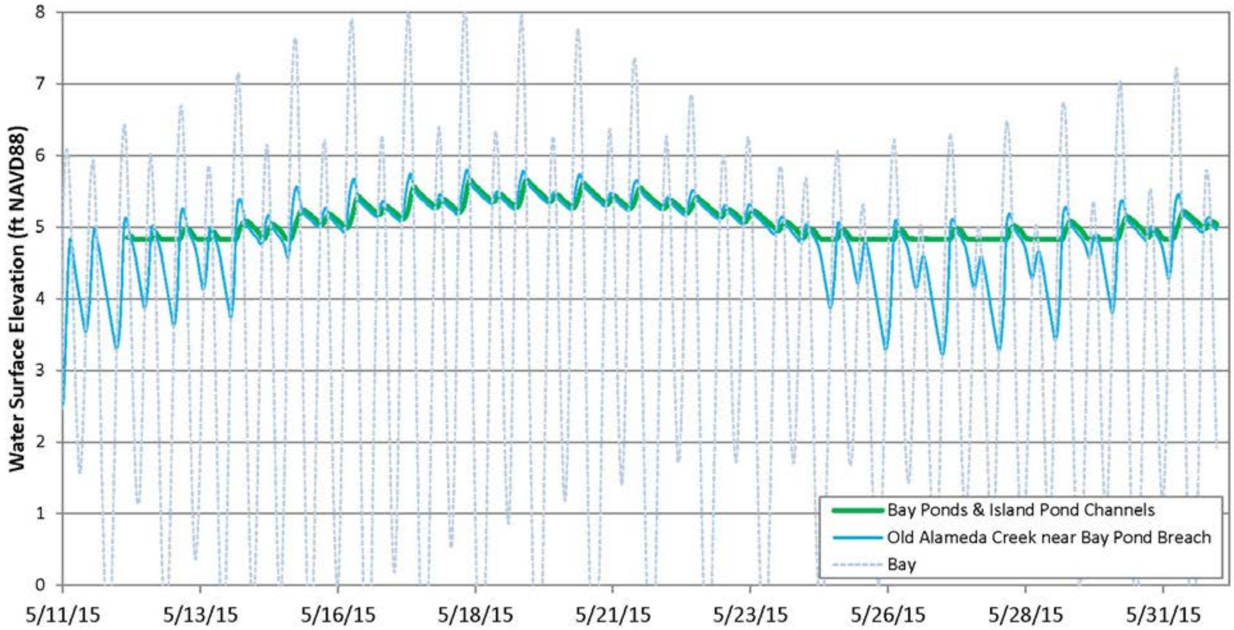

Figure 3.3. Tidal Elevations in the Bay and Island Ponds

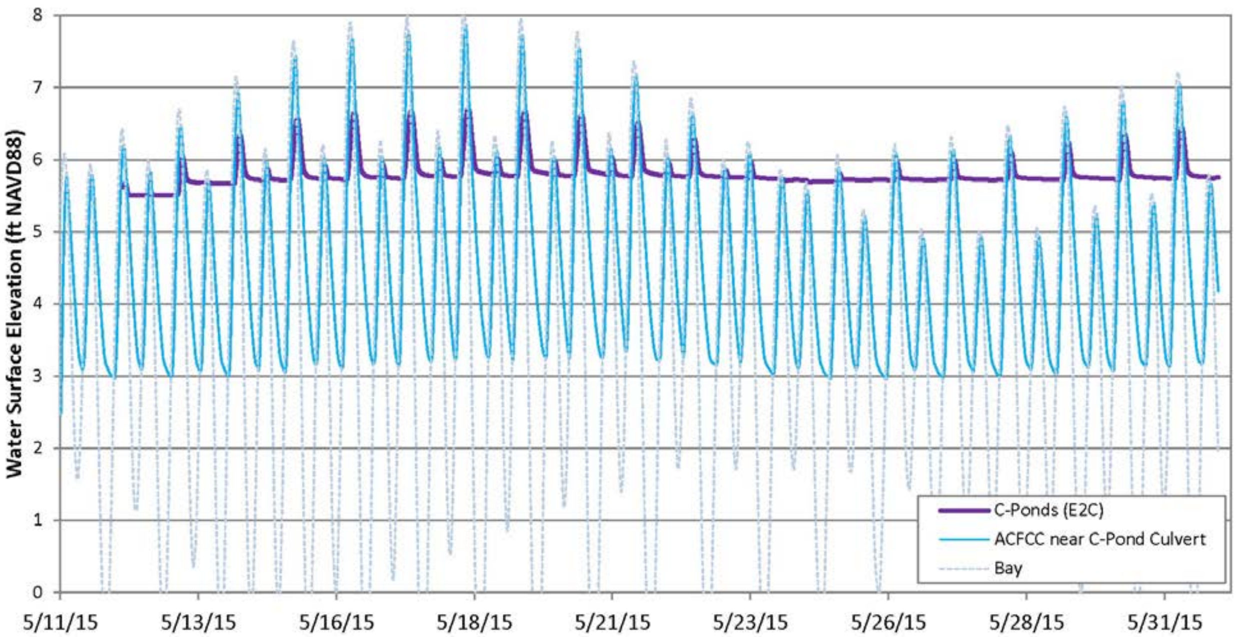

Figure 3.4. Tidal Elevations in the C-Ponds

The major Tide Scenario modeling results include:

- The OAC constricts conveyance into the ponds; therefore increasing the number of breaches above those already included along the OAC would not significantly increase conveyance into the ponds. The OAC is anticipated to scour over time with the restoration project, thereby increasing the tidal prism in the Bay and Inland Ponds.
- "Natural" channels constructed in the center of the wet pond bottoms were modeled, however eliminated due to anticipated construction cost (except for in the C-Ponds where the ponds may be dried sufficiently to support low ground pressure equipment). More economical "borrow ditch" channels were included in the Bay and Inland Ponds where equipment can excavate to the side while on existing levees. Both channel types enhance draining of low depressions in the ponds; without constructed channels, the ponds do not fully drain.
- Because the design is constrained to including a culvert through the ACFCC Federal levee (as opposed to a breach), the channel through the Alameda County Wetlands to Ponds E2 and E4 should only be as large as the volume that may be conveyed through the culvert. Model results show the hydraulic conveyance into the Bay Ponds through this culvert and channel is minimal. Fish habitat and passage is an important goal of this restoration design, therefore this connection culvert and channel remains in the restoration alternatives to predominately support fish passage into the Bay Ponds, as opposed to hydraulic connectivity.
- The C-Ponds are the highest elevation ponds of the southern Eden Landing Ponds, and although the restoration design proposes to double the existing culverts and construct a channel in the pond bottom, the tide will remain muted in the C-Ponds. The proposed additional culverts and channel will increase management flexibility, if the ponds remain managed permanently or temporarily (Alternatives C and D).

3.2 MIKE21 Flood Scenario Results

The results of the Flood Scenarios informed the levee crest elevation design in all three action alternatives and allowed for comparison of pre- and post-project flood levels. For each of the Flood Scenarios and model configurations, maximum water depth was analyzed along the four proposed raised levees found in Alternatives B, C, and D, as well as three areas of potential flooding outside the complex, as listed in Table 3.1 and shown in Figure 3.5.

Table 3.1. Flood Scenario Areas of Analysis

	Flood Scenario Areas of Analysis	Applicable Alternative
Levee Alignments	Inland Ponds Landside Levee	B & D
	C-Ponds Landside Levee	B & D
	Bay Levee	C & D
	Mid Complex Levee	C & D
Areas of Potential Flooding Outside of Complex	J-Ponds	B, C, & D
	Alameda County East Property	B, C, & D
	Alameda County South Property	B, C, & D

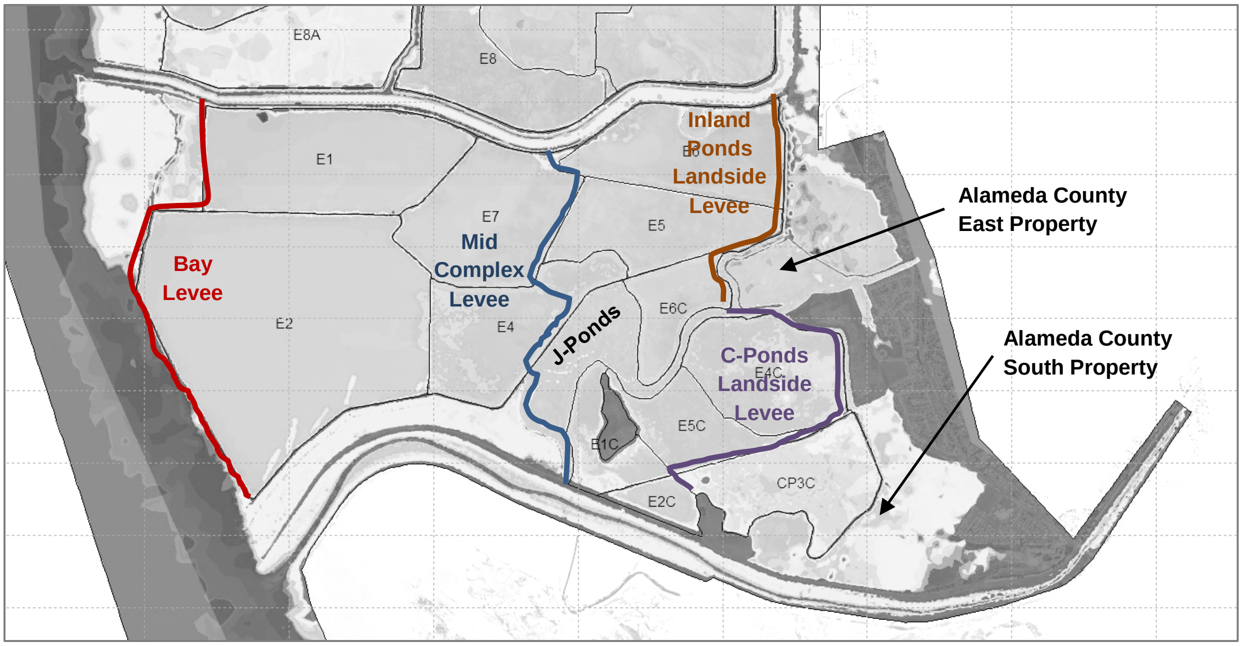

Figure 3.5. Flood Scenario Areas of Analysis for Alternatives A, B, C & D

The following is a summary of the Flood Scenario results in each of these areas of interest, discussed in the context of each model configuration: Alternative A (existing conditions), Alternative B (full tidal restoration), and Alternative C & D (partial tidal restoration and pond management).

Alternative A Configuration (Existing Conditions)

Figure 3.6 and Figure 3.7 show the maximum water surface elevations reached during the 10-year tide and 100-year discharge and the 100-year tide and 10-year discharge Flood Scenarios.

During the 10-year tide and 100-year discharge, the blue arrows in Figure 3.6 indicate the general flow path of the water. The 100-year discharge event overtops the ACFCC levee near the Bay and travels back upstream through the Alameda County Wetlands, J-Ponds, Pond E6C, C-Ponds, and to the Alameda County East Property and South Property.

During the 100-year tide and 10-year discharge, the blue arrows in Figure 3.7 also indicate the general flow path of the water. In this case, the 100-year tide overtops the pond levees via the OAC and Alameda County Wetlands. The Alameda County East Property is flooded by water traveling upstream through the J-Ponds and overtopped levees of Pond E6C (also fed by the J-Ponds). The FEMA FIRMs (see Figure 2.9) project the 100-year tide elevation farther inland than shown in Figure 3.7 because FEMA assumes non-accredited levees do not prevent water from traveling inland.

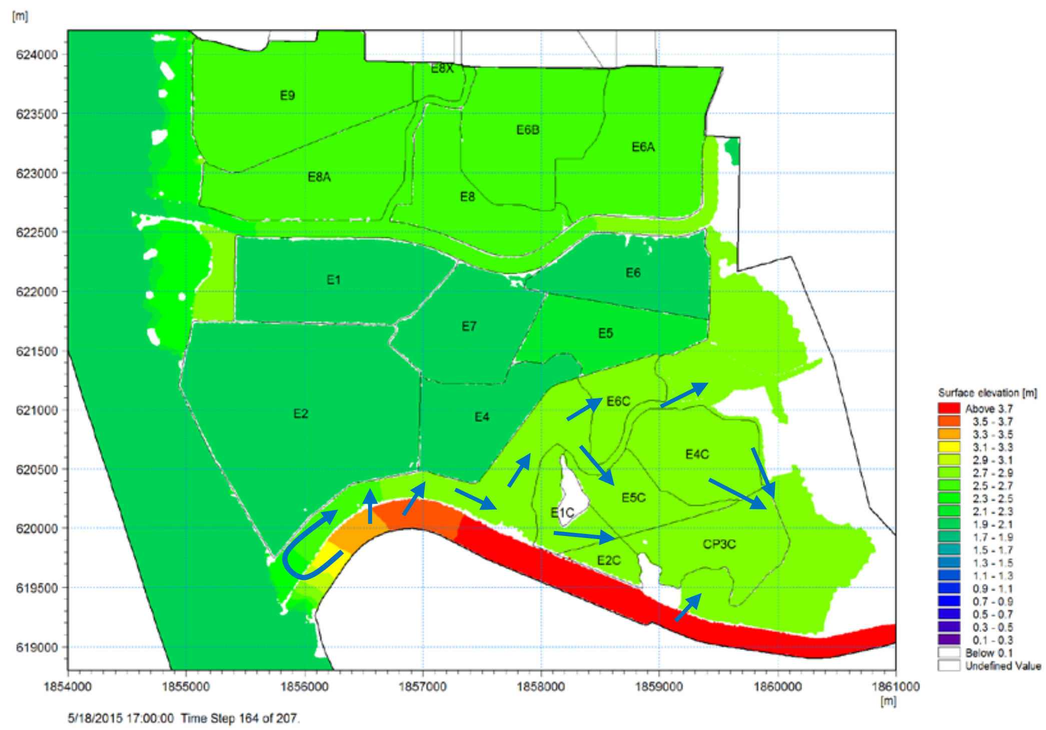

Figure 3.6. Alternative A Existing Conditions, Maximum Water Surface Elevation, Flood Scenario 10-year Tide & 100-year Discharge

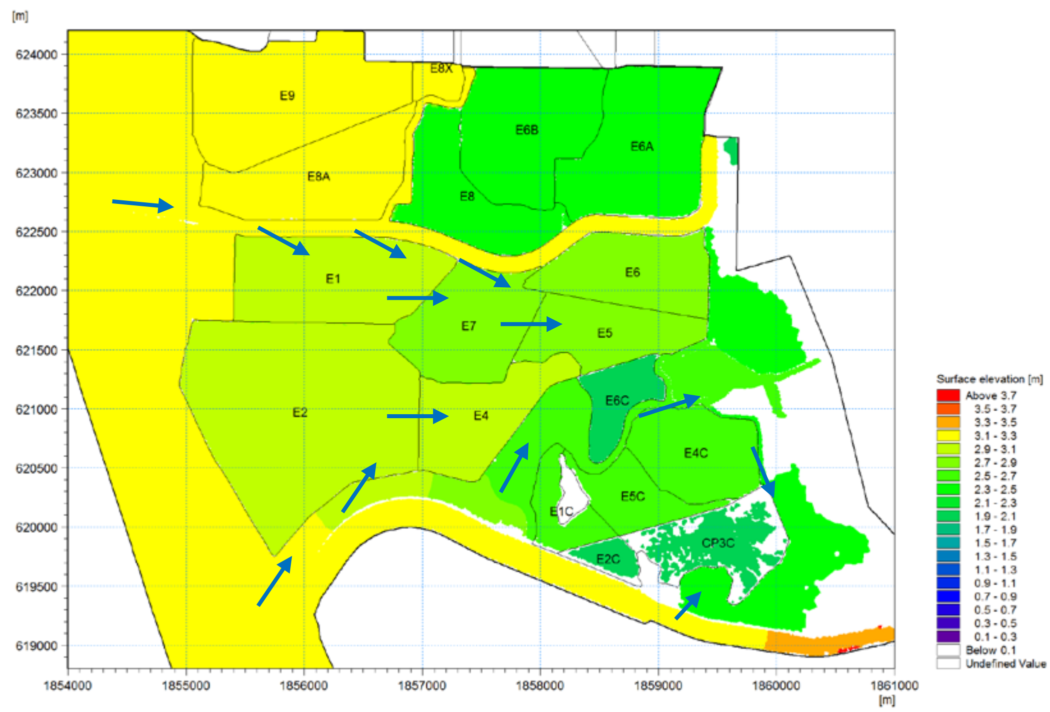

Figure 3.7. Alternative A Existing Conditions, Maximum Water Surface Elevation, Flood Scenario 100-year Tide & 10-year Discharge

The peak water surface elevations near the four proposed levee improvements for the Alternative A configuration (existing condition) are shown in Figure 3.8. Figure 3.8 shows that maximum water surface elevations near most proposed levees are near 9.5 feet, or about 10.2 feet in the case of the Bay Levee. The J-Ponds and Alameda County East and South Properties have a maximum water surface elevation of about 9 to 9.5 feet. In general, the C-Ponds, J-Ponds, and Alameda County Wetlands are most influenced by a large flood discharge down the ACFCC, whereas the Bay Ponds are much more influenced by a large tide. The Inland Ponds generally reach the same maximum water surface elevations during either Flood Scenario.

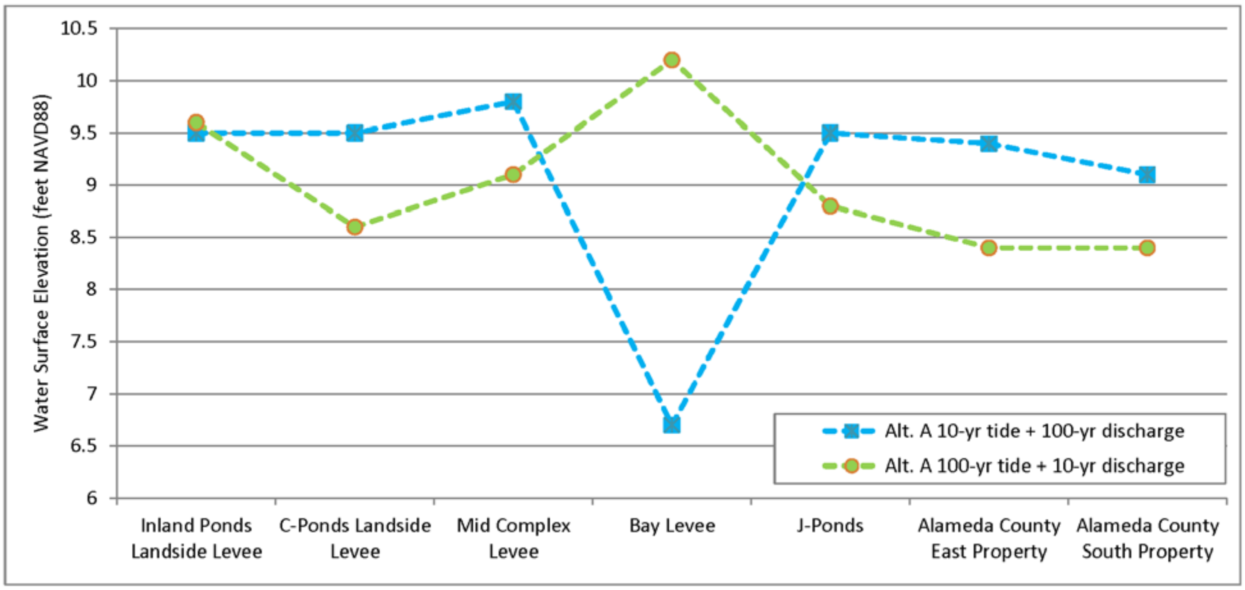

Figure 3.8. Alternative A Existing Conditions, Flood Scenarios, Maximum Water Surface Elevations in Vicinity of Improved Levees

Alternative B Configuration (full tidal restoration)

In the case of the Alternative B configuration, Figure 3.9 and Figure 3.10 (on the following page) show the maximum water surface elevations reached during the 10-year tide and 100-year discharge and the 100-year tide and 10-year discharge Flood Scenarios.

During the 10-year tide and 100-year discharge, the blue arrows in Figure 3.9 indicate the general flow path of the water. The 100-year discharge event overtops the ACFCC levee near the Bay similar to the Alternative A configuration, however with the proposed levee lowering to MHHW along the southern Pond E2 and northern Pond E1 levees, the majority of the water passes into the Bay and Inland Ponds and out through the OAC. With this restoration design, the ponds act as detention during peak discharge events, reducing the maximum water depths and extents experienced in the J-Ponds and Alameda County East and South Properties compared to existing conditions (see Figure 3.6).

During the 100-year tide and 10-year discharge, the blue arrows in Figure 3.10 indicate that the 100-year tide overtops the pond levees via the OAC and Alameda County Wetlands, similar to the Alternative A Configuration. Because the restoration design includes pilot channels, the maximum water surface elevation experienced is of shorter duration because the water can more quickly recede with the outgoing tide. The maximum water surface elevation is slightly increased about half a foot in the Bay Ponds (as one would expect with tidal restoration) due to the 100-year tide entering the Bay Ponds over the lowered levees along the OAC and Alameda County Wetlands; the maximum water surface elevation does however remain below the maximum occurring during the 10-year tide and 100-year discharge hydrologic scenario.

The peak water surface elevations for this configuration compared to existing conditions are summarized in Figure 3.11 (on the following pages). (Please note, in comparison to Figure 3.8, Figure 3.11 does not include the extraction points near the Mid-complex and Bay Levees, as those levee raises are not included in Alternative B and this information was extracted to inform levee height design.)

Within the J-Ponds, Alameda County East and South Properties, the maximum water surface elevations of the Alternative B configuration are all maintained or less than the peak elevation of about 9 to 9.5 feet in these areas. The maximum water surface elevation near the Inland Ponds and C-Ponds landside levees increase less than a half of foot. This slight increase is the driver for improving the Inland and C-Ponds Landside Levees between 2 and 2.5 feet in this Alternative, thereby increasing flood protection beyond existing conditions.

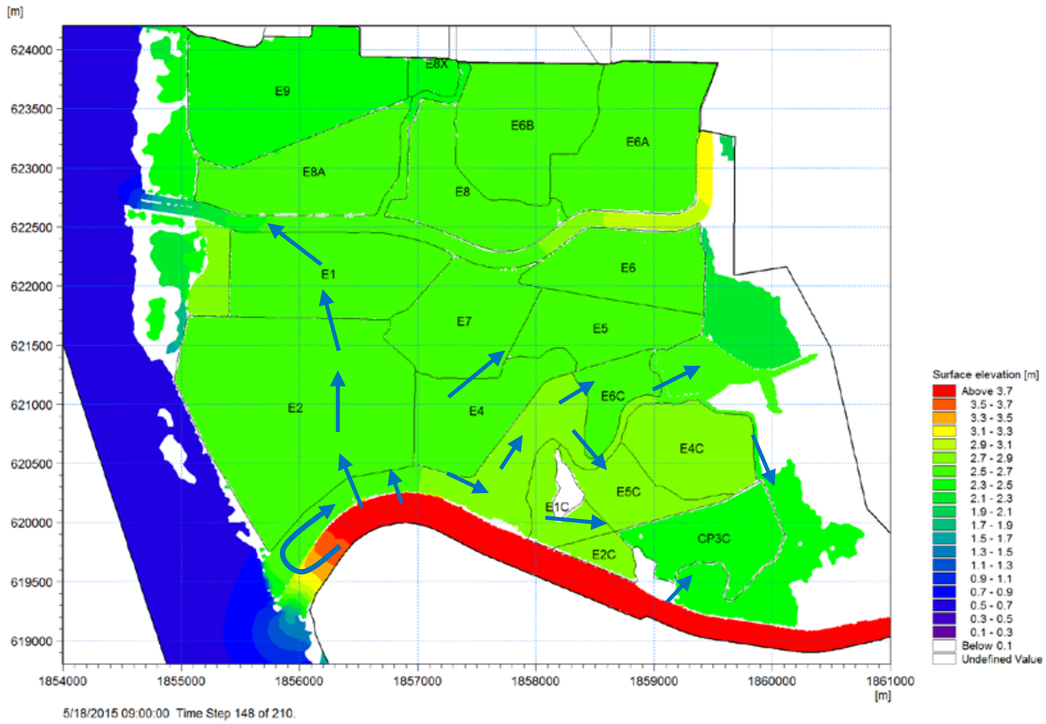

Figure 3.9. Alternative B Tidal Restoration, Maximum Water Surface Elevation, Flood Scenario 10-year Tide & 100-year Discharge

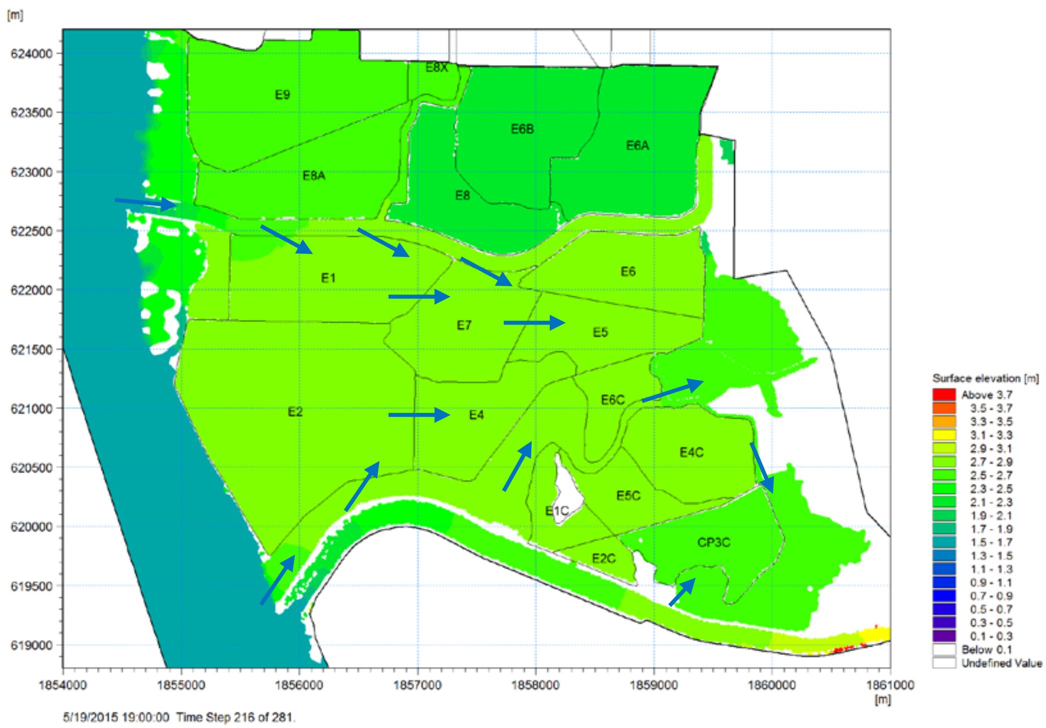

Figure 3.10. Alternative B Tidal Restoration, Maximum Water Surface Elevation, Flood Scenario 100-year Tide & 10-year Discharge

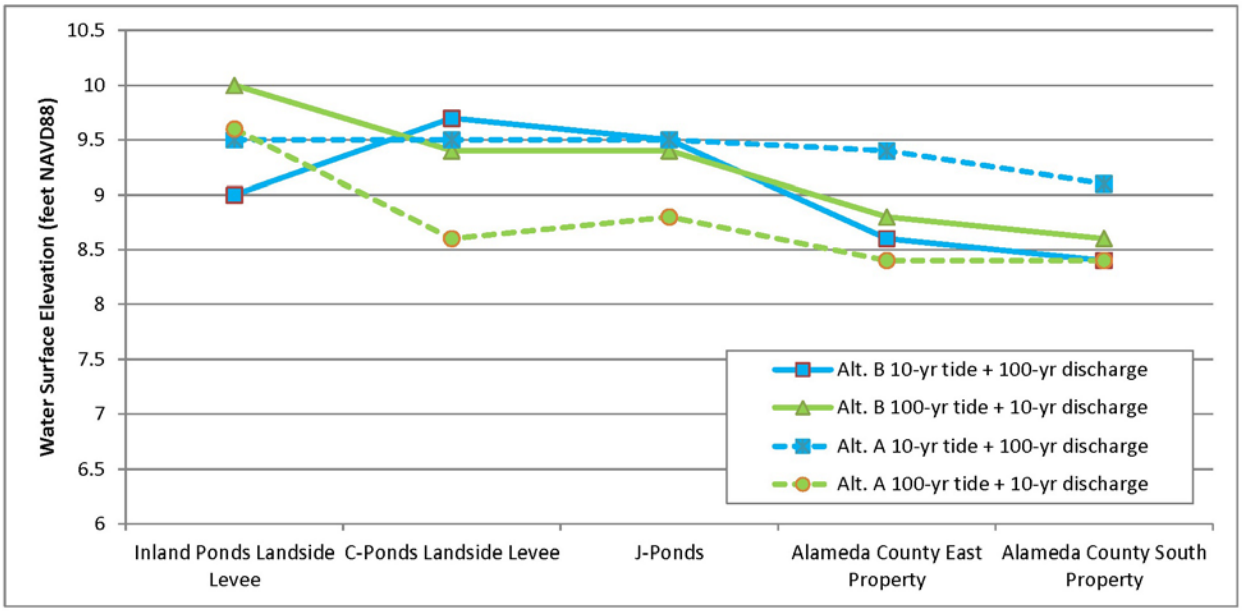

Figure 3.11. Alternative B Tidal Restoration, Flood Scenarios, Maximum Water Surface Elevations in Vicinity of Improved Levees

Additional general results from the Alternative B tidal restoration include:

- If the northern Pond E1 and southern Pond E2 levees were not lowered in Alternative B, the maximum water surface elevation in the J-Ponds increases over two feet, and the water surface elevation in the Alameda County East and South Properties increase about a foot. Levee lowering is an important flood control method necessary in the design to allow for flood waters from the ACFCC to travel through the ponds and out through the OAC.
- A levee breach into the C-Ponds from either the ACFCC or the J-Ponds would result in significantly higher water surface elevations in the C-Ponds compared to existing conditions. A breach in either of these locations allows for the ACFCC large discharge event to travel directly into the C-Ponds, and would require additional levee raising than what is proposed in the Preliminary Design to prevent levee overtopping into Alameda County South Property via Cargill's Pond CP3C.
- To investigate the potential fish passage culvert along ACFCC, a relatively small 3,500 cfs (less than the 10-year event) was discharged from ACFCC during a model run with a dye tracer in it. Dye concentration results indicate water travels from ACFCC through the proposed fish passage culverts and into the Bay Ponds. Little to no tidal water extend up to the fish passage culverts during such an event. The ACFCC discharge enters the Bay and Inland Ponds, indicating that a percentage of juvenile fish traveling with flow would be transported into the Bay and Inland Ponds and then out the OAC.

Alternative C & D Configuration (mid complex levee and phased restoration)

In the case of the Alternative C & D configuration, Figure 3.12 and Figure 3.13 (on the following page) show the maximum water surface elevations reached during the 10-year tide and 100-year discharge and the 100-year tide and 10-year discharge Flood Scenarios.

During the 10-year tide and 100-year discharge, the blue arrows in Figure 3.12 indicate the general flow path of the water. The 100-year discharge event overtops the ACFCC levee near the Bay similar to the Alternative A configuration, however with proposed levee lowering to MHHW along the southern Pond E2 and northern Pond E1 levees, the majority of the water passes into the Bay Ponds, and is blocked by the Mid Complex levee from entering the Inland and C-Ponds, and travels out through the OAC. With this restoration design, the ponds act as detention during peak discharge events, reducing the maximum water surface elevations and extents experienced in the Inland Ponds, C-Ponds, J-Ponds and Alameda County East and South Properties compared to existing conditions (see Figure 3.6).

During the 100-year tide and 10-year discharge, the blue arrows in Figure 3.13 indicate that the 100-year tide overtops the pond levees via the OAC and Alameda County Wetlands, similar to the Alternative A Configuration. The Mid Complex Levee prevents the high tide from entering the all ponds and properties east of the Bay Ponds.

The peak water surface elevations for this configuration compared to existing conditions are summarized in Figure 3.14 (on the following pages). The maximum water surface elevations in the J-Ponds and Alameda County East and South Properties are reduced between 0.5 to one foot compared to the peak flood elevation. The water surface elevation at the Mid Complex Levee increases from about 9.7 to 10.4 feet, and the Bay Levee water surface elevation remains about the same compared to Alternative A existing conditions. The Mid Complex Levee is not overtopped, and therefore the increase in water surface elevation at this location is anticipated as all the water previously allowed to flood the Inland Ponds, J-Ponds, C-Ponds, and Alameda County Properties is now contained only within the Bay Ponds.

Additional general results from the Alternative C & D partial tidal restoration and managed pond configuration include:

- The maximum water surface elevations in the OAC and ACFCC near the model extents do not increase in Alternative C & D compared to Alternative A (existing conditions). The same is true for the Northern Eden Landing Ponds, which reach a maximum water surface elevation of about 8 feet, which does not flood into the property immediately behind the existing Pond E6A levee.

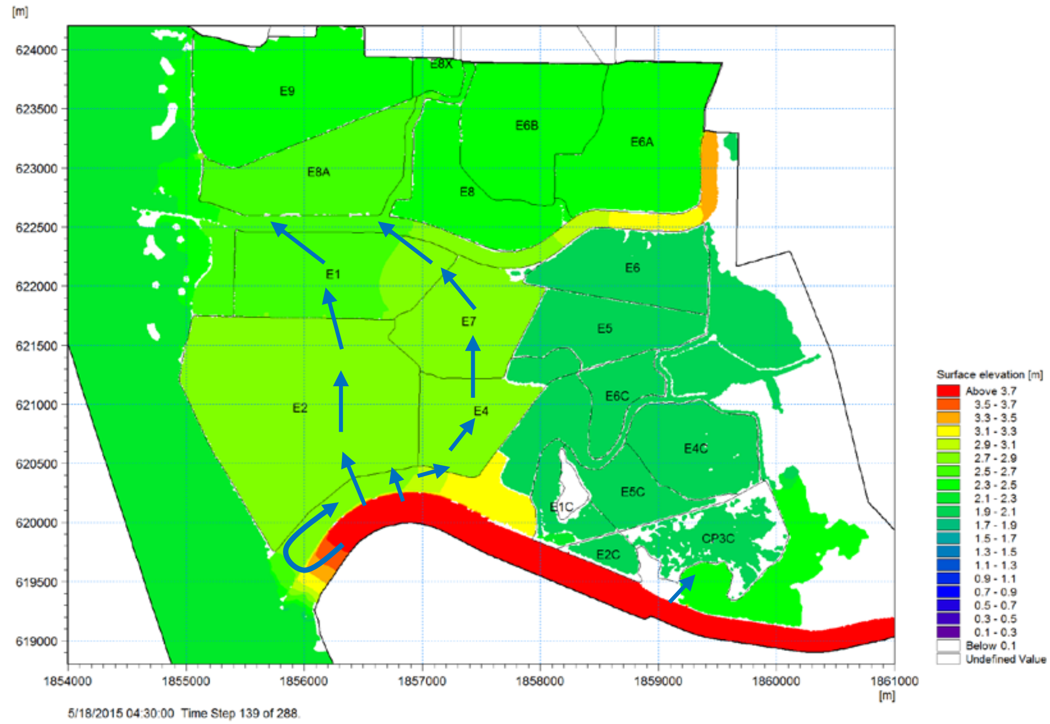

Figure 3.12. Alternative C & D Partial Tidal Restoration and Managed Ponds, Maximum Water Surface Elevation, Flood Scenario 10-year Tide & 100-year Discharge

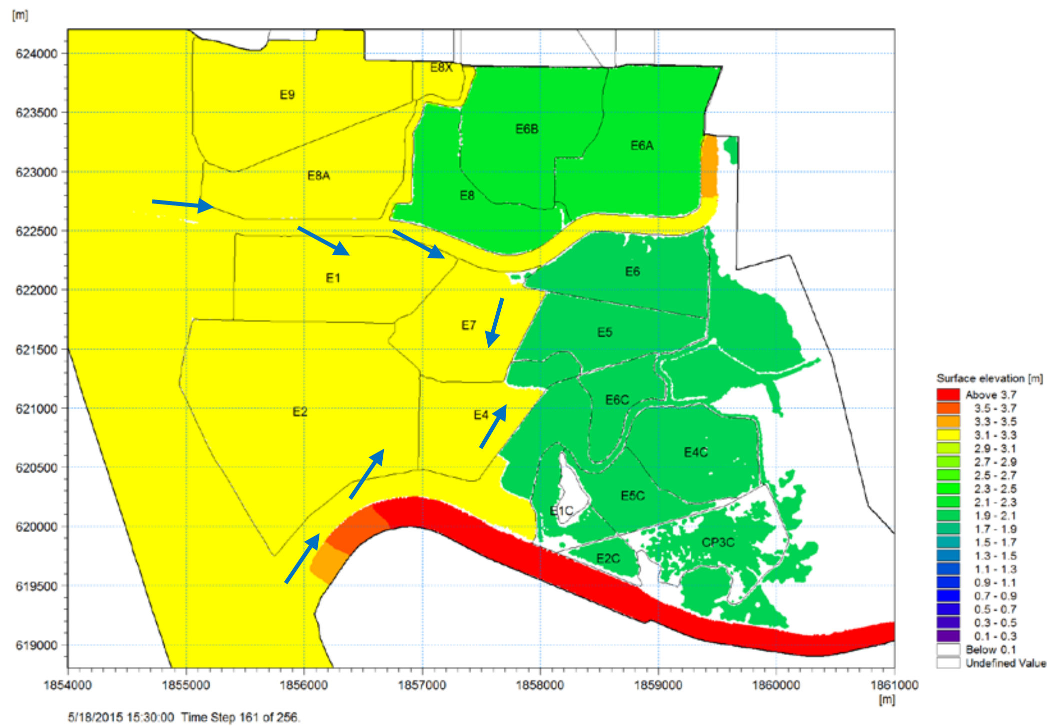

Figure 3.13. Alternative C & D Partial Tidal Restoration and Managed Ponds, Maximum Water Surface Elevation, Flood Scenario 100-year Tide & 10-year Discharge

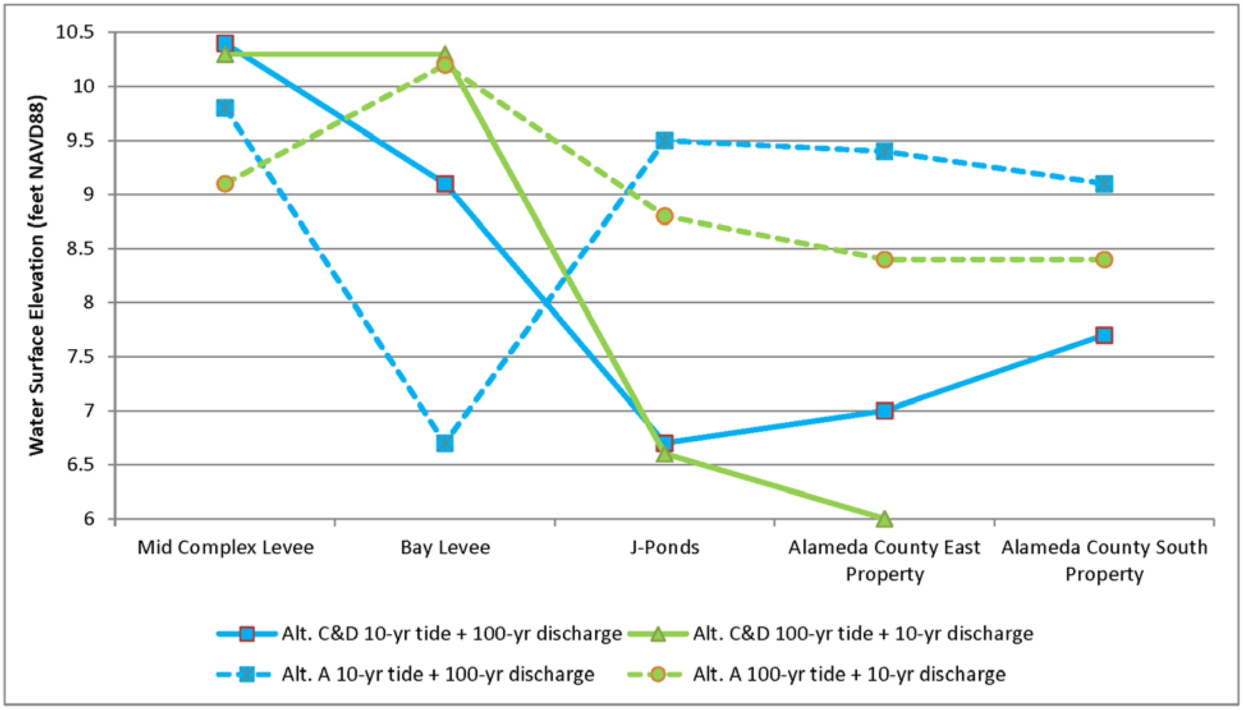

Figure 3.14. Alternative C & D Tidal Restoration and Pond Management, Flood Scenarios, Maximum Water Surface Elevations in Vicinity of Improved Levees

<u>Flood Scenario Conclusions</u>

Based on results from all Flood Scenarios, a consistent 12 foot NAVD88 levee improvement elevation was included in the Preliminary Design for all proposed levee improvements to provide over 1.5 feet of freeboard at all locations. Further analysis may allow the Inland and C-Ponds Landside Levees to be reduced to 11 feet NAVD88, however the higher elevation, greater volume, and larger environmental impact is appropriate to assume at this stage in the design. The Bay Levee may also be eliminated from improvement if habitat value is added elsewhere, as the Bay Levee currently provides wave protection; no flood protection. Of note, these maximum water surface elevations do not include wave setup and runup, therefore a freeboard is recommended.

Table 3.2. Preliminary Design Levee Improvement Elevations

	Max. Water Surface Elev. (feet NAVD88)			Freeboard	Preliminary Design Elevation
	Alt. A	Alt. B	Alt. C & D	(feet)	(feet NAVD88)
Inland Ponds Landside Levee	9.6	10.0	-	2.0	12.0
C-Ponds Landside Levee	9.5	9.4	-	2.5	12.0
Mid Complex Levee	9.8	-	10.4	1.6	12.0
Bay Levee	10.2	-	10.3	1.7	12.0

3.3 HEC-RAS Water Control Structure Results

New water control structures will facilitate the controlled movement of water between the ponds. The number, location, sizes, and operation of these water control structures differs by Alternative. Below is a summary of the results obtained from the HEC-RAS modeling analysis performed on the Inland and C-Ponds. Proposed water control structures (new and existing) are shown in Table 3.3, as well as Appendix A Figures A-7, A-8, and A-9. Additional information can be found in the Eden Landing Preliminary Design (AECOM 2016a).

Table 3.3. Design Criteria of Water Control Structures

Location	(Number), Size, Type	Length (ft.)	Existing Invert Elev. (ft. NAVD88)	Design Invert Elev. (ft. NAVD88)	Purpose	Applicable Alternatives
ACFCC/E2C (existing)	(2) 48 in. dia. HPDE/CMP	170	2.7	-	Hydraulic connectivity (Alt. B) or Pond management (Alt. C and D)	B, C and D
ACFCC/E2C	(2) 48 in. dia. HPDE/CMP	170	-	2.7		
E1C/E5C (S)	(2) 48 in. dia. HPDE/CMP	60	-	2.7		
E1C/E5C (N)	(1) 48 in. dia. HPDE/CMP	50	-	2.7		C and D
E2C/CP3C (existing)	(1) 48 in. dia. HPDE/CMP	60	Unknown	-		B and D
OAC/E6	(2) 48 in. dia. HPDE/CMP	150	-	0		C and D
E6/E5 (W)[1]	(1) 48 in. dia. HPDE/CMP	40	-	0		
E6/E5 (E)[1] (existing)	(1) 48 in. dia. HPDE/CMP	40	-	0		
E5/E6C (W)[2] (existing)	(1) 36 in. dia. HDPE/CMP	60	Unknown	0		
E5/E6C (E)[2] (existing)	(1) 36 in. dia. HDPE/CMP	60	Unknown	0		
ACFCC/E2&E4 via Alameda County Wetlands	(1) 6 ft. x 6 ft. concrete box or (3) 48 in. diam. HDPE/CMP	200	-	2.7	Fish passage	B
E7/E5	(1) 48 in. dia. HPDE/CMP	50	-	0	Culvert redundancy	C
ACFCC/Alameda County Wetlands	(1) 6 ft. x 6 ft. concrete box or (3) 48 in. diam. HDPE/CMP	200	-	2.7	Fish passage	
Alameda County Wetlands/E1C	(1) 48 in. dia. HPDE/CMP	30	-	2.7	Fish passage/pond management	
Alameda County Wetlands/J-Ponds	(1) 48 in. dia. HPDE/CMP	50	-	2.7	Detention basin management	

Note 1: E6/E5 (W) and (E) could be combined into a single set of culverts to reduce costs as opposed to two separate culverts.

Note 2: E5/E6C (W) and (E) could be combined into a single set of culverts to reduce costs as opposed to two separate culverts.

3.3.1 Inland Ponds

In Alternatives C and D (the managed pond alternatives), two culverts will connect the OAC and Pond E6. One culvert could provide the desired conveyance over a longer period, however redundancy in the system is desired. The water level in the Inland Ponds may be increased up to the high tide level in the OAC by operating the combination gate on the inside of Pond E6 as a tide gate, and leaving open the outside gate on the OAC end.

Figure 3.15 shows the water surface elevations in the Inland Ponds with the proposed culverts for Alternatives C and D listed in Table 3.3. The results in the figure indicate sufficient capacity to convey water between the ponds.

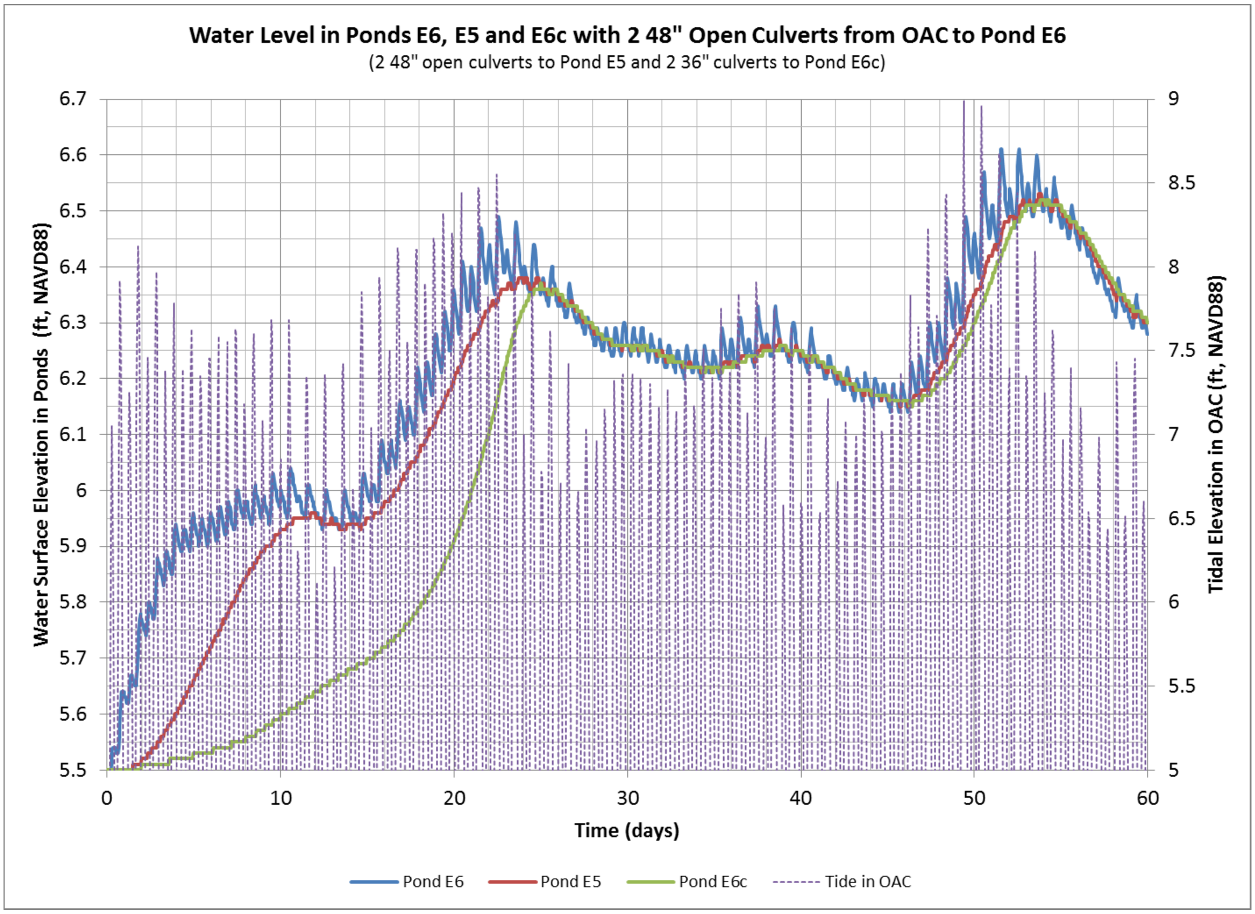

Figure 3.15 Water Surface Elevations in Inland Ponds with Proposed Water Control Structures

Figure 3.16 shows the predicted water surface elevations in the OAC near the Pond E6 culverts relative to the Bay tides. When the OAC is flowing during rain events, the limited conveyance capacity of the OAC causes water surface elevations in the OAC to rise. With a 10 cfs base flow in the OAC, the low tide in the OAC just outside the Inland Ponds is about one to two feet higher than that experienced in the Bay. With a higher base flow of about 100 cfs, the low tide in the OAC is about three to four feet higher than the low tide in the Bay. After the breach is constructed connecting the OAC and Pond E1

(Alternatives B, C and D), the OAC is anticipated to scour and increase its conveyance capacity; however the OAC reach from Pond E1 to the culvert at Pond E6 is not anticipated to scour.

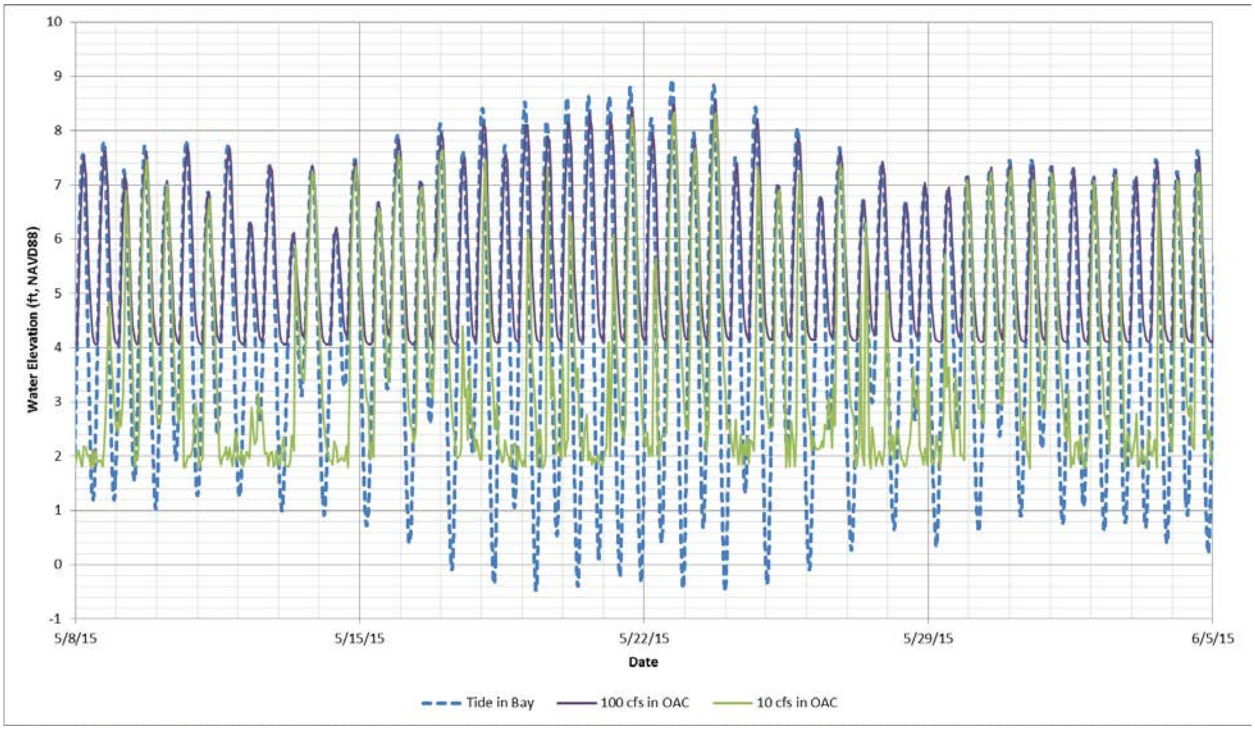

Figure 3.16 Tidal Elevations in the Bay and OAC (near Pond E6)

3.3.2 C-Ponds

Presently there are two 48 inch gates culverts connecting Pond E2C to the ACFCC. Adding two more culverts raises the maximum water level in the ponds by about a half a foot in Pond E2C and about 0.1 feet in Ponds E5C and E4C. This assumes that a 48 inch culvert is installed between Ponds E1C and E5C.

4. LIMITATIONS

This memorandum summarizes a modeling study based on information available at the time and our professional judgment pending future analyses. Future design decisions or additional information may change the findings, and corresponding professional judgments presented in this report. 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, unless we have been given an opportunity to review and concur with such conclusions in writing

5. REFERENCES

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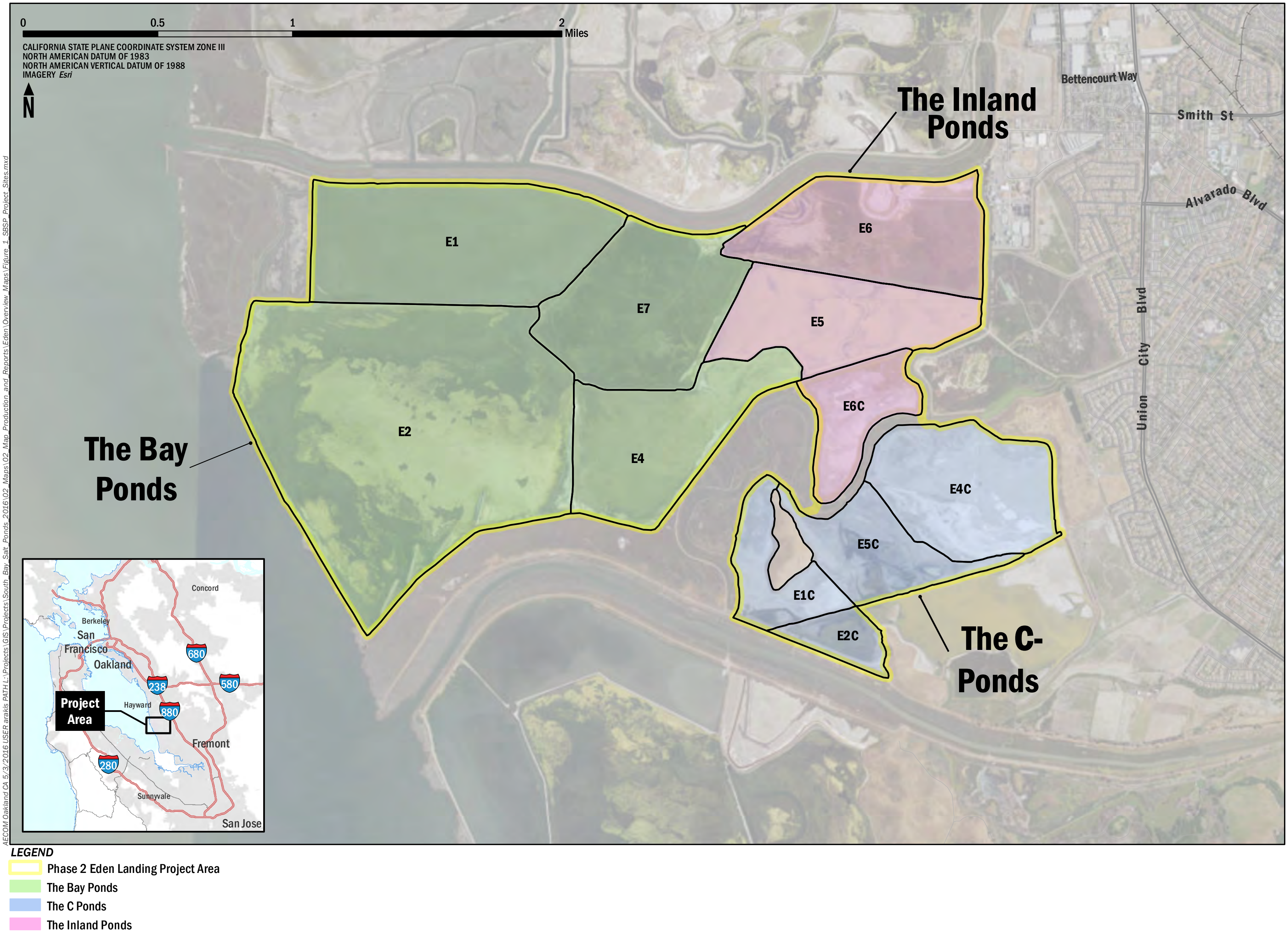
Appendix A

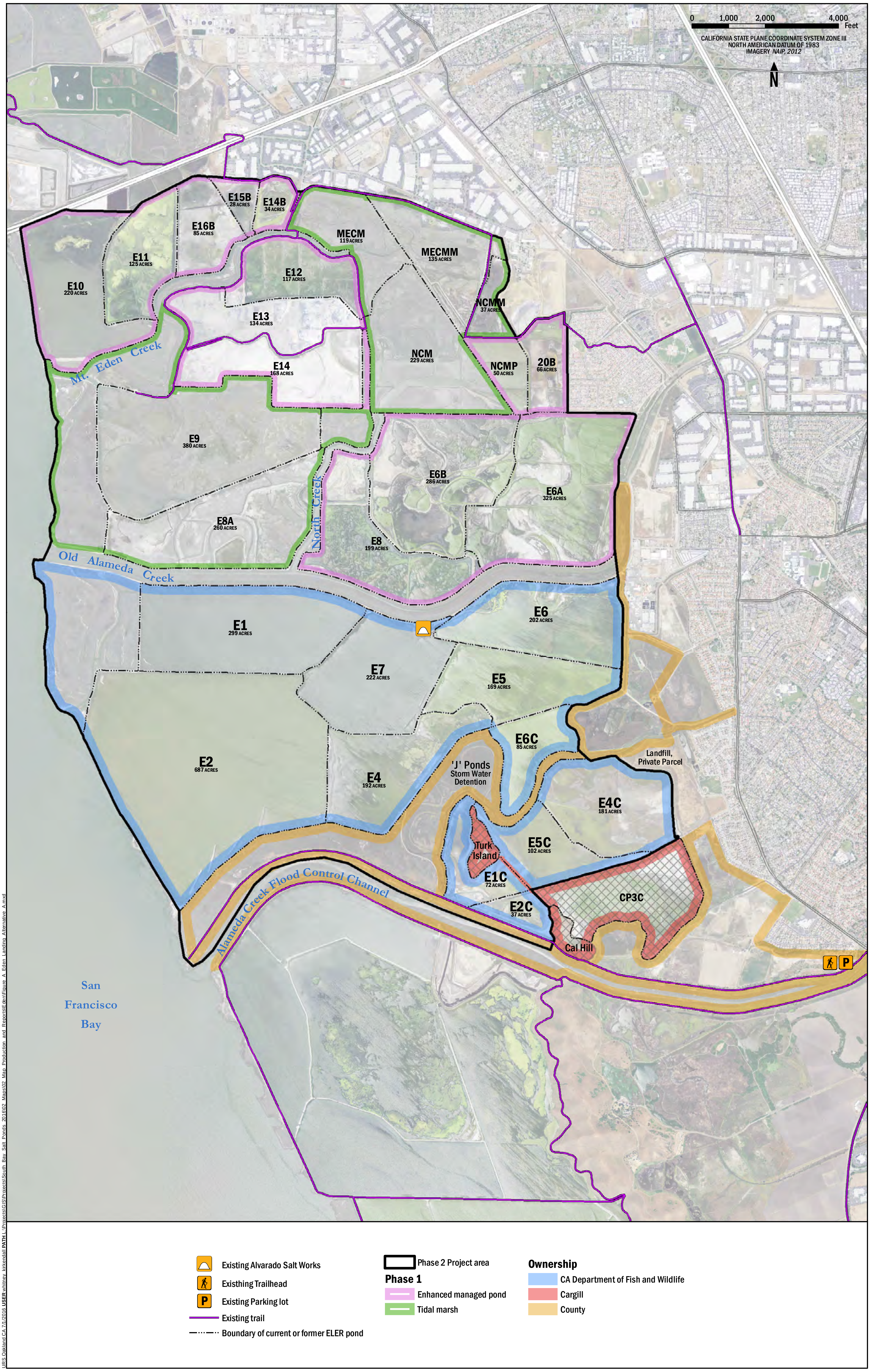
Eden Landing Figures



AECOM

South Bay Salt Pond Restoration Project
Eden Landing Phase 2: Project Area

Figure A-1
Eden Landing Phase 2: Project Area



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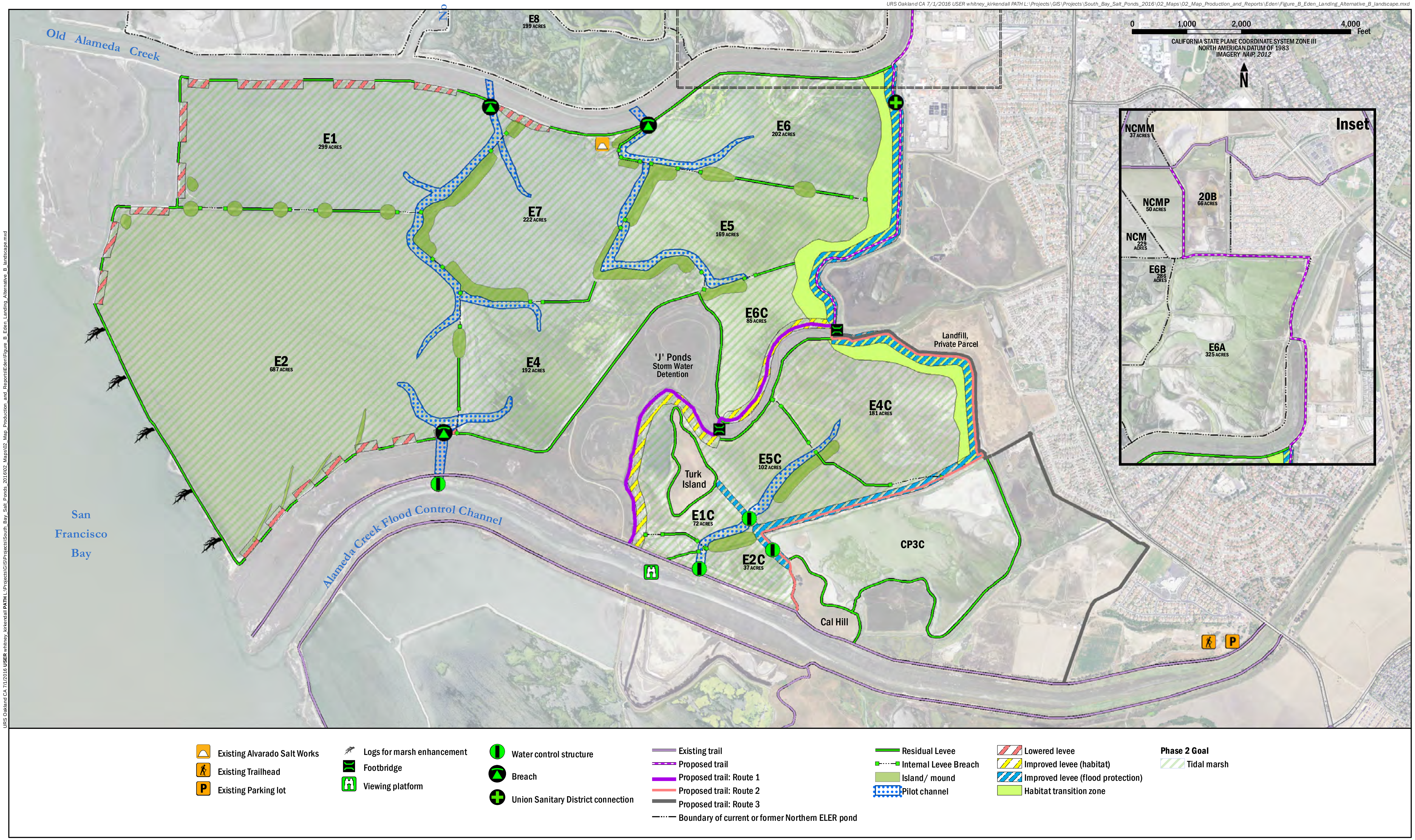
South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden A



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South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden B

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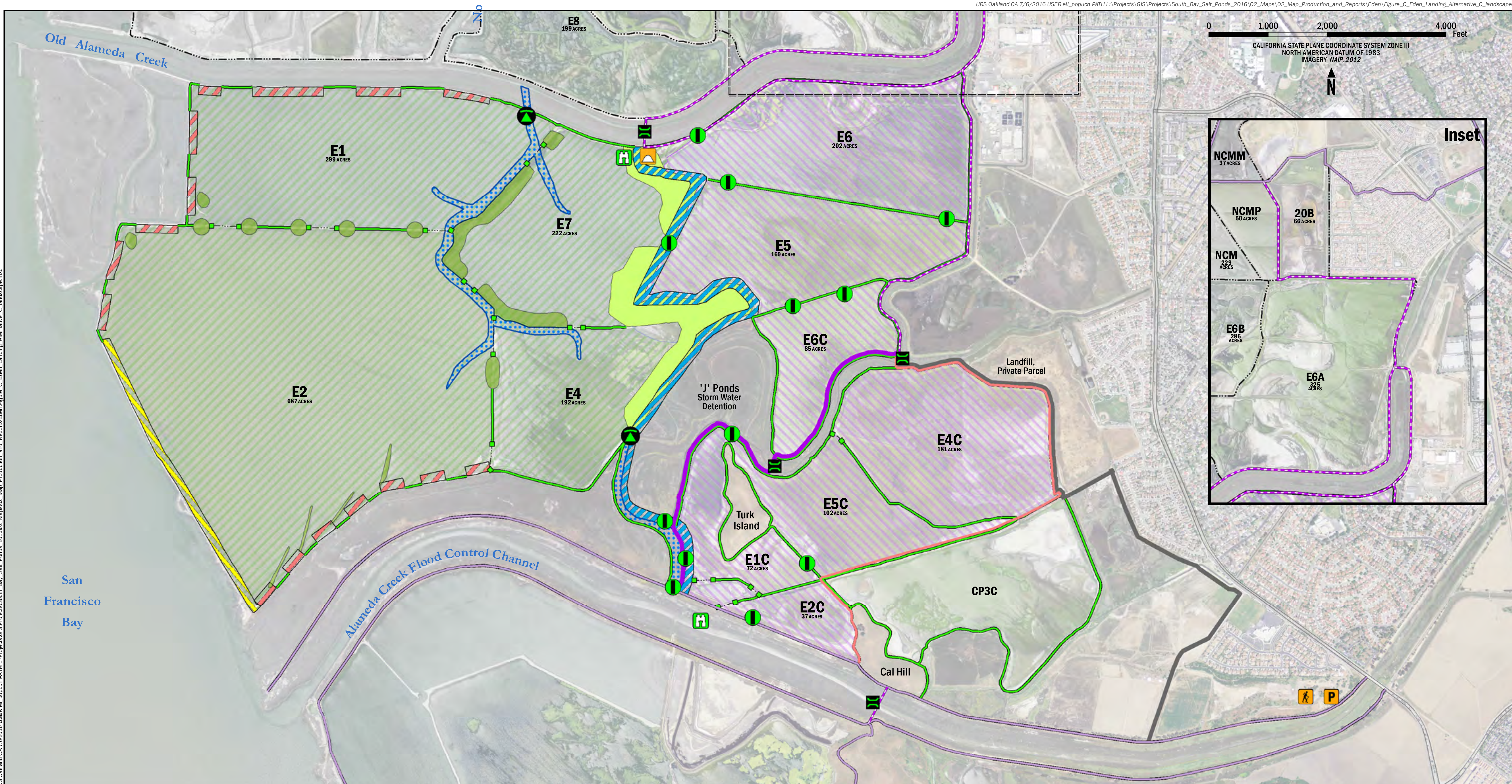

Existing Alvarado Salt Works
Existing Trailhead
Existing Parking lot
Footbridge
Viewing platform
Water control structure
Breach
Existing trail
Proposed trail
Proposed trail: Route 1
Proposed trail: Route 2
Proposed trail: Route 3
Boundary of current or former ELER pond
Residual Levee
Internal Levee Breach
Island/ mound
Pilot channel
Lowered levee
Improved levee (flood protection)
Improved levee (habitat)
Habitat transition zone

Phase 2 Goal
Managed Pond, Permanent
Tidal marsh

AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden C

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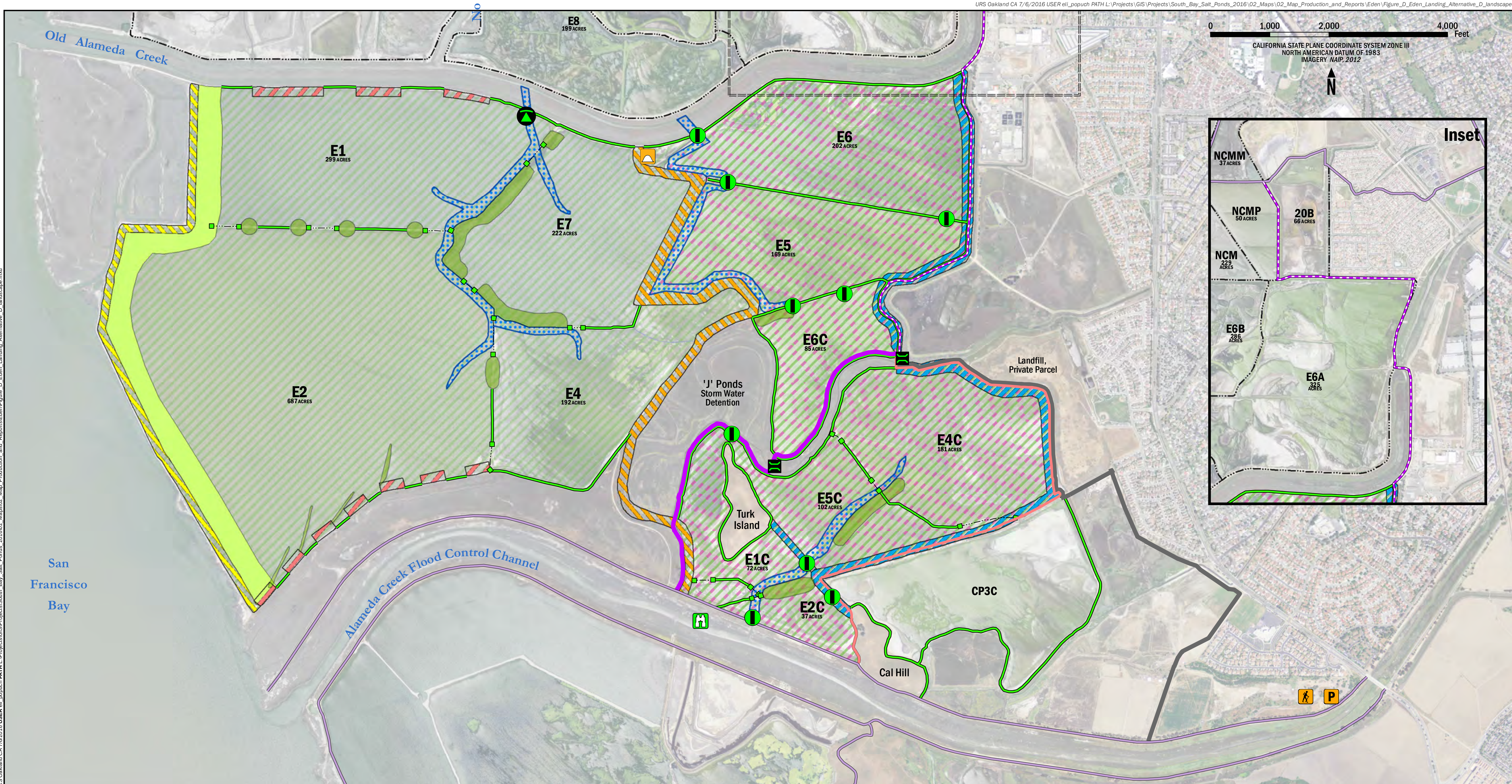

Existing Alvarado Salt Works
Existing Trailhead
Existing Parking lot
Viewing platform
Water control structure
Breach
Existing trail
Proposed trail
Proposed trail: Route 1
Proposed trail: Route 2
Proposed trail: Route 3
Boundary of current or former ELER pond
Residual Levee
Internal Levee Breach
Habitat transition zone
Island/ mound
Pilot channel
Lowered levee
Improved levee (flood protection)
Improved levee (habitat)
Temporary levee
Phase 2 Goal
Managed Pond, then tidal marsh
Tidal marsh

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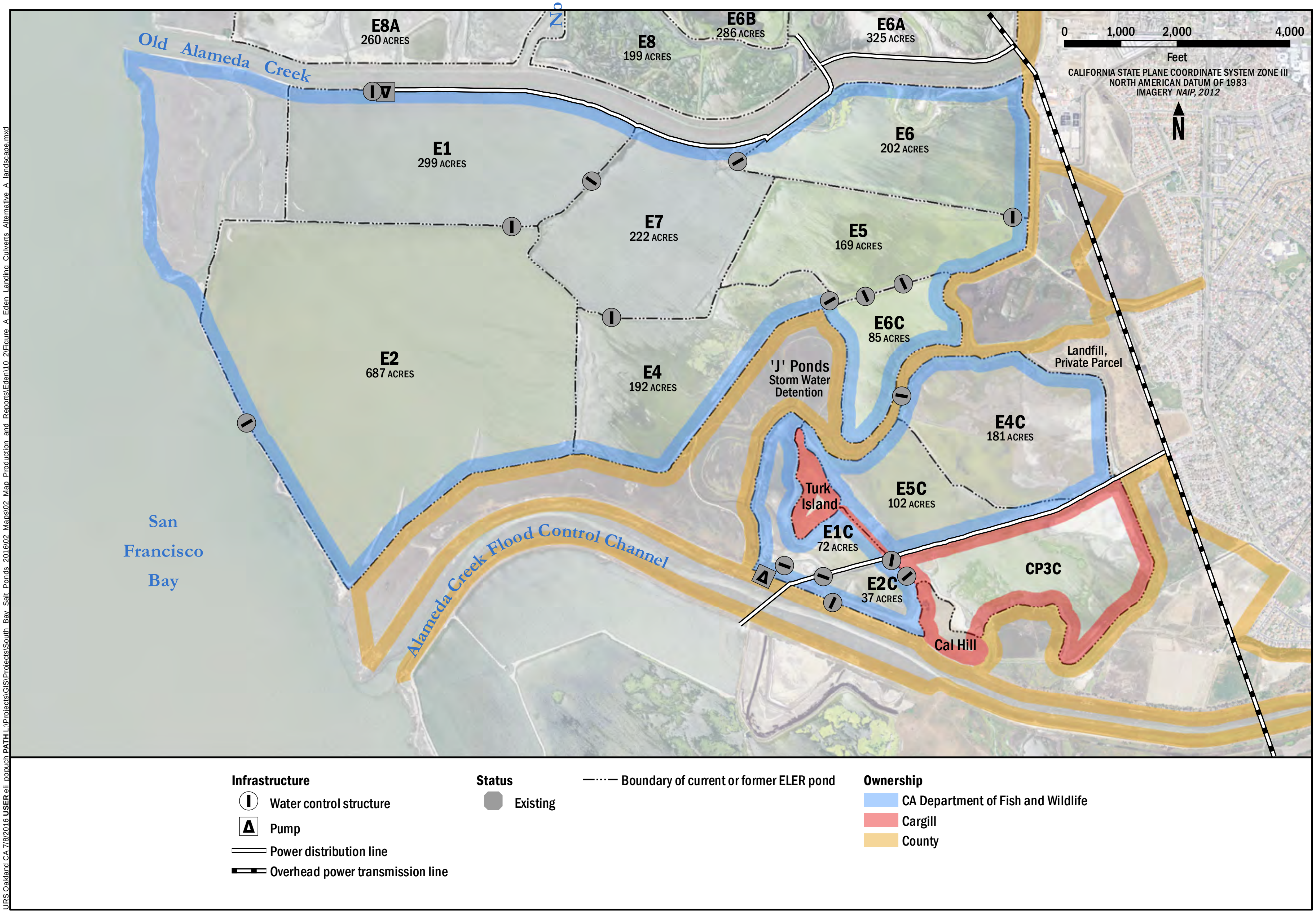
South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Alternative Eden D



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South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative A

Infrastructure

- Water control structure
- Pump
- Power distribution line
- Overhead power transmission line

Status

- New
- Demolish
- Replace/Repair

Boundary of current or former ELER pond

Phase 2 Goal

- Tidal marsh

Ownership

- CA Department of Fish and Wildlife
- Cargill
- County

Note: Levee breaches will be created where infrastrcture is demolished, except at the Bay-E2 water control structue where the levee will be backfilled after structure removal.

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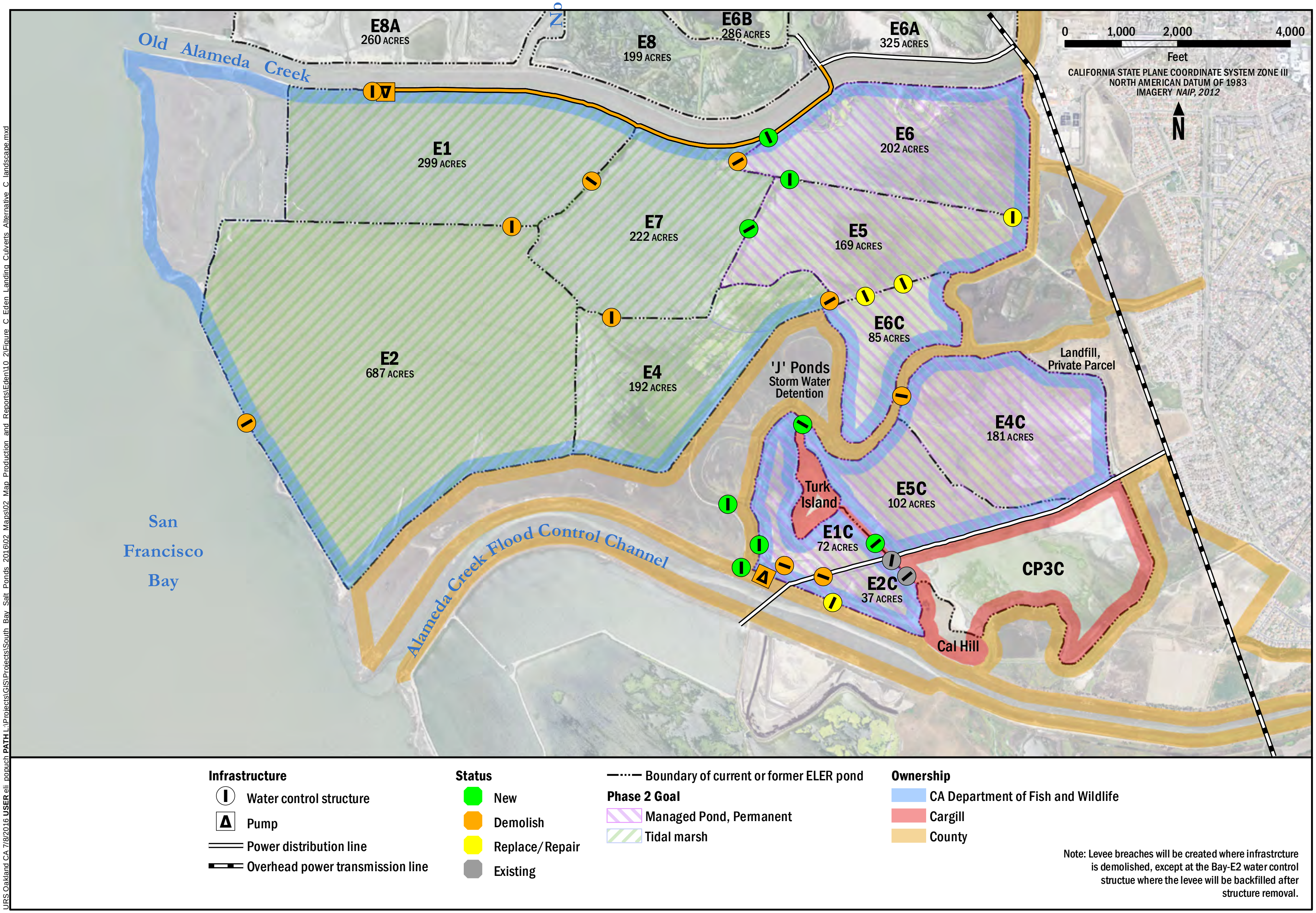
South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

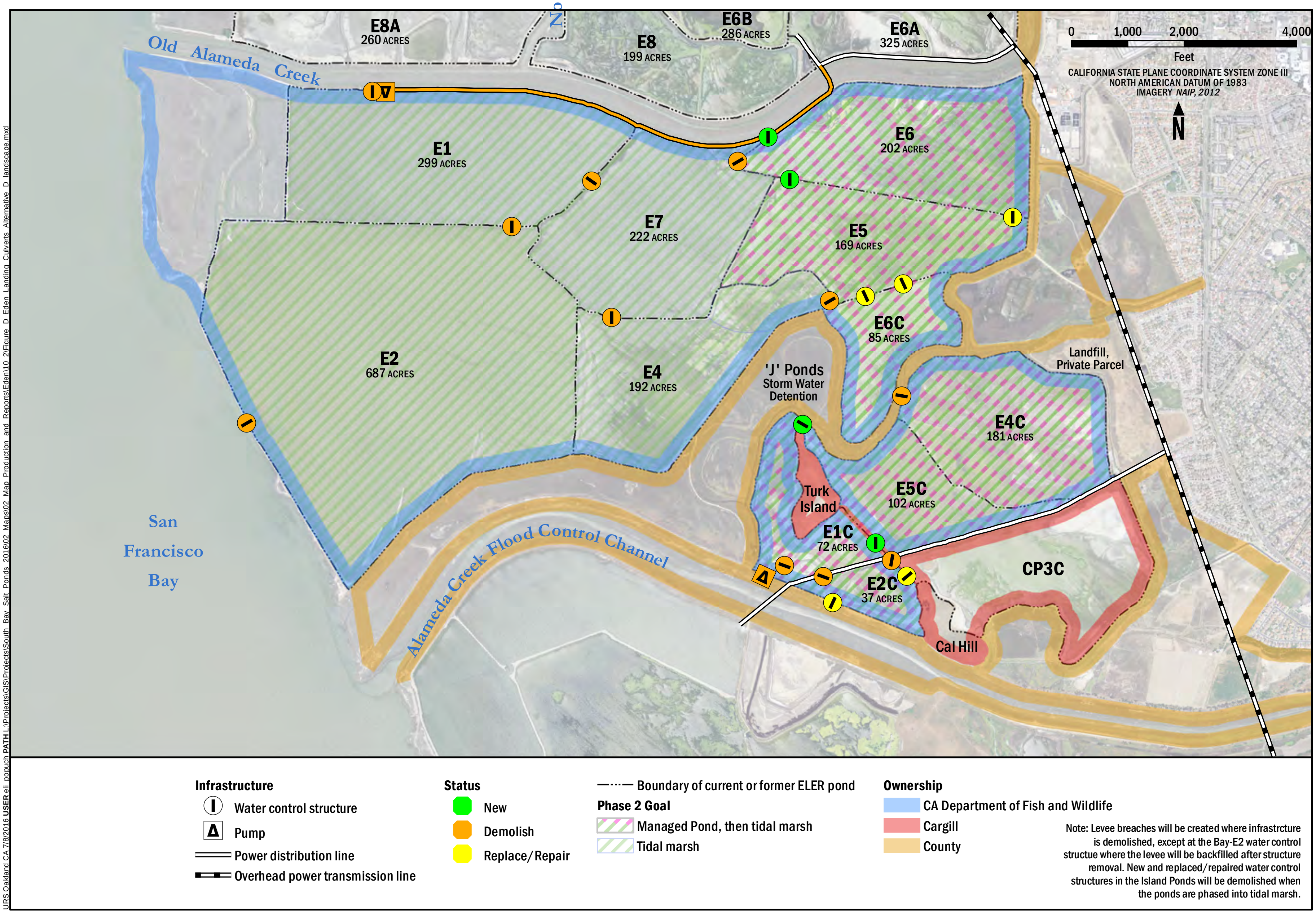
Infrastructure Alternative B



AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative C



AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Infrastructure Alternative D

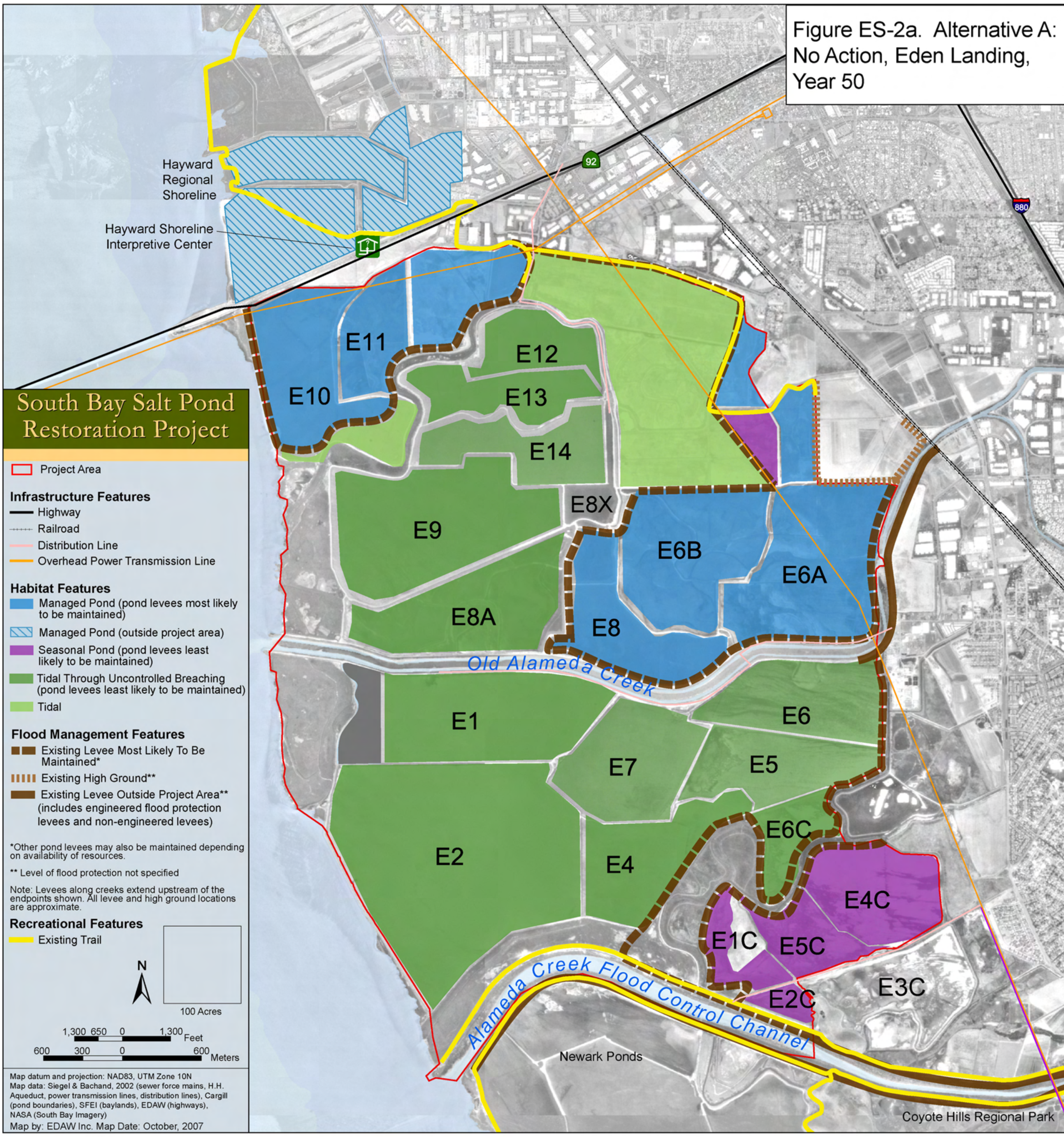


Figure A-6. Programmatic EIS/R Alternative A: No Action

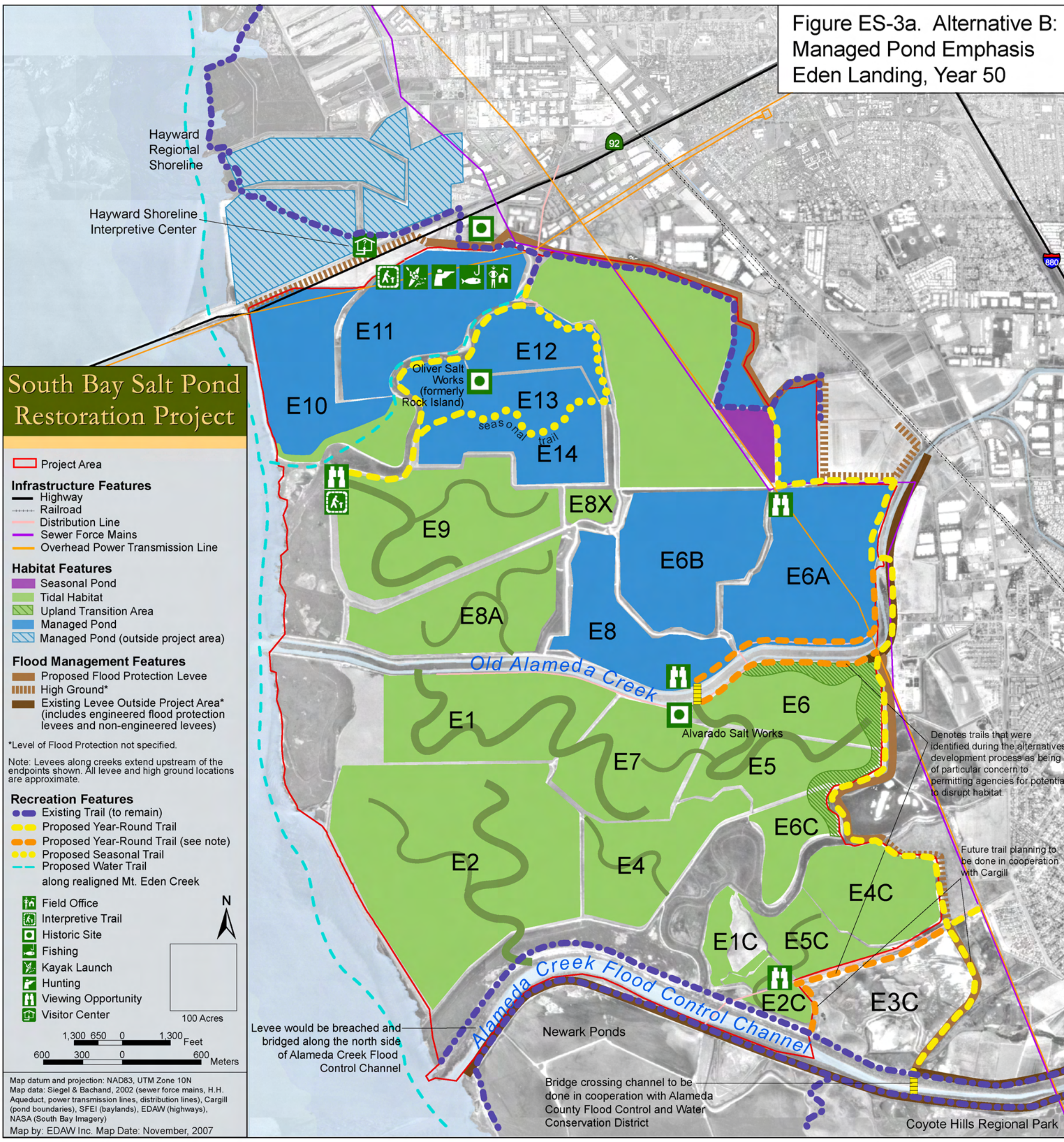


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Figure A-7. Programmatic EIS/R Alternative B: Managed Pond Emphasis

Figure A-8. Programmatic EIS/R Alternative C: Tidal Habitat Emphasis

Appendix B

David Schoellhamer (USGS) comments on AECOM modeling of Eden Landing Ponds

David Schoellhamer comments on AECOM modeling of Eden Landing Ponds

March 18, 2016

On March 17, 2016, Phil Mineart and Megan Collins of AECOM presented their modeling of the Eden Landing Ponds to me via a webinar. The objective of the modeling at this 10% design stage is to conceptually determine how to obtain water levels in the ponds that meet management objectives without increasing flood risk. AECOM is applying the MIKE21 model, a commonly used model that simulates depth-averaged flow varying in time and varying horizontally. This is an appropriate model for the task and overall the modeling is appropriate for the task. Specific comments follow.

- Accurate bathymetry data are essential and they have utilized the latest and best data available.
- Boundary conditions of Bay tides and the 100-year flood are also essential and well-defined. For flood simulations they have aligned the arrival of the flood peak with a high tide which is a good conservative approach. Perhaps now or a later design stage the effect of sea level rise on the flood scenario should be considered. *[AECOM insert: The SBSP Project's approach is to maintain existing flood protection and work with external partners as practicable to improve existing conditions. Designing for sea level rise would improve existing conditions, and is therefore not an incorporated component of the Eden Landing design at this time.]*
- There is no water level data that I know of that could be used for model calibration. Ideally, such data would exist and be used to calibrate the model. Fortunately water level is the easiest model variable to predict (compared to velocity, salinity, sediment, water quality), the model domain is small, bathymetry is well-defined, and the boundary conditions are well-defined. So lack of data adds uncertainty to the model but is not a fatal flaw.
- The management objective for restoration is to maximize pond area that is wetted and dried during a tidal cycle. A different management objective would likely lead to a different restoration design.
- AECOM will double check that there is no overtopping of the levee on the landward side of the model domain that protects an urban area. *[AECOM insert: The model extent was expanded to the east to capture the full flood extent.]*
- The model does not consider bathymetric change created by restoration actions. The simulation of a scoured OAC was a good idea to test what could happen with increased tidal prism and potential scour. OAC at the E7 breach (I am 90% sure I have the right one) has a mid-channel marsh island. The E7 breach to the south channel could increase scour there. The south channel would then take more tidal prism, reducing tidal flows in the north channel that could lead to deposition there (similar to deposition in Steinberger Slough when the Port of Redwood City was deepened). The north channel presently takes most of the flood flow, so deposition in it would have the potential to make flooding worse. AECOM proposed making a cut in the mid-channel island at the E7

breach to try to better balance the increased flow in the north and south channels, which makes sense to me. I expect this would also improve wetting and drying of E7. I also expect it would reduce erosion of seaward fringe marsh in OAC along the south channel and so the cut may preserve some seaward marsh and may not result in a net loss of marsh. *[AECOM insert: OAC island cuts are proposed for external breaches connecting Ponds E1 and E7 to the OAC.]*

ATTACHMENT 2. EDEN LANDING GEOTECHNICAL INVESTIGATION AND ANLYSES

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Memorandum

To	State Coastal Conservancy	Pages 5
Subject	Eden Landing Geotechnical Investigation and Analyses	
From	Seth Gentzler, PE, Project Manager Kanax Kanagalingam, PE, GE, Benjamin Choy, PE	
Date	November 8, 2016	

This memorandum presents geotechnical data collected from the recent AECOM geotechnical field investigation and results of the geotechnical analyses performed for the conceptual restoration design of the southern half of the Eden Landing Ecological Reserve (ELER).

1.0 AECOM Geotechnical Investigation

In June 2016, AECOM planned and executed a subsurface field investigation in order to collect geotechnical field data, and to perform laboratory testing on the samples collected during the investigation. The investigation consisted of six soil borings, B-01-through B-06. Table 1 summarizes the approximate locations of these borings and the boring depths. Figure 1 shows the locations of these boring on the project vicinity map. The field investigation was performed between June 20 and 22, 2016.

Pitcher Drilling Company of East Palo Alto, California drilled the exploratory borings using a truck-mounted Failing 1500 drill rig. The borings were advanced using rotary wash drilling techniques to depths ranging from 56.5 to 63 feet. An AECOM geologist on site during drilling, visually classified the soils encountered during the drilling, and logged the borings. The draft boring logs are included as Attachment 1. The borings were backfilled with a neat cement-bentonite grout in accordance with the appropriate county permits.

Samples were collected at five foot intervals using a split-spoon sampler during standard penetration testing (SPT), a 2.5-inch Modified California (ModCal) sampler, or a 2.8-inch Shelby tube sampler. The sampler utilized in the field was determined based on the encountered materials.

Samples collected during the exploration were transferred to Cooper Testing Laboratories in Palo Alto, California for testing. Tests were performed on select samples and included moisture content and density, sieve analysis, Atterberg limits, unconsolidated-undrained triaxial tests (TXUUs), consolidated-undrained triaxial tests (TXCUs) with pore pressure measurements, and consolidation tests. The geotechnical laboratory test results are presented in Attachment 2.

2.0 Geotechnical Analyses

As part of the restoration of the southern half of the ELER, existing levees in the Eden Landing pond complex are proposed to be raised to a design crest elevation of 12 feet (NAVD88). Based on hydrodynamic modeling results, the proposed raise is expected to provide equal or better flood protection compared to existing conditions. Based on the subsurface soil conditions and the levee geometry after the proposed raise, representative levee cross sections were selected for geotechnical analyses.

The details of the representative analysis sections, material characterization, analysis procedures, and the results of the analyses are discussed in the following sections.

2.1 Representative Analysis Sections and Material Characterization

The selected representative analysis cross sections and their idealized soil profiles are shown on Figures 2 and 3. The section shown on Figure 2, named as Section A, represents the existing levees that will be raised by about 2 feet. Section A represents the majority of the levees that will be raised as part of the ELER restoration. The section shown on Figure 3, named as Section B, represents a relatively short levee section where the levees will be raised by about 4 feet to meet the design crest elevation of 12 feet. This section is located along the Mid-Complex Levee between approximate Stations 81+00 and 115+00. Considering the thickness of the soft bay mud (as described below) at the project site, the levee side slopes of 4H:1V were assumed for the geotechnical evaluation.

The idealized profiles and material properties for the analyses were developed based on the geotechnical data collected from the recent AECOM investigation, available historical data collected by others (Geo/Resource Consultants, INC. 2008, AMEC 2010, Wood Rodgers, CE&G and GEI 2011), past similar projects, and engineering judgement. In general, the existing levees are underlain by a soft compressible Young Bay Mud (YBM). The YBM is underlain by stiff old bay clay (OBC). The thickness of the YBM at the project site ranges from 15 to 35 feet. The idealized soil profile modeled the YBM as a 30-foot–thick layer underlying the existing levee. It is recommended that a more comprehensive field investigation program shall be performed to refine the subsurface conditions for final design.

Since the source of the new levee fill material is not yet determined, conservative strengths were assigned to the new levee fill in performing the slope stability analysis. It is recommended that a test fill be constructed to confirm that the strengths and densities assumed in this analysis are attainable. Due to the difficulty in working with the YBM, it is recommended that the levee test fill be constructed near the site of the future levee in an area with similar subsurface conditions as the foundations for the future levees. Depending on the results of the test fill, modifications of the design may be warranted. For now, the strengths assigned to the levee fill in this analysis are judged to be sufficiently conservative to achieve in the field.

Table 2 summarizes the idealized soil profile and the material parameters selected for the settlement and stability analyses.

2.2 Analysis Procedures

The stability of the levees was analyzed for two cases: the end of construction case and the long-term steady state seepage during a potential high water event. Rapid drawdown was judged to not be applicable since the tidal fluctuations would not allow the levees to fully saturate.

As the levee raises will, in general, be constructed over soft compressible YBM, one dimensional settlement analysis was performed for the selected representative sections using the geometry determined to be stable for the target design crest elevation. Slope stability analysis was then performed with the levee crest height selected at a higher elevation to approximately compensate for the estimated settlement.

As provided in Table 2, the soft YBM layer was modeled using undrained shear strength. For the end of construction case, the undrained shear strength was first estimated using the current effective stresses and the undrained strength ratio (Su/σ_v') of 0.27, and then modeled using a depth-dependent strength model. For the long term steady state case, the undrained strength was modeled directly using the undrained strength ratio to represent the long term consolidated stress conditions. In both cases the lower bound of the undrained strength was limited to 200 psf.

Finite element seepage analyses were performed using SEEP/W (2012 Version 8.15), a two-dimensional, finite element analysis software program developed by GEO-SLOPE International, Ltd. SEEP/W analyzes groundwater seepage and excess pore water pressure dissipation conditions in porous materials, such as soil and rock. Slope stability analyses were completed using SLOPE/W (2012 Version 8.15), a slope stability analysis program also developed by GEO-SLOPE International, Ltd. Pore water pressures calculated in SEEP/W analyses, assuming steady-state seepage conditions, were imported and used in the static slope stability.

2.3 Analysis Results and Discussion

2.3.1 Section A

The anticipated settlement of the raised levee crest was first estimated by performing a settlement analysis on Section A with the design crest elevation of 12 feet. The estimated immediate settlement is on the order of 1-inch, and the consolidation settlement is on the order of 17-inches. The consolidation settlement is expected to occur over 20 to 85 years. In order to compensate for the consolidation settlement the constructed crest elevation will be 13.4 feet, which is assumed to be sufficient to maintain the levee crest at or above elevation of 12 feet. It is noted that along the alignment of the levee, differential settlement is likely to occur due to differences in the subsurface materials.

Slope stability analyses were performed on the levee section with the increased crest height (elevation 13.4 feet). The results of the stability analyses are summarized in Table 3, and in Figures 4 and 5. The section calculated a factor of safety of 1.2 for end of construction, and 1.3 for long term stability. Based on the results of the slope stability analyses performed as part of the 30 percent design of the levees at Alviso and Ravenswood Pond Complexes (not included in this memorandum), the calculated factors of safety were judged to be adequate for both the end of construction and long term conditions. Based on these analysis results, 4H:1V or flatter side slopes and the construction crest elevation of 13.4 feet are recommended for the levee construction.

2.3.2 Section B

Similar to Section A, the anticipated settlement of the raised levee crest was first estimated by performing a settlement analysis on Section B with the design crest elevation of 12 feet. The estimated immediate settlement is on the order of 2-inches, and the consolidation settlement is on the order of 36-inches. The consolidation settlement is expected to occur over 20 to 85 years. In order to compensate for the consolidation settlement, the proposed constructed crest elevation will be 15 feet, which is assumed to be sufficient to maintain the levee crest at or above elevation of 12 feet. It is noted that along the alignment of the levee, differential settlement is likely to occur due to differences in the subsurface materials.

Slope stability analyses were performed on the levee section with the increased crest height (crest elevation 15 feet). The results of the stability analyses showed that the factor of safety calculated for the end of construction case was judged to be not adequate for construction.

Three alternatives were considered for raising the levee to provide a long term crest elevation at 12 feet or above:

(1) Construct to elevation 15 feet with flattened side slopes of 5H:1V,
(2) Excavation and replacement of the top 10 feet thick soft YBM and construct to elevation 15 feet with 4H:1V side slopes, and
(3) Staged construction with first stage construction to elevation 12 feet following by periodic maintenance to keep crest at elevation 12 feet.

The factors of safety calculated for the end of construction stability of both (1) and (2) did not meet the assumed adequate factors of safety of 1.2 for end of construction case. The alternative involving the excavation and replacement of deeper than 10-foot thick soft YBM is considered to be an expensive alternative, and therefore not considered for evaluation. The results of analysis for staged construction are summarized in Table 3, and in Figures 6 and 7. The section with the crest elevation at 12 feet calculated a factor of safety of 1.2 for end of construction, and 1.4 for long term stability. The calculated factors of safety for this scenario were judged to be adequate for construction.

Based on these analysis results, 4H:1V or flatter side slopes and the construction crest elevation of 12 feet are recommended for the levee construction. In addition to the alternatives discussed above, an alternate levee alignment closer to nearby existing levees could also be considered for Section B.

3.0 Limitations

This memorandum was developed in accordance with the standard of care commonly used as state-of-practice in the engineering profession. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. No warranty is either expressed or implied that actual encountered site and subsurface conditions will conform exactly to the conditions described herein; nor is it expressed or implied that this memorandum's recommendations will be sufficient for all construction planning aspects of the work. The conclusions presented in this memorandum are professional opinions based on the indicated project criteria and data available at the time this report was prepared.

The conclusions presented in this memorandum are intended only for the purpose, site location, and project indicated. The recommendations made in this report are based on the assumption that the subsurface soil and groundwater conditions do not deviate appreciably from those disclosed in the site-specific exploratory borings, including those performed by others. Additional borings are recommended for final design.

4.0 References

Geo/Resource Consultants, INC., 2008. Geotechnical Investigation Report, SBSP Eden Landing Ponds E8A, E9, and E8X Phase 1 Action Tidal Restoration/ New E10 Levee, Report.

AMEC, 2010. Geotechnical Study, South Bay Salt Pond Restoration Project, Eden Landing Restroations, Ponds E8/E9 and E12/13, Report.

Wood Rodgers, CE&G and GEI, 2011. Alameda County Category 1 Levee Evaluation, Flood Control Zone 5, Site Plan and Exploration Data.

TABLES

Table 1 AECOM Boring Locations and Depths

Boring	Location	Approximate Latitude	Approximate Longitude	Depth (ft)
B-01	Eden Landing – near Pond E6/E7	37.590270°	-122.116008°	61.5
B-02	Eden Landing – Pond E2	37.573452°	-122.137606°	56.5
B-03	Eden Landing – Pond E6C	37.584964°	-122.091962°	61.5
B-04	Eden Landing – Pond E6C/J Ponds	37.575561°	-122.103004°	61.5
B-05	Eden Landing – Pond E5C	37.572686°	-122.088808°	63
B-06	Eden Landing – Pond E2C	37.568414°	-122.105628°	61.5

Table 2 Idealized Soil Profile and Material Properties Used for Analyses

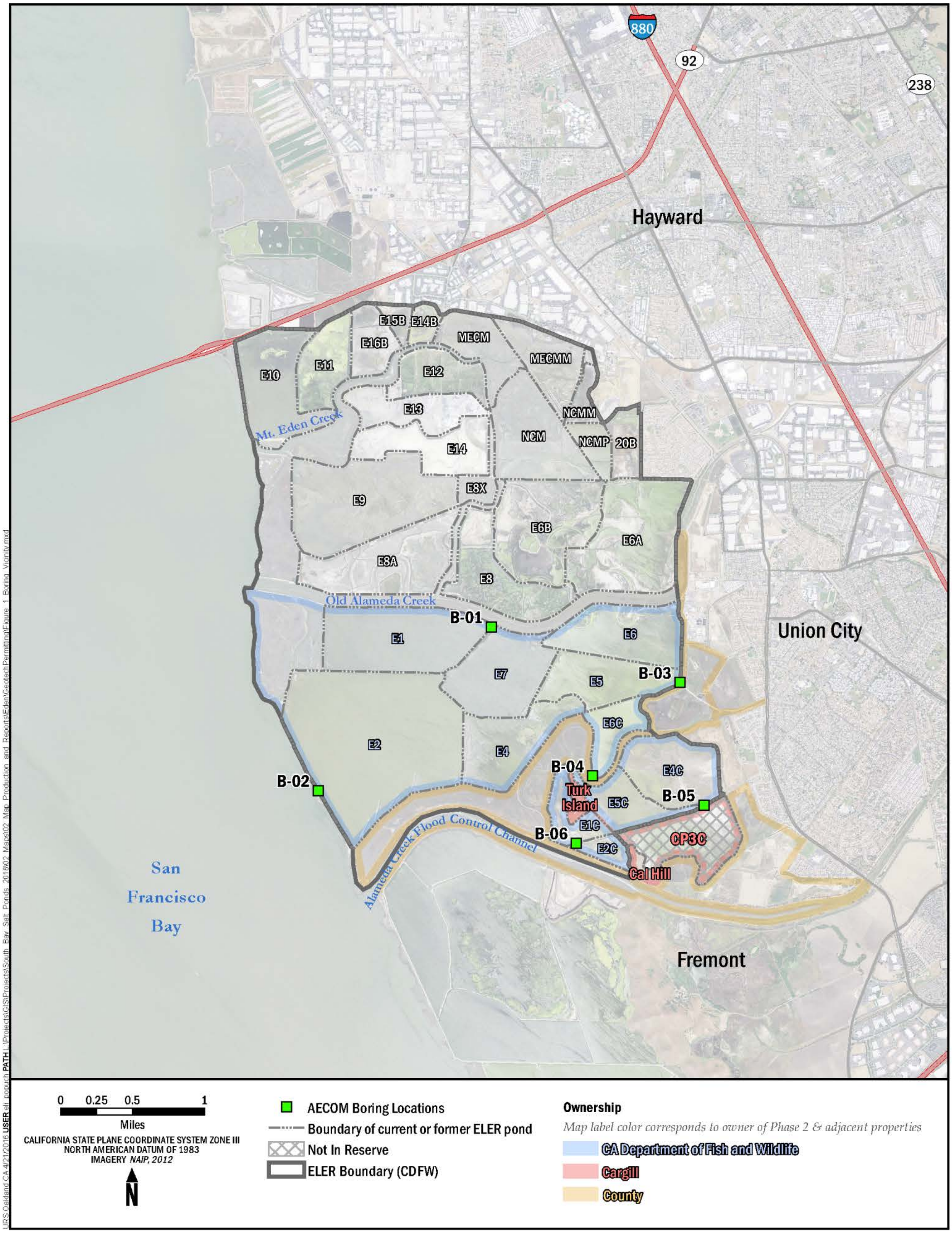
Material Layer	Elevation Below Levee Centerline (ft)				Unit Weight (pcf)	Soil Strength Parameters					Settlement Analysis Parameters			
	Section A		Section B											
	Top	Bottom	Top	Bottom		c' (psf)	ϕ' (deg.)	Su (psf)	S_u/σ_v'	Su,min (psf)	OCR	Cc	Cr	e_0
New Fill	12.0	10.3	12	7.6	125	100	32	-	-	-	-	-	-	-
Existing Fill	10.3	5.3	7.6	5	120	50	28	-	-	-	-	-	-	-
Young Bay Mud (YBM)	5.3	-24.8	5	-25	95	-	-	-	0.27	200	1.2	1.1	0.2	2.5
Old Bay Clay (OBC)	-24.8	-50.0	-25	-50	120	-	-	1000	-	-	3.0	0.3	0.1	0.8

Table 3 Slope Stability Analysis Results for Sections A and B

Slope Stability Analysis Case	Analysis Water Surface Elevation (ft)		Assumed Adequate Factor of Safety[3]	Calculated Factor of Safety	
	Assumed Waterside[4]	Assumed Landside		Section A[1]	Section B[2]
End of Construction	10.5	Dry	1.2	1.2	1.2
Long Term Steady State	10.5	Dry	1.3	1.3	1.4

Notes: [1]Crest elevation 13.4 ft, [2] Crest elevation 12 ft.
[3]Assumed factors of safety are based on the results of the slope stability analyses performed as part of the 30 percent design of the levees at Alviso and Ravenswood Pond Complexes (not included in this memorandum).
[4]Assumed based on 100-yr flood level and regional typical tidal high water.

FIGURES



AECOM

South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

FIGURE 1. VICINITY MAP

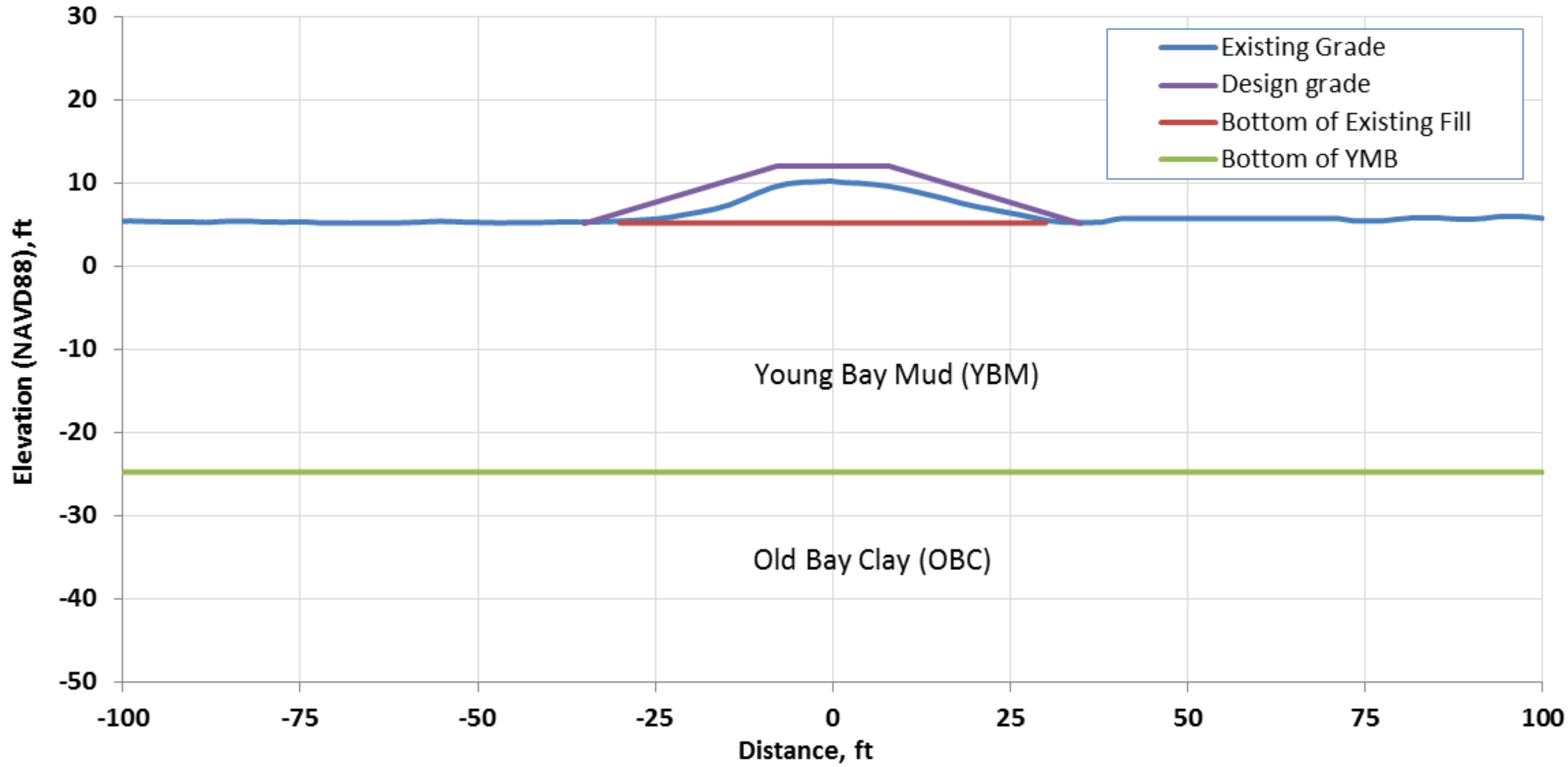


Figure 2 Idealized Cross Section – Section A

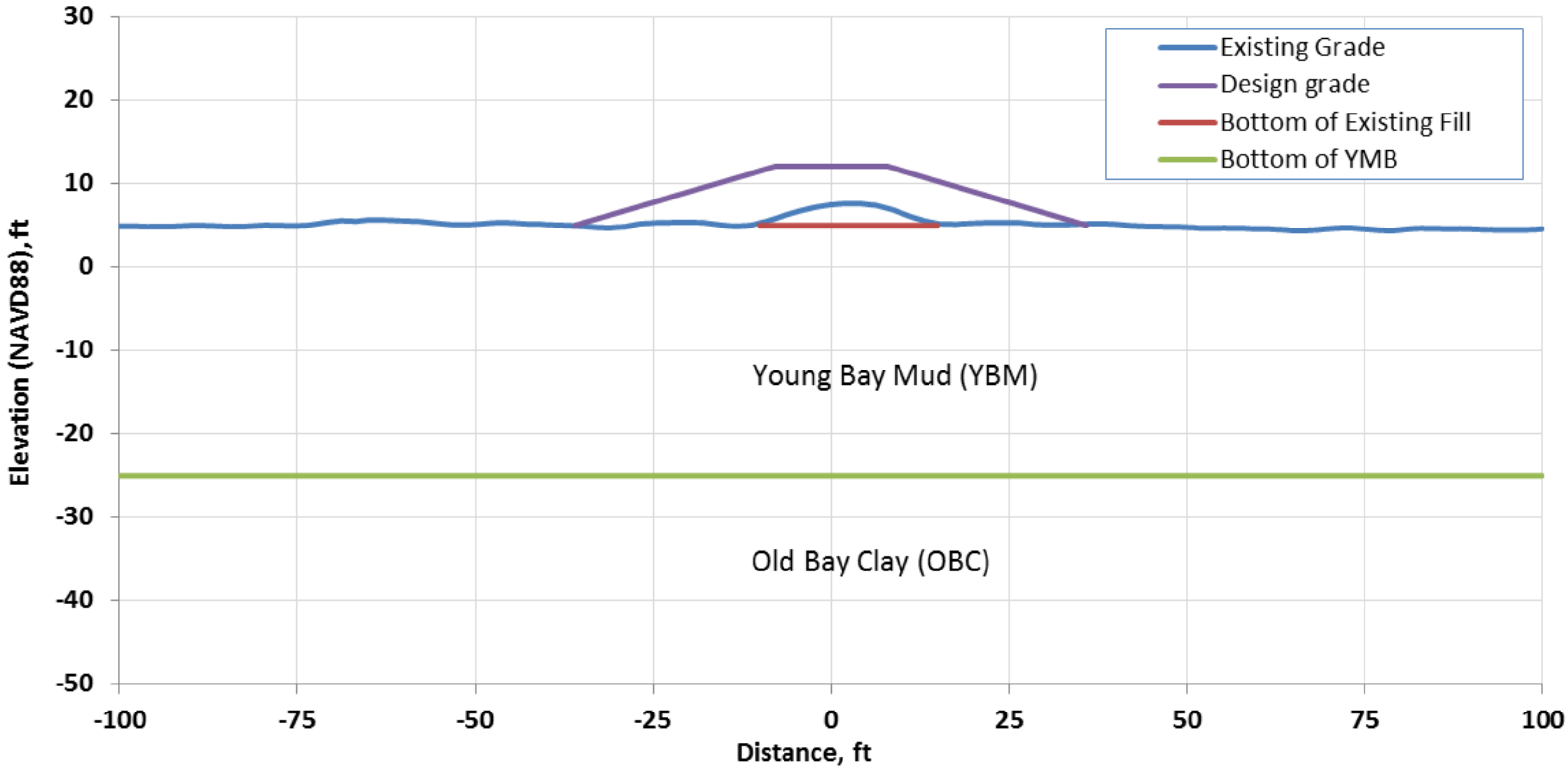


Figure 3 Idealized Cross Section – Section B

Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 50 psf Phi': 28 ° Phi-B: 0 °
Name: Clay-OBM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 1,000 psf Phi': 0 ° Phi-B: 0 ° Constant Unit Wt. Above Water Table: 125 pcf
Name: YBM-shallow (for EOC Run- Sumin=200psf) Model: Mohr-Coulomb Unit Weight: 95 pcf Cohesion': 200 psf Phi': 0 ° Phi-B: 0 °
Name: New Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 100 psf Phi': 32 ° Phi-B: 0 °
Name: YBM -deep ff (for EOC Run- Su=200-265 psf) Model: S=f(depth) Unit Weight: 95 pcf C-Top of Layer: 200 psf C-Rate of Change: 8.8 (lbs/ft²)/ft C-Maximum: 265 psf
Name: YBM -deep below ext levee (for EOC Run- Su=200-340 psf) Model: S=f(depth) Unit Weight: 95 pcf C-Top of Layer: 200 psf C-Rate of Change: 8.8 (lbs/ft²)/ft C-Maximum: 340 psf

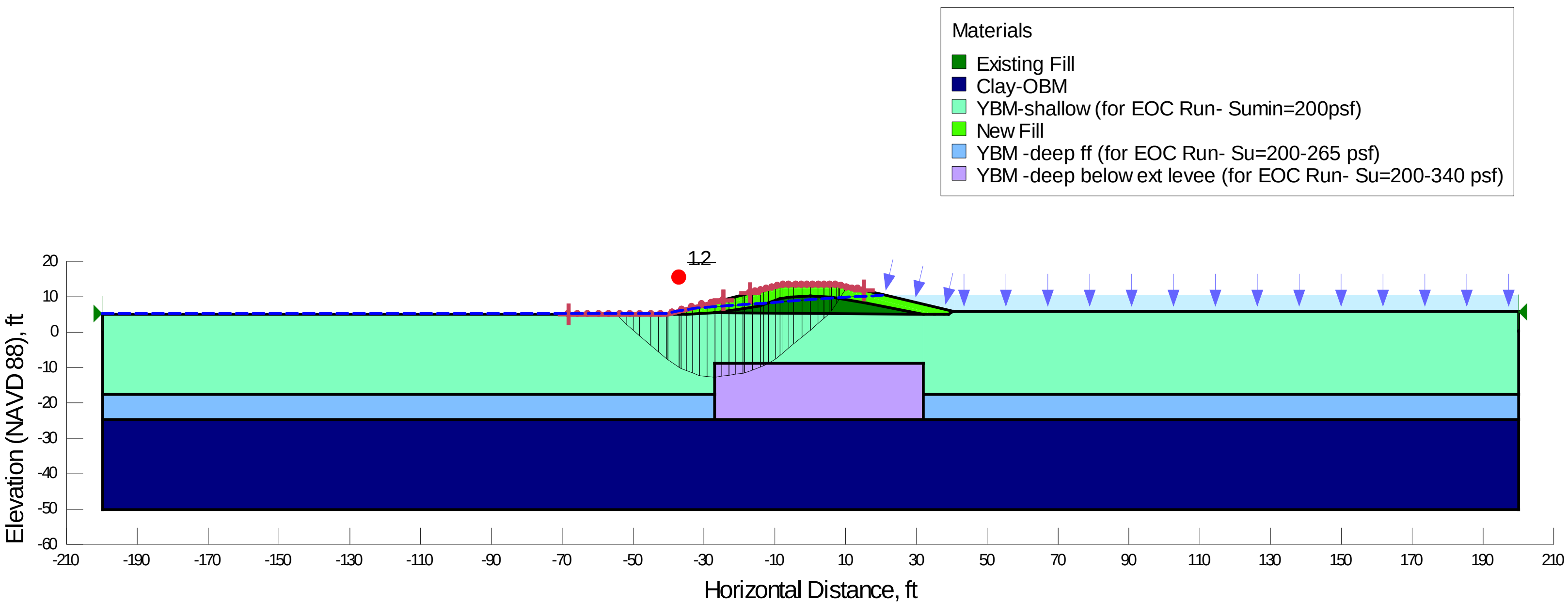


Figure 4 End of Construction Stability - Section A

Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 50 psf Phi': 28 ° Phi-B: 0 °
Name: Clay-OBM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 1,000 psf Phi': 0 ° Phi-B: 0 ° Constant Unit Wt. Above Water Table: 125 pcf
Name: YBM Model: S=f(overburden) Unit Weight: 95 pcf Tau/Sigma Ratio: 0.27 Minimum Strength: 200 psf
Name: New Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 100 psf Phi': 32 ° Phi-B: 0 °

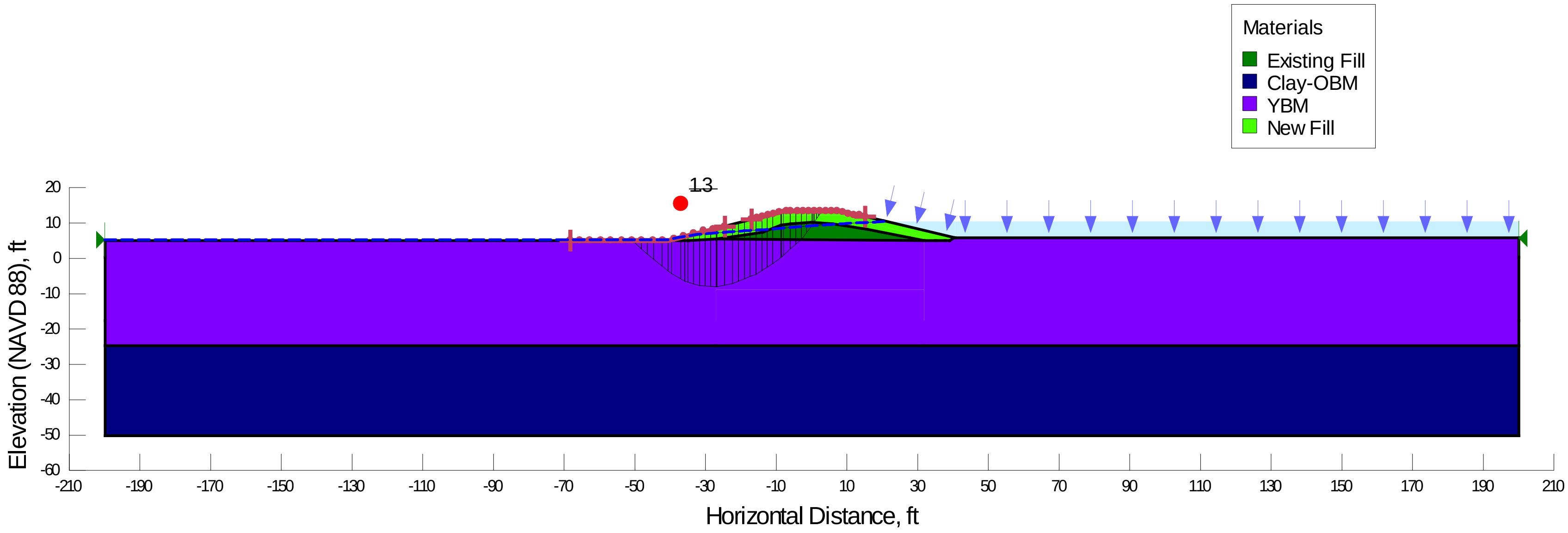


Figure 5 Long Term Steady State Stability - Section A

Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 50 psf Phi': 28 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay-OBM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 1,000 psf Phi': 0 ° Phi-B: 0 ° Constant Unit Wt. Above Water Table: 125 pcf Piezometric Line: 1
Name: YBM-shallow (for EOC Run- Sumin=200psf) Model: Mohr-Coulomb Unit Weight: 95 pcf Cohesion': 200 psf Phi': 0 ° Phi-B: 0 ° Piezometric Line: 1
Name: New Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 100 psf Phi': 32 ° Phi-B: 0 ° Piezometric Line: 1
Name: YBM -deep (for EOC Run- Su=200-265 psf) Model: S=f(depth) Unit Weight: 95 pcf C-Top of Layer: 200 psf C-Rate of Change: 8.8 (lbs/ft²)/ft C-Maximum: 265 psf Piezometric Line: 1

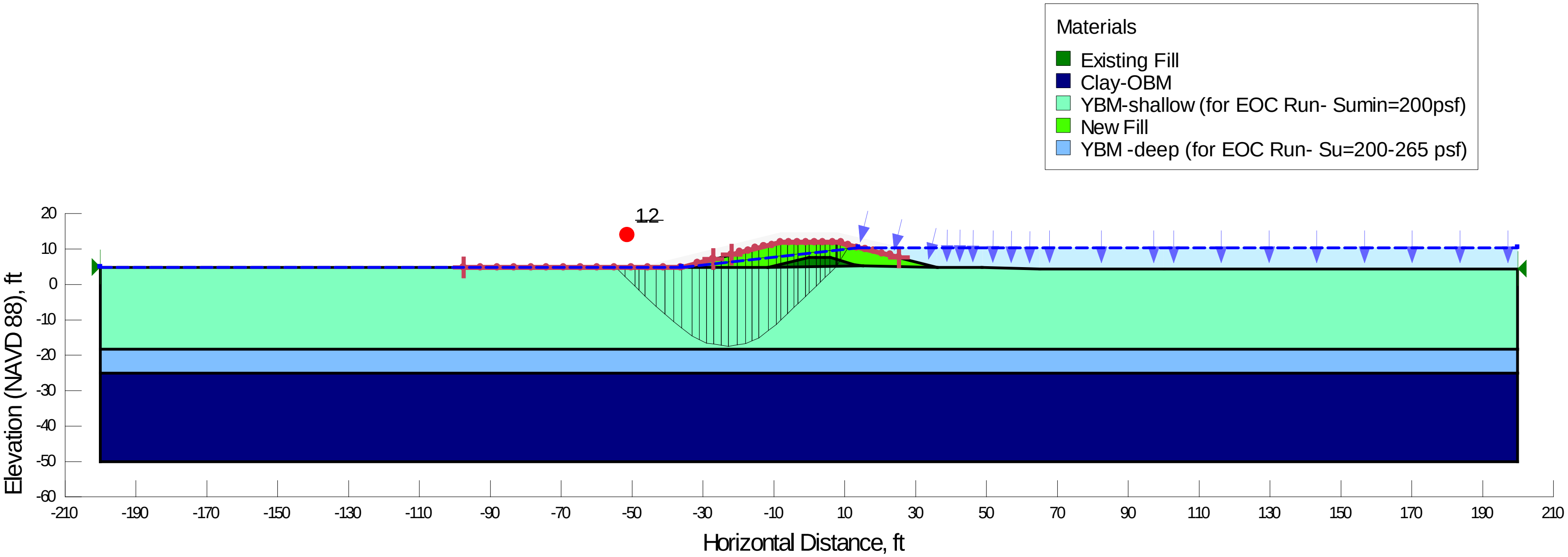


Figure 6 End of Construction Stability - Section B

Name: Existing Fill   Model: Mohr-Coulomb   Unit Weight: 120 pcf   Cohesion': 50 psf   Phi': 28 °   Phi-B: 0 °   Piezometric Line: 1
Name: Clay-OBM   Model: Mohr-Coulomb   Unit Weight: 120 pcf   Cohesion': 1,000 psf   Phi': 0 °   Phi-B: 0 °   Constant Unit Wt. Above Water Table: 125 pcf   Piezometric Line: 1
Name: YBM   Model: S=f(overburden)   Unit Weight: 95 pcf   Tau/Sigma Ratio: 0.27   Minimum Strength: 200 psf   Piezometric Line: 1
Name: New Fill   Model: Mohr-Coulomb   Unit Weight: 125 pcf   Cohesion': 100 psf   Phi': 32 °   Phi-B: 0 °   Piezometric Line: 1

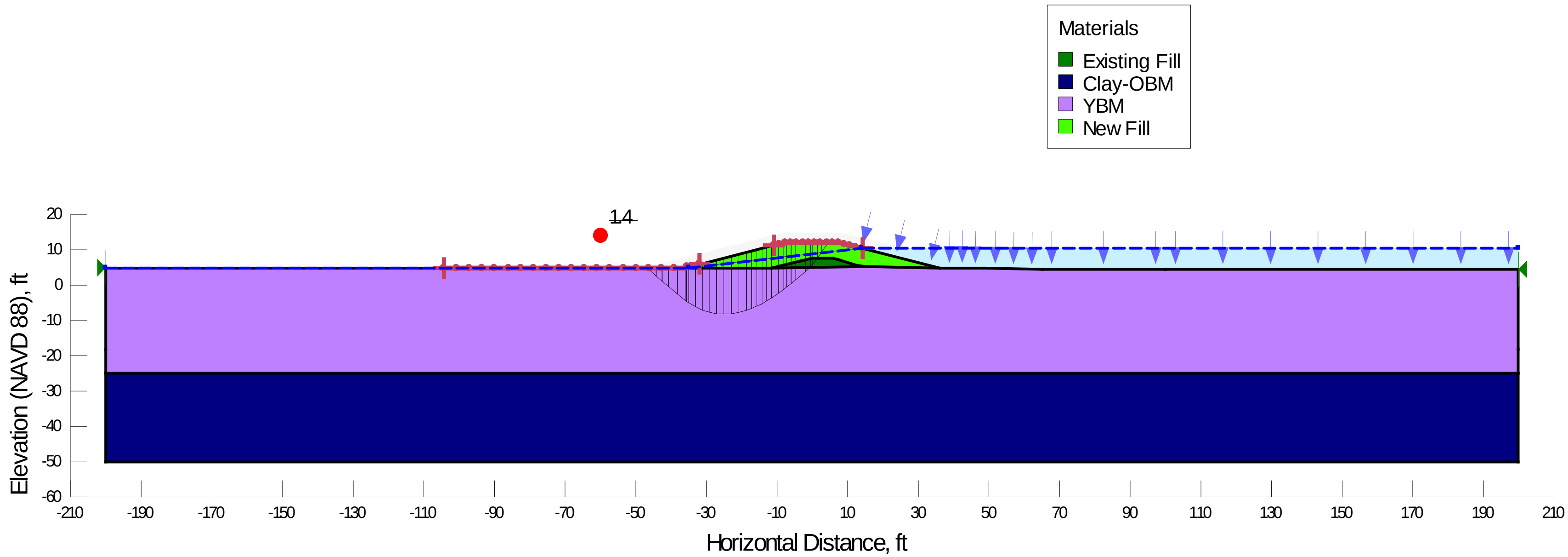


Figure 7 Long Term Steady State Stability - Section B

ATTACHMENT-1

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Key to Log of Boring

Sheet

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation in feet referenced to specified datum.

2 **Depth:** Depth in feet below the ground surface.

3 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

4 **Sample Number:** Sample identification number.

5 **Sampling Resistance:** Number of blows required to advance driven sampler 12 inches beyond first 6-inch interval, or distance noted, using a 140-lb hammer with a 30-inch drop; or down-pressure for pushed sampler.

6 **Recovery:** Percentage of driven or pushed sample length recovered; "NA" indicates data not recorded.

7 **Graphic Log:** Graphic depiction of subsurface material encountered; typical symbols are explained below.

8 **Material Description:** Description of material encountered; may include density/consistency, moisture, color, and grain size.

9 **Water Content:** Water content of soil sample measured in laboratory, expressed as percentage of dry weight of specimen.

10 **Dry Unit Weight:** Dry weight per unit volume of soil measured in laboratory, expressed in pounds per cubic feet (pcf).

11 **Unconfined Compressive Strength:** Unconfined compressive strength of soil sample measured in laboratory, expressed in psf.

12 **Remarks and Other Tests:** Comments and observations regarding drilling or sampling made by driller or field personnel. Other field and lab test results, using the following abbreviations:

LL	Liquid Limit (from Atterberg Limits test), percent
PI	Plasticity Index (from Atterberg Limits test)
SA	Sieve analysis, percent passing #200 sieve
WA	Wash on #200 sieve, percent passing #200 sieve
UC	Unconfined compressive strength (qu), psf
CONS	Consolidation test
TX-UU	Unconsolidated undrained triaxial compression test, peak deviator stress and confining pressure, psf
TX-CU	Consolidated undrained triaxial compression test
PP	Pocket penetrometer

TYPICAL MATERIAL GRAPHIC SYMBOLS

POORLY GRADED SAND (SP)

POORLY GRADED SAND WITH SILT (SP-SM)

SILTY SAND (SM)

CLAYEY SAND (SC)

WELL-GRADED SAND (SW)

LEAN CLAY (CL)

FAT CLAY (CH)

SILTY CLAY (CL)

POORLY GRADED GRAVEL (GP)

POORLY GRADED GRAVEL WITH SILT (GP-GM)

SILT (ML)

CLAYEY SILT (ML)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Standard Penetration Test (SPT) unlined split spoon

Modified California (2.5-inch OD) with brass liners

California (3-inch OD) split barrel

Shelby tube (3-inch OD, thin-wall, fixed head)

Pitcher barrel with Shelby tube liner

Bulk (5-gallon bucket)

OTHER GRAPHIC SYMBOLS

First water encountered at time of drilling and sampling (ATD)

Static water level measured after drilling and sampling completed

Change in material properties within a lithologic stratum

Inferred or transitional contact between lithologies

GENERAL NOTES

1. Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive; actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.

2. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Report: GEO_10B1_OAK_KEY; File: 20161103_EDEN_BORINGS.GPJ; 11/4/2016 keyKP44

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Log of Boring B-01

Date(s) Drilled	**6/21/2016**	Logged By	**Stacy Ball**	Checked By	
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit**	Total Depth of Borehole	**61.5 feet**
Drill Rig Type	**Failing 1500**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**feet (NAVD88)**
Groundwater Level(s)		Sampling Method(s)	**SPT, Modified California, Shelby**	Hammer Data	**140 lb/30-inch drop Auto Hammer**
Borehole Backfill	**Neat Cement Grout**	Location		Coordinates	**N 2041436.29 E 6093467.52**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML), medium stiff, Olive brown (2.5Y 4/4), moist, medium plasticity				
	3.5						ELASTIC SILT (MH), soft to medium stiff, very dark grayish brown (2.5Y 3/2), wet, high plasticity [Young Bay Mud]				set casing at 3.5 feet
	5		1		95						mud rotary 50 to 75 psi
	6.5						At 6.5 feet, as above except black (2.5Y 2.5/1)				
	10		2		80						50 to 85 psi
	11.5						At 11.5 feet, as above except very dark gray (2.5Y 3/1)				
	15		3		95						consolidation test 50 to 75 psi
	20		4	0 0 0	100		- grades to medium stiff - color changes to dark greenish gray (gley 4/5GY)				PP: 0.5 tsf PP: 0.75 tsf
	25		5	0 0 0	100		- trace find sand				PP: 0.5 tsf
	30										

Report: GEO_10B1_OAK; File: 20161103_EDEN_BORINGS.GPJ; 11/4/2016 01

Project: SBSP, Eden Landing	Log of Boring B-01
Project Location: South Bay	Sheet 2 of 2
Project Number: 60423372	

Elevation feet	Depth, feet	Type (Samples)	Number (Samples)	Sampling Resistance, blows / foot (Samples)	Recovery, % (Samples)	Graphic Log	MATERIAL DESCRIPTION -	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND - OTHER TESTS -
	30		6	0 0 0	100						PP: 0.75 tsf
							FAT CLAY (CH), very stiff to hard, dark greenish gray (gley 3/10Y). At 33.5 feet, shells and sand transition				
	35		7	5 14 20	70						PP: 4.25 tsf
							- grades to light olive brown with white and yellowish brown mottling				
	40		8	7 9 12	55		FAT CLAY with fine Sand (CH), very stiff, high plasticity				PP: 3.25 tsf
							- becomes stiff				
	45		9	0 4 4	70		- becomes soft to medium stiff				PP: 2.0 tsf
											driller notes soil becomes sandy, soft
	50		10	1 2 9	60		Poorly-Graded SAND with CLAY (SP-SC), very loose to loose, olive brown (2.5Y 4/3), fine grained sand.				
			SPT-1	1 3 8							
	55		11	5 4 3	100		LEAN CLAY with Sand (CL), medium stiff, olive brown (2.5Y 4/3), fine grained sand.				
							SILTY CLAY (CL-ML), stiff, olive brown (2.5Y 4/3).				
	60		12	3 6 7	60						PP: 1-1.5 tsf
											End of boring at a depth of 61.5 feet; Grout boring with portland cement
	65										

Project: SBSP, Eden Landing **Project Location: South Bay** **Project Number: 60423372**	**Log of Boring B-02** Sheet 1 of 2

Date(s) Drilled	**6/21/2016**	Logged By	**Stacy Ball**	Checked By	
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit**	Total Depth of Borehole	**56.5 feet**
Drill Rig Type	**Failing 1500**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**feet (NAVD88)**
Groundwater Level(s)		Sampling Method(s)	**Modified California, Shelby**	Hammer Data	**140 lb/30-inch drop Auto Hammer**
Borehole Backfill	**Neat Cement Grout**	Location		Coordinates	**N 2035422.39 E 6087103.51**

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						LEAN CLAY (CL) with trace fine sand, medium stiff, very dark grayish brown (10YR 3/2), medium to high plasticity fines.				
											set casing at 3.5 feet
	5						ELASTIC SILT (MH), soft, dark greenish gray (gley 3 10Y), medium to high plasticity fines [Young Bay Mud]				mud rotary at 5 feet
			1		95						weight of hammer to 50 psi
	10		2		95						50 psi
	15		3		95						50 psi
	20		4		95		- with shells				50 psi ICU triaxial test PP: 0 tsf ICU triaxial test
							- increasing fine sand				
	25		5	0 0 0	80						PP: 0-0.25 tsf
	30										

Log of Boring B-02

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	30		6	0 0 0	90						PP: 0 tsf
	35		7	0 0 0							
	40		8	6 17 22	50		LEAN CLAY (CL), very stiff, dark greenish gray (gley 4 10G), medium to high plasticity fines. - gravel at tip of sample				PP: 2.75 tsf PP: 3.25 tsf
	45		9	7 12 12	55		- color changes to olive brown (2.5Y 4/4)				PP: 3.25 tsf PP: 5.5 tsf
	50		10	0 0 4	75		- soft to medium stiff, light olive brown (2.5Y 5/4)				PP: 1.25 tsf
	55		11	4 7 8			- becomes stiff to very stiff, - becomes low to medium plasticity SILT (ML)				PP: 1.75 tsf PP: 2.0 tsf End of boring at a depth of 56.5 feet; Grout boring with portland cement
	60										
	65										

Project: SBSP, Eden Landing	Log of Boring B-03
Project Location: South Bay	Sheet 1 of 2
Project Number: 60423372	

Date(s) Drilled	6/20/2016	Logged By	Stacy Ball	Checked By	
Drilling Method	Mud Rotary	Drill Bit Size/Type	6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit	Total Depth of Borehole	61.5 feet
Drill Rig Type	Failing 1500	Drilling Contractor	Pitcher Drilling Co.	Surface Elevation	feet (NAVD88)
Groundwater Level(s)		Sampling Method(s)	SPT, Modified California, Shelby	Hammer Data	140 lb/30-inch drop Auto Hammer
Borehole Backfill	Neat Cement Grout	Location		Coordinates	N 2037620.45 E 6099203.59

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						LEAN CLAY (CL), medium stiff, brown (7.5YR 4/2), medium to high plasticity fines.				
							- some organics, dark grayish brown (10YR 4/2) with dark red mottling (2.5YR 3/6)				set casing at 3.5 feet
	5		1		85		ELASTIC SILT (MH), soft to medium stiff, dark greenish gray (gley 3/1 10Y), high plasticity fines [Young Bay Mud]				mud rotary at 5 feet ICU triaxial test 50-85 psi water at a depth of 8 feet on 6-12-16
	10		2		35						75-85 psi sample started to slip out, contractor pushed it back in shelby tube
	15		3		80						50-85 psi
	20		4		50		SILTY CLAY (CL-ML), very stiff, dark greenish gray (gley 4/2 10Y).				PP: 2.75 tsf 50-125 psi, and refusal at a depth of 21.5 feet
	25		5	3 3 2	65		- becomes stiff with fine sand, dark greenish gray (gley 3/10Y)				PP: 1.5 tsf
	30										

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION -	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND - OTHER TESTS -
	30		6	0 2 2	75						UU Triaxial test PP: 1.5 tsf
	35		7	0 0 0	? -		- little organics -				PP: 1.25 tsf
	40		8	3 5 5	65 -		SILTY CLAYEY SAND (SC-SM), loose, dark greenish gray - (gley3/10Y), fine-grained sand				
							SILTY CLAY (CL-ML) with fine Sand.				
	45		9	2 5 5	65 -		- becomes soft to medium stiff -				PP: 1.25 tsf
							SILTY CLAY (CL-ML), very stiff, olive gray (5Y 5/2) with light olive brown (2.5Y 5/4)				
	50		10	4 7 8	65						PP: 2.75 tsf end of the day resume drilling
	55		11	15 22 19			Well-Graded SAND with Silty Clay and Gravel (SW-SC), dense, dark grayish brown (2.5Y 4/2) with multi color gravel, gravel up to 1/2", well graded.				
							Well-Graded GRAVEL with Sand (GW), loose, multi color.				
	60		12	4 5 4	partial		SILTY CLAY with Sand (CL-ML), medium stiff to stiff, light olive brown (2.5Y 5/4).				End of boring at a depth of 61.5 feet; Grout boring with portland cement
	65										

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Log of Boring B-04

Date(s) Drilled	**6/20/2016**	Logged By	**Stacy Ball**	Checked By	
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit**	Total Depth of Borehole	**61.5 feet**
Drill Rig Type	**Failing 1500**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**feet (NAVD88)**
Groundwater Level(s)		Sampling Method(s)	**SPT, Modified California, Shelby**	Hammer Data	**140 lb/30-inch drop Auto Hammer**
Borehole Backfill	**Neat Cement Grout**	Location		Coordinates	**N 2036016.57 E 6097143.01**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						LEAN CLAY (CL), medium stiff, dark grayish brown (2.5Y 4/2) with brown mottles, medium plasticity fines.				Native Fill
											set casing at 3.5 feet
							- organics				
	5		1	0 0 0	100		ELASTIC SILT (MH), soft to medium stiff, dark greenish gray (gley 5/1 10Y), medium to high plasticity [Young Bay Mud]				mud rotary at 5 feet PP: 0.5 tsf
							- becomes moist to very moist, organics				
							- transitions to soft				
	10		2		95						weight of bar (50 psi) 15 minutes wait for sample expansion
	15		3		90						50 psi; last 6" with 75 psi
							Poorly-Graded SAND (SP), fine-medium grained, shells and gravel.				
	20		4	3 5 8	40		LEAN CLAY with Silt (CL), medium stiff to stiff, mottled yellowish brown (10YR 5/4) and greenish gray (gley 6/5 BG), medium plasticity.				PP: 2.5 tsf
							SILTY CLAY (CL-ML), medium stiff to stiff, dark greenish gray (gley 3/1 10Y), medium to high plasticity				
	25		5	0 4 4	65						
	30										

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Log of Boring B-04

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION -	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND - OTHER TESTS -
	30		6	2 7 7	80						UU Triaxial test PP: 1.5 tsf
	35		7	0 5 9	?		- with brown mottling				PP: 0.75 tsf PP: 3.0 tsf
							SILTY SAND (SM), medium dense, grayish brown.				
	40		8	7 8 8	75						
							SILTY CLAY (CL-ML), medium stiff, very dark gray (2.5Y 3/1).				
	45		9	3 7 18	85						PP: 0.75 tsf
							Poorly-Graded SAND with SILT (SP-SM), very loose, fine-grained sand, dark olive gray (5Y 3/2).				
			SPT-9	0 1 2	?						
							- clay lens				
	50						SILTY SAND (SM) with Well-Graded GRAVEL lenses (GW), medium dense, very dark grayish brown, fine to medium multi colored gravel up to 1/4".				
			10	9 22 17	95						PP: 1.5 tsf
			SPT-10	8 11 25	95?						
							Well-Graded SAND with Gravel (SW), medium dense, dark grayish brown (2.5Y 4/2), multi colored gravel.				
	55		SPT-11	7 14 12	65						
							- becomes dense				
	60		SPT-12	17 24 24							Grout inspection at 1 PM
											End of boring at a depth of 61.5 feet; Grout boring with portland cement
	65										

Project: SBSP, Eden Landing **Project Location: South Bay** **Project Number: 60423372**	**Log of Boring B-05** Sheet 1 of 2

Date(s) Drilled	**6/22/2016**	Logged By	**Stacy Ball**	Checked By	
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit**	Total Depth of Borehole	**63.0 feet**
Drill Rig Type	**Failing 1500**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**feet (NAVD88)**
Groundwater Level(s)		Sampling Method(s)	**SPT, Modified California, Shelby**	Hammer Data	**140 lb/30-inch drop Auto Hammer**
Borehole Backfill	**Neat Cement Grout**	Location		Coordinates	**N 2034043.71 E 6098580.55**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance, blows / foot	SAMPLES Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML), medium stiff, Olive brown (2.5Y 4/4) and olive gray (5Y 4/2) with reddish brown mottling, moist, medium to high plasticity fines.				
											set casing to 3.5 feet
							ORGANIC SILT (OH) with trace fine sand, very soft, black (7.5YR 2.5/1), medium plasticity with organics [Young Bay Mud]				
	5		1		50						mud rotary at 5 feet PP: 0 tsf 50-75 psi
							- becomes dark gray (5Y 4/1)				
	10		2		90		- becomes medium stiff				50,125,185 psi
							SILT with Sand (ML), stiff, light olive brown with gray (2.5Y 5/3 with 2.5Y 5/1) and dark yellowish brown mottling				PP: 1.5 tsf
	15		3	2 3 3	70						PP: 1.25 tsf
							SILT (ML), stiff, dark gray (2.5Y 4/1), medium to high plasticity fines				
	20		4		90						50-95 psi
	25		5		90						50-100 psi PP: 1.75 tsf
	30										

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Log of Boring B-05

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION -	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS -
	30		6	0 5 7	70						PP: 1.5 tsf
							FAT CLAY (CH) with trace fine sand, stiff, dark gray, high plasticity fines.				
	35		7	0 4 4	40		- becomes very stiff, with white and dark yellowish brown mottling				PP: 3.0 tsf
	40		8	6 12 17	40						PP: 3.75 tsf PP: 3.0 tsf
	45		9	8 21 26	40		- becomes very stiff to hard				PP: 3.0 tsf PP: 4.5 tsf
							Well-Graded GRAVEL with Sand (GW), very dense, olive brown (2.5Y 4/4) with multi colored sand and gravel, coarse sand.				
							Well-Graded SAND with SILT and GRAVEL (SW-SM), very dense, olive brown (2.5Y 4/4) with multi colored sand and gravel, coarse sand.				
	50		10	18 25 30	80						losing circulation , add bentonite
	55		11	17 18 15	0		- becomes dense				sample - slough?
											caving back up to 55 feet
	60		12	20 22 36							
			SPT-12	11 22 21							
											End of boring at a depth of 63 feet; Grout boring with portland cement
	65										

Project: SBSP, Eden Landing
Project Location: South Bay
Project Number: 60423372

Log of Boring B-06

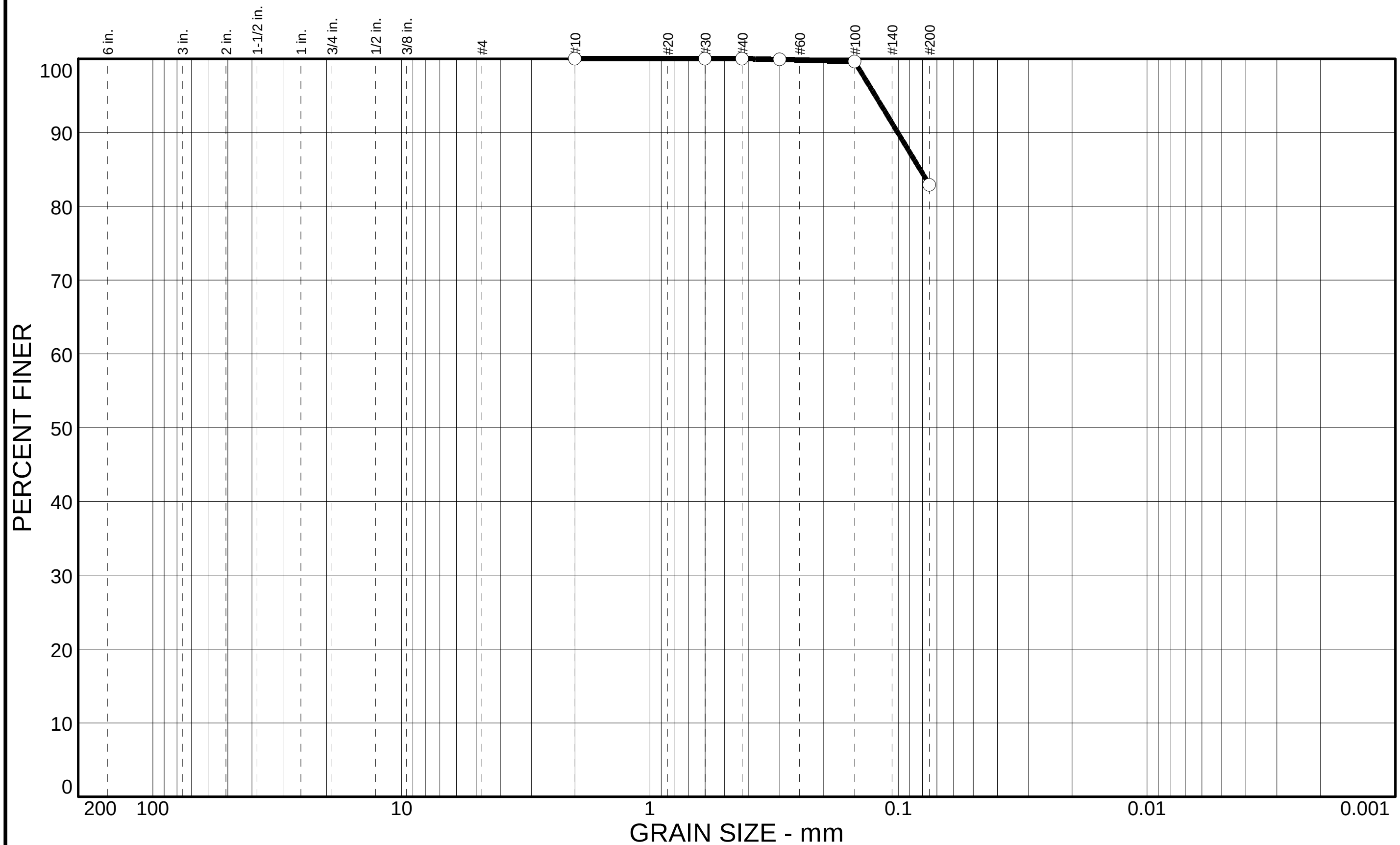
Date(s) Drilled	**6/22/2016**	Logged By	**Stacy Ball**	Checked By	
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**6-inch OD Core Barrel/ 6-inch OD Auger/ 4.75-inch OD Drag bit**	Total Depth of Borehole	**61.5 feet**
Drill Rig Type	**Failing 1500**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**feet (NAVD88)**
Groundwater Level(s)		Sampling Method(s)	**SPT, Modified California, Shelby**	Hammer Data	**140 lb/30-inch drop Auto Hammer**
Borehole Backfill	**Neat Cement Grout**	Location		Coordinates	**N 2033102.70 E 6096899.46**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						SILTY CLAY with sand and gravel (CL-ML), very stiff, dark brown (7.5Y 3/4), moist				
							FAT CLAY to ORGANIC CLAY(CH-OH), medium stiff, black, moist, high plasticity fines, petroleum smell, greasy.				set casing to 3.5 feet
	5		1		90		ORGANIC SILT (OH), soft, very dark grayish brown (10YR 3/2), medium plasticity fines [Young Bay Mud]				mud rotary at 5 feet 50 psi PP: 0.25 tsf
							- becomes very soft, very dark gray (10YR 3/1), medium to high plasticity fines, no visible organics				
	10		2								weight of bar (300 lbs) PP: 0.0 tsf
	15		3								consolidation test weight of bar (300 lbs)
							ORGANIC SILT with Sand (OH), very soft, very dark gray (10YR 3/1), low to medium plasticity fines with organics, shells.				
	20		4				ELASTIC SILT (MH), very soft, very dark gray, medium to high plasticity.				weight of bar (300 lbs) PP: 0.75 tsf
	25		5		90						weight of bar (50 psi) PP: 0.75 tsf
							- becomes stiff				
	30										

Elevation feet	Depth, feet	Samples: Type	Samples: Number	Samples: Sampling Resistance, blows / foot	Samples: Recovery, %	Graphic Log	MATERIAL DESCRIPTION -	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS -
	30		6		60		LEAN CLAY with Sand (CL), hard, olive brown (2.5Y 4/3).				UU Triaxial test 75 to 200 psi, and refusal for pushing at 52 feet consolidation test PP: 2.0 tsf
	35		7	0 4 5			SILTY SAND TO SANDY SILT (SM-ML), loose, olive brown (2.5Y 4/3).				
			SPT-7	1 2 3							
	40		8	2 3 5							
							- becomes very dark gray (2.5Y 3/1)				
	45		9	7 12 12			- becomes medium dense				
							SILTY CLAY (CL-ML), very stiff.				PP: 3.0 tsf
							- becomes black (2.5Y 2.5/1)				
	50		10	4 8 12			SANDY SILT TO SILTY SAND(ML-SM), medium dense, fine sand.				
			SPT-10	2 5 9							
							SILTY SAND with Gravel (SM), dense, olive brown (2.5Y 4/4), fine to coarse sand, multi colored fine gravel.				
	55		11	14 20 22							
							SILTY SAND (SM), medium dense, olive brown and dark olive brown (2.5Y 4/3 and 2.5Y 3/3), fine grained sand.				
	60		12	6 9 14							
											End of boring at a depth of 61.5 feet; Grout boring with portland cement
	65										

ATTACHMENT-2

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			17.1	82.9					

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#10	100.0		
#30	100.0		
#40	100.0		
#50	99.9		
#100	99.6		
#200	82.9		

SOIL DESCRIPTION

○ Light Olive Brown CLAY w/ Sand

REMARKS:

○

○ Source: B-06-7

Elev./Depth: 35'

COOPER TESTING LABORATORY

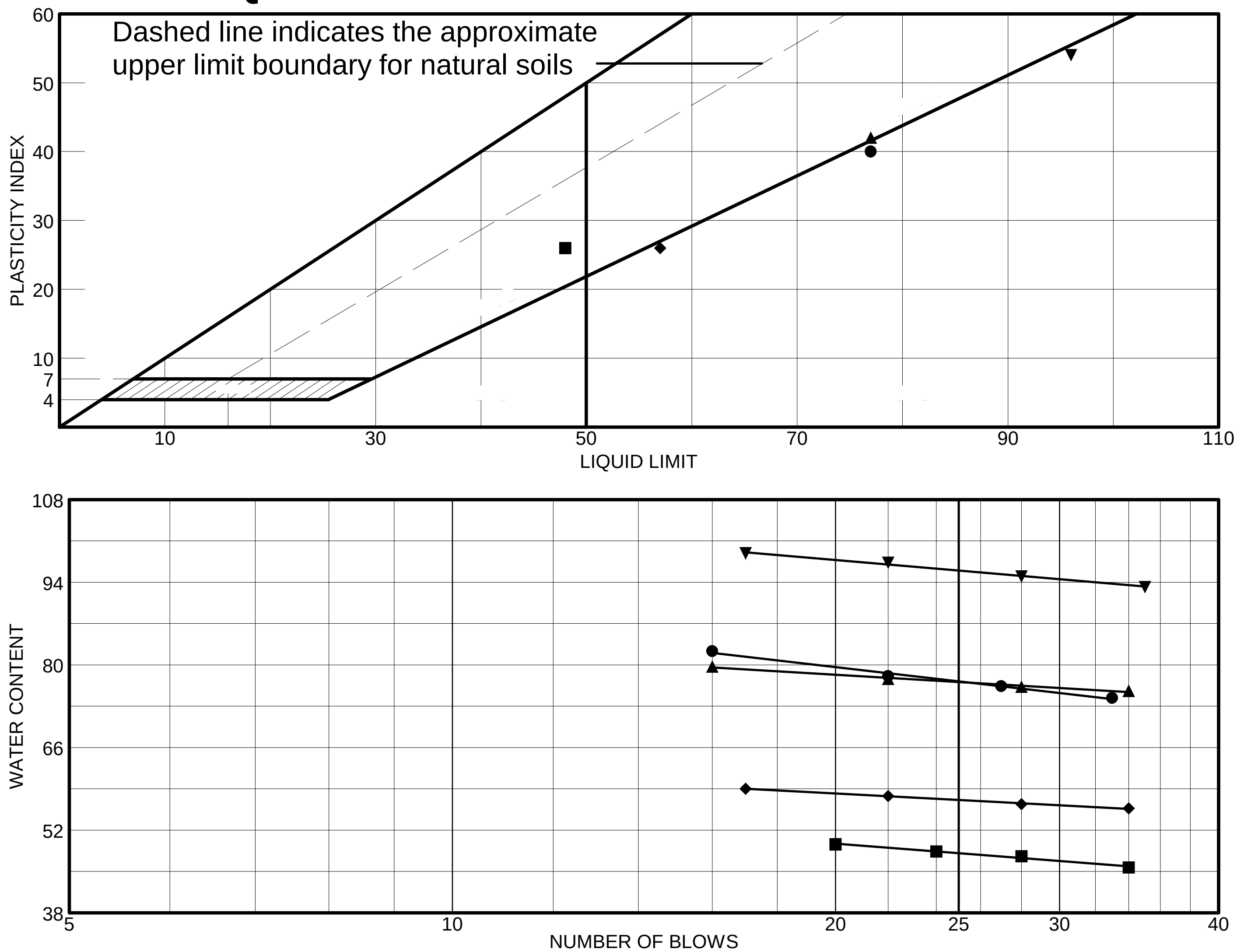
Client: AECOM

Project: Eden Landing - 60423372

Project No.: 020-209

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray Elastic SILT (Bay Mud)	77	37	40			
■	Greenish Gray Lean CLAY w/ shells	48	22	26			
▲	Greenish Gray Fat CLAY	77	35	42			
◆	Greenish Gray Elastic SILT (Bay Mud)	57	31	26			
▼	Greenish Gray Elastic SILT (Bay Mud)	96	42	54			

Project No. 020-209 **Client:** AECOM

Project: Eden Landing - 60423372

● **Source:** B-01-3 **Elev./Depth:** 15-17.5'

■ **Source:** B-01-7 **Elev./Depth:** 35-36'

▲ **Source:** B-02-2 **Elev./Depth:** 10-12.5'

◆ **Source:** B-02-4 **Elev./Depth:** 20.5-23(Tip-1/2")

▼ **Source:** B-03-1 **Elev./Depth:** 5-7.5(Tip-1")

Remarks:

●

■

▲

◆

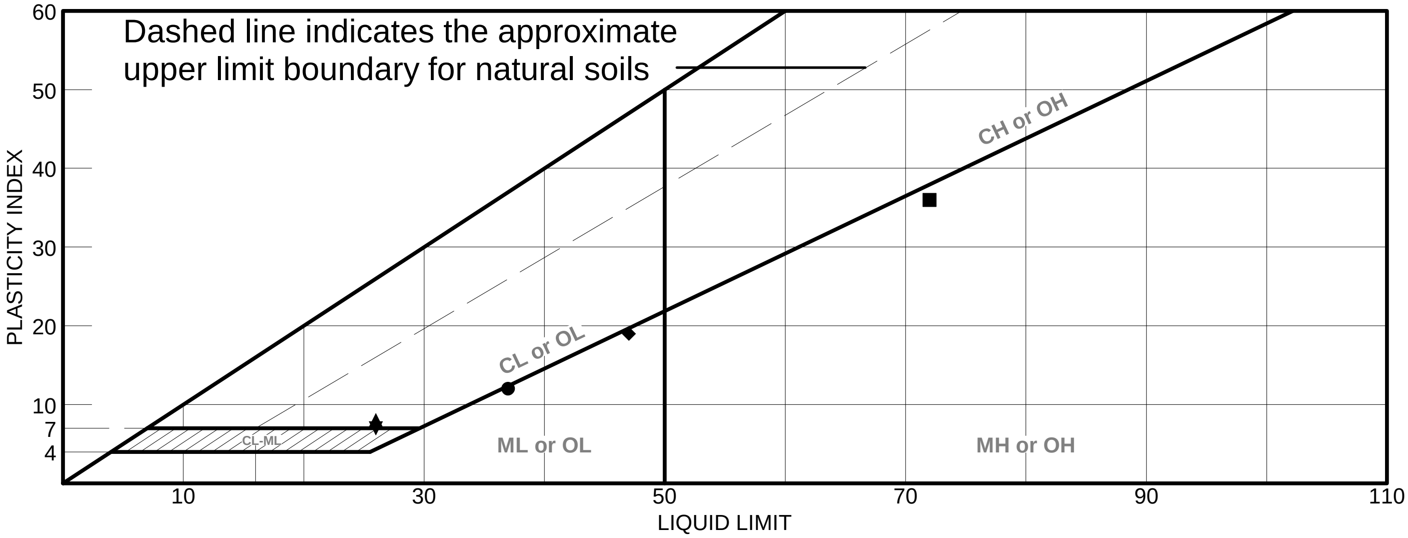
▼

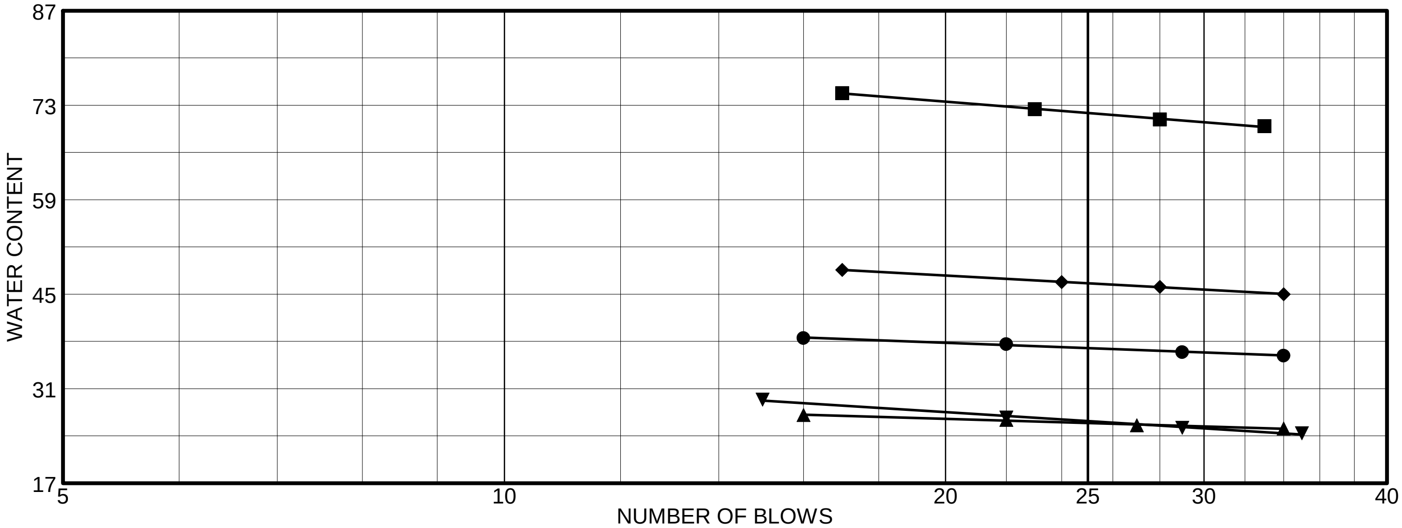
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bluish Gray SILT	37	25	12			
■	Bluish Gray Elastic SILT	72	36	36			
▲	Light Greenish Gray Sandy Lean CLAY	26	18	8			
◆	Bluish Gray SILT	47	28	19			
▼	Dark Gray Silty, Clayey SAND w/ shell fragments	26	19	7			

Project No. 020-209 **Client:** AECOM

Project: Eden Landing - 60423372

● **Source:** B-03-4 **Elev./Depth:** 20-21.5'

■ **Source:** B-04-2 **Elev./Depth:** 10-12.5'

▲ **Source:** B-05-2 **Elev./Depth:** 10-12.5(Tip-1")

◆ **Source:** B-05-4 **Elev./Depth:** 20-22.5'

▼ **Source:** B-06-3 **Elev./Depth:** 15-17.5(Tip-8")

Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

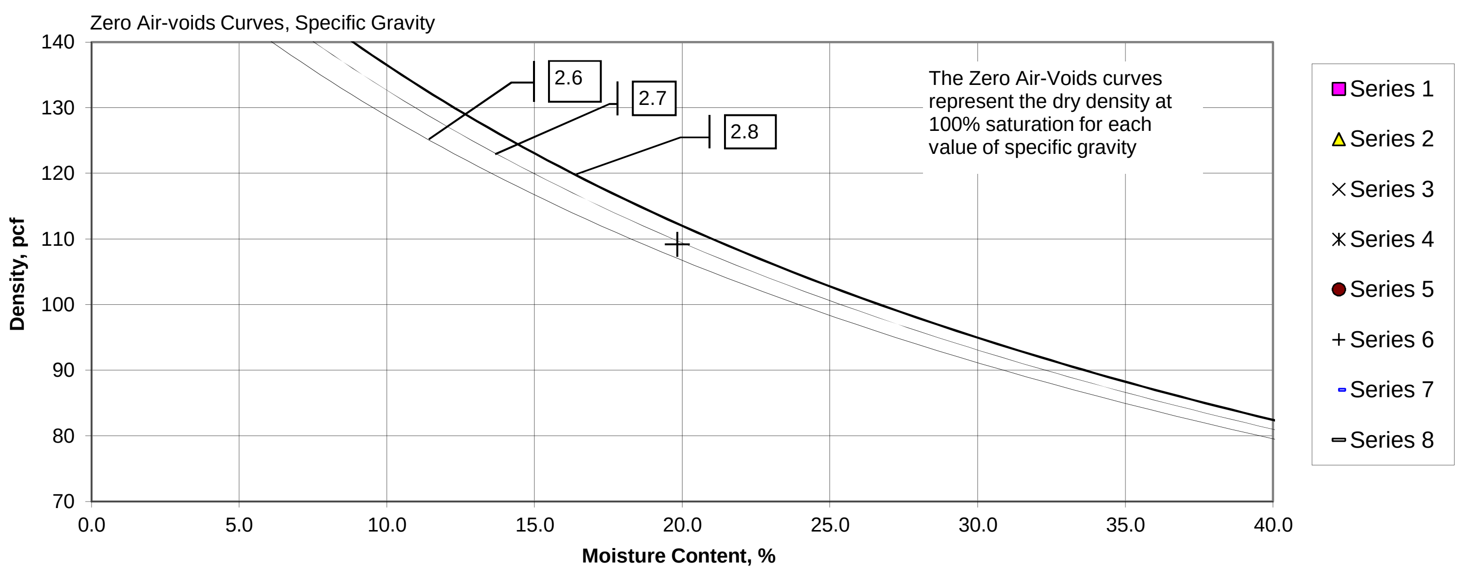
Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No:	020-209	**Project No.**	60423372	**By:**	RU
Client:	AECOM	**Date:**	08/05/16		
Project Name:	Eden Landing	**Remarks:**			

Boring:	B-01	B-02	B-03	B-04	B-05	B-05		
Sample:	7	2	4	2	4	2		
Depth, ft:	35-36	10-12.5	20-21.5	10-12.5	20-22.5	10-12.5(Tip-1")		
Visual Description:	Greenish Gray Lean CLAY w/ shells	Greenish Gray Fat CLAY	Bluish Gray SILT	Bluish Gray Elastic SILT	Bluish Gray SILT	Light Greenish Gray Sandy Lean CLAY		
Actual G_s								
Assumed G_s						2.70		
Moisture, %	55.7	81.2	30.1	86.3	40.5	19.8		
Wet Unit wt, pcf						130.8		
Dry Unit wt, pcf						109.1		
Dry Bulk Dens.pb, (g/cc)						1.75		
Saturation, %						98.1		
Total Porosity, %						35.3		
Volumetric Water Cont,Ѳw,%						34.6		
Volumetric Air Cont., Ѳa,%						0.7		
Void Ratio						0.55		
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

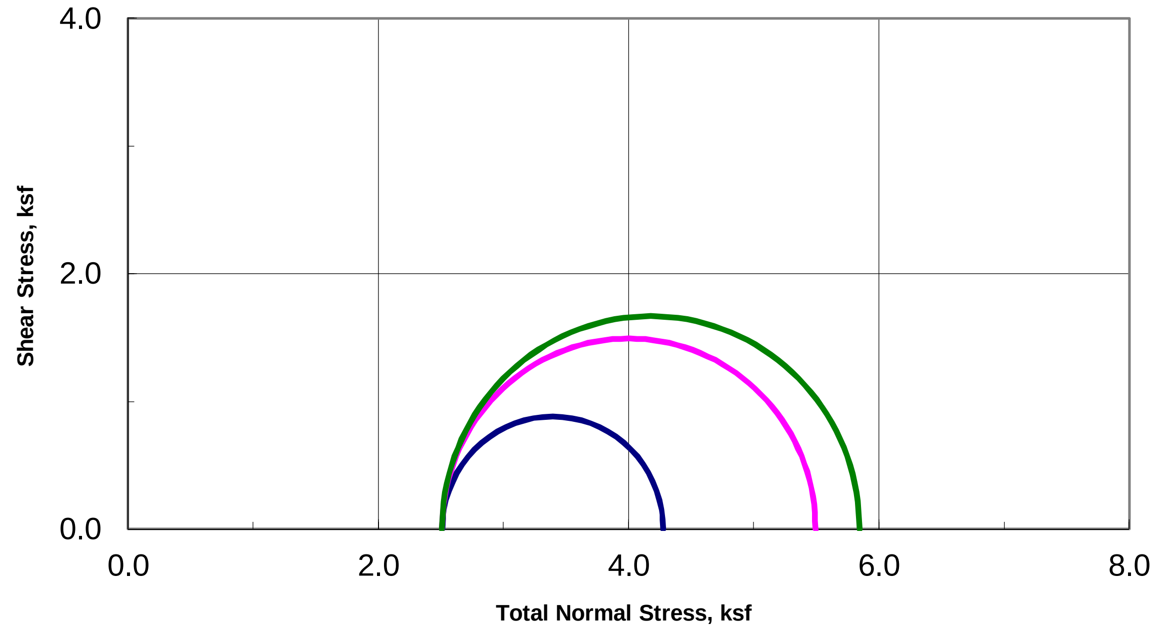
Moisture-Density

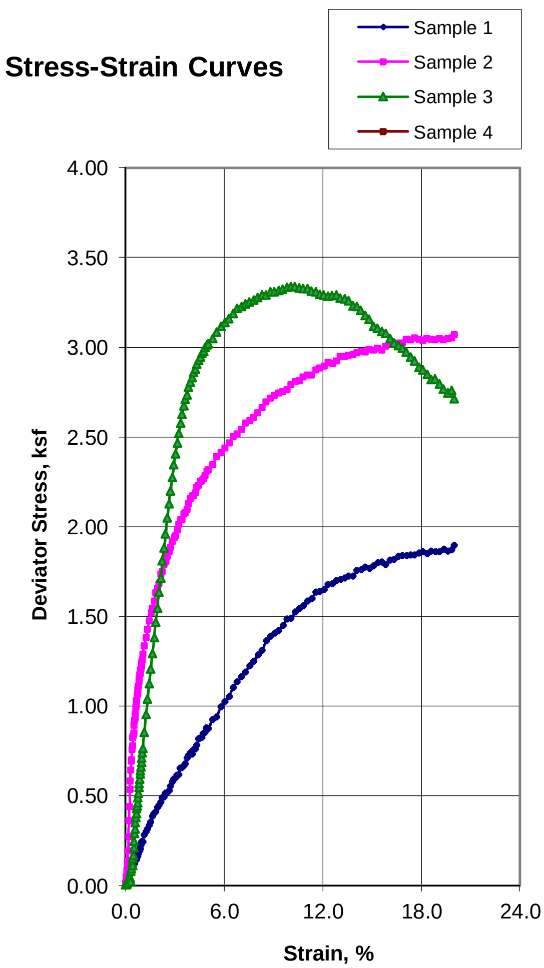


Cooper Testing Labs, Inc.
937 Commercial Street
Palo Alto, CA 94303

Unconsolidated-Undrained Triaxial Test

ASTM D2850





Sample Data				
	1	2	3	4
Moisture %	34.4	28.1	28.0	
Dry Den,pcf	87.3	94.8	95.3	
Void Ratio	0.931	0.777	0.769	
Saturation %	99.9	97.6	98.3	
Height in	4.98	4.98	6.07	
Diameter in	2.41	2.41	2.87	
Cell psi	17.4	17.4	17.4	
Strain %	15.00	15.00	10.31	
Deviator, ksf	1.766	2.987	3.337	
Rate %/min	1.00	1.00	1.00	
in/min	0.050	0.050	0.061	
Job No.:	**020-209**			
Client:	**AECOM**			
Project:	**Eden Landing - 60423372**			
Boring:	B-03-6	B-04-6	B-06-6	
Sample:				
Depth ft:	30-31.5	30	30-32(Tip-4")	

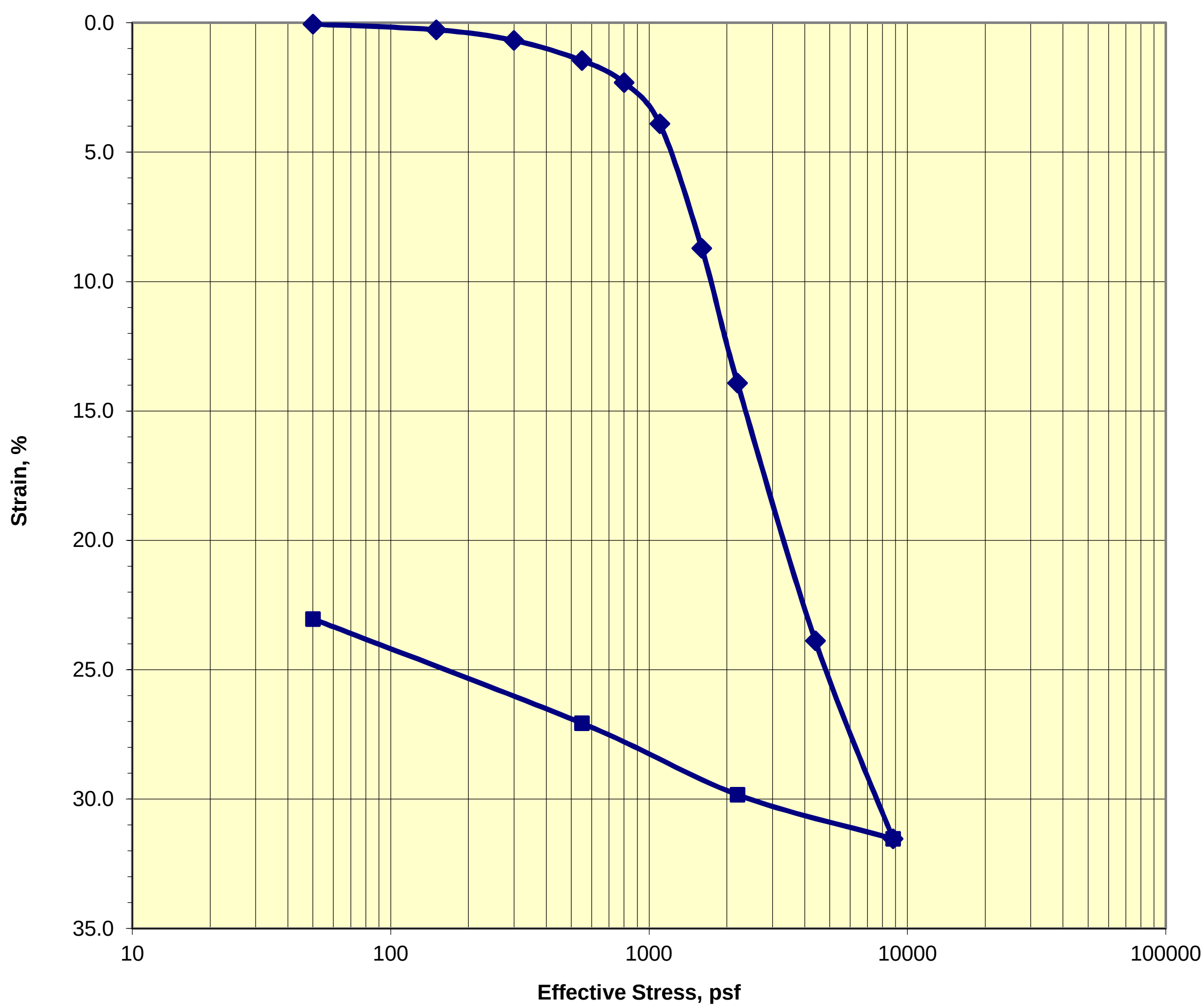
Visual Soil Description	
Sample #	
1	Gray CLAY
2	Gray CLAY
3	Olive Gray CLAY
4	

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Consolidation Test
ASTM D2435

Job No.:	020-209	**Boring:**	B-01-3	**Run By:**	MD
Client:	AECOM	**Sample:**		**Reduced:**	PJ
Project:	60423372	**Depth, ft.:**	15-17.5(Tip-9")	**Checked:**	PJ/DC
Soil Type:	Gray Elastic SILT (Bay Mud)			**Date:**	8/9/2016

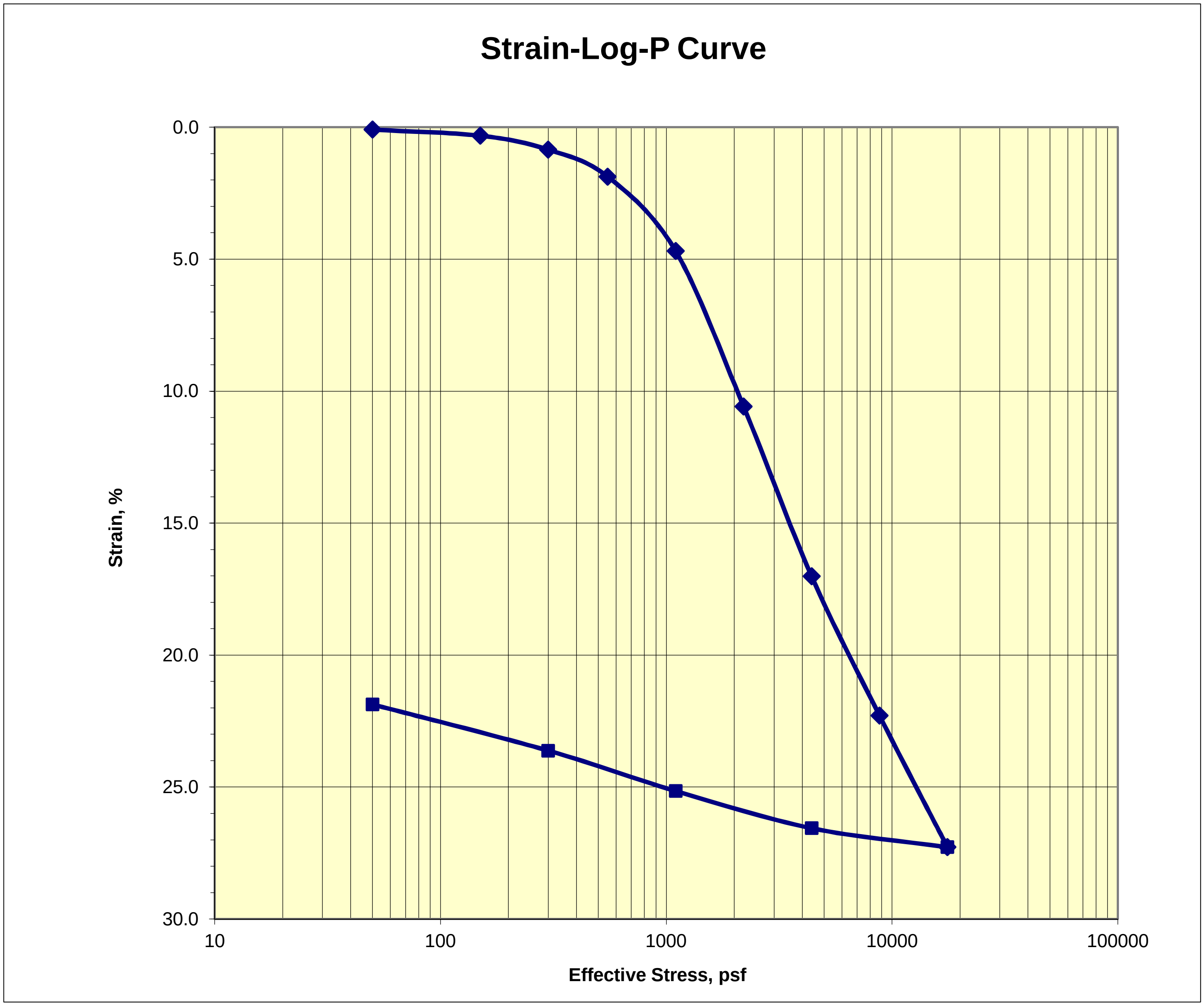


Assumed Gs 2.7	Initial	Final
Moisture %:	90.2	60.3
Dry Density, pcf:	49.0	64.1
Void Ratio:	2.438	1.628
% Saturation:	99.9	100.0

Consolidation Test
ASTM D2435

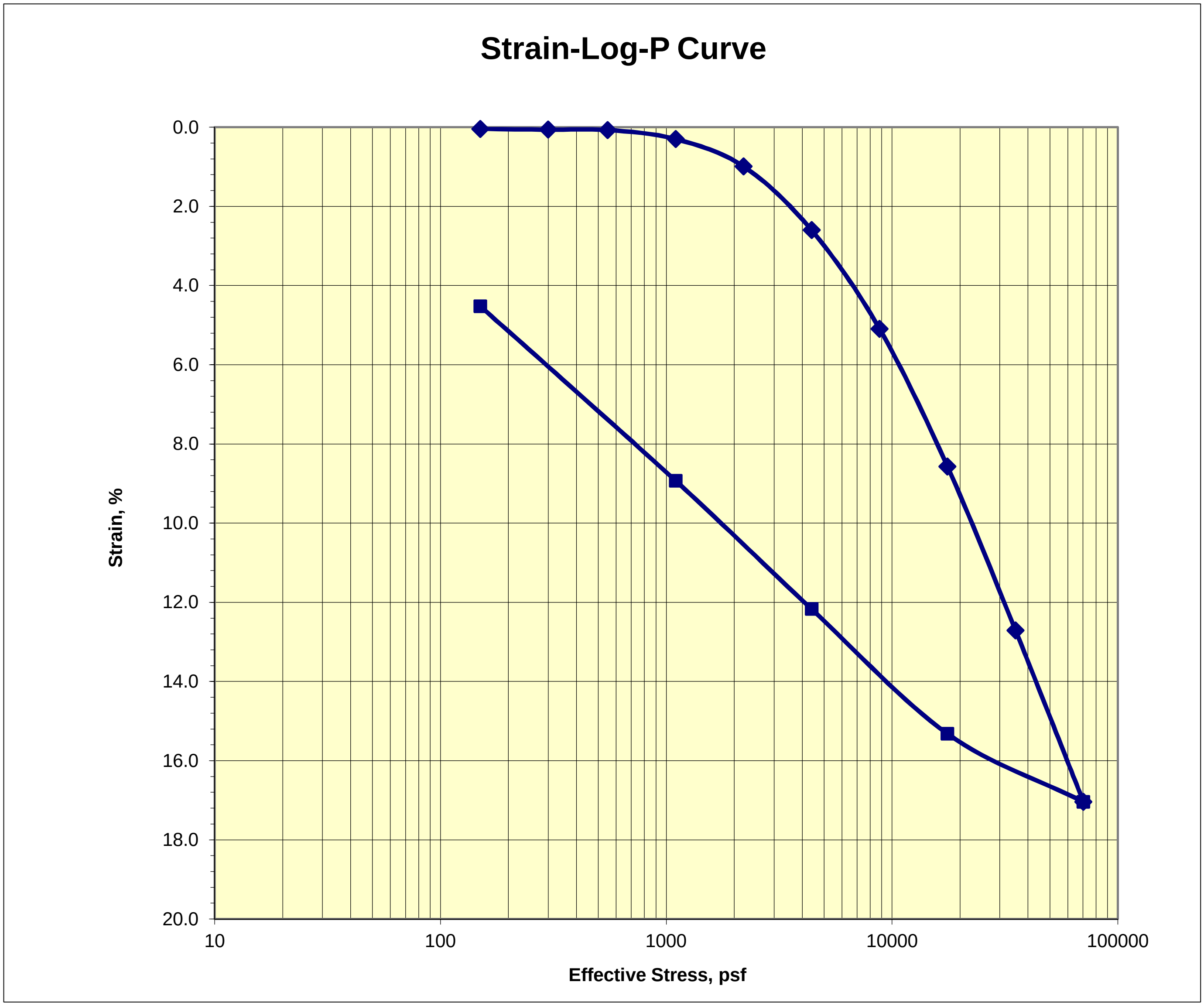
COOPER TESTING LABORATORY

Job No.:	020-209	**Boring:**	B-06-3	**Run By:**	MD
Client:	AECOM	**Sample:**		**Reduced:**	PJ
Project:	60423372	**Depth, ft.:**	15-17.5(Tip-7")	**Checked:**	PJ/DC
Soil Type:	Dark Gray Silty, Clayey SAND w/ shell fragments			**Date:**	8/9/2016



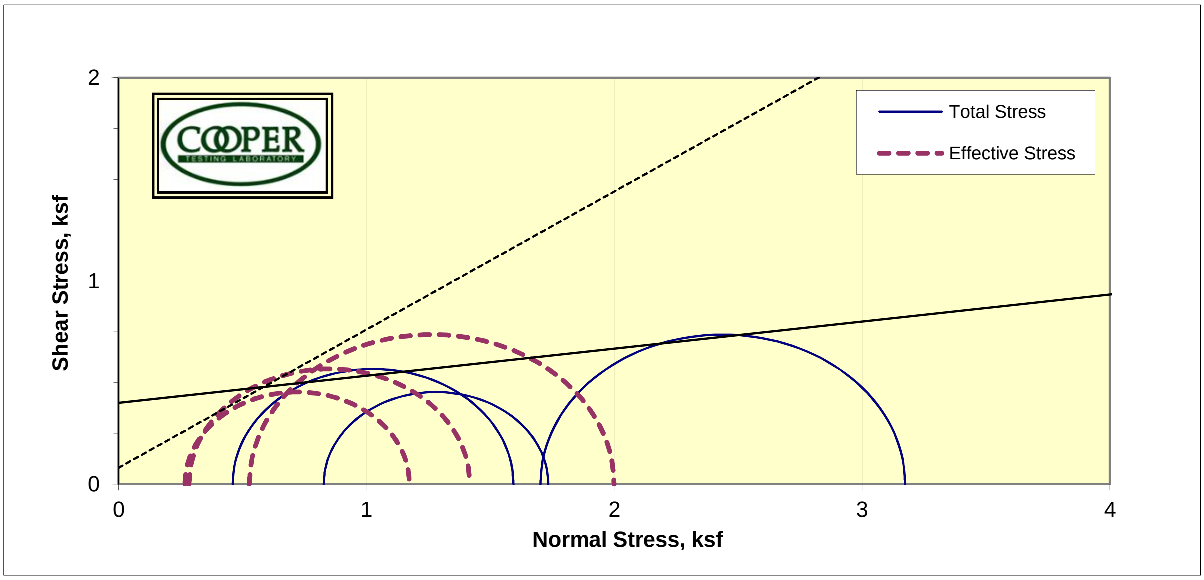
Assumed Gs 2.7	**Initial**	**Final**
Moisture %:	50.3	31.1
Dry Density, pcf:	71.3	91.6
Void Ratio:	1.364	0.840
% Saturation:	99.6	100.0

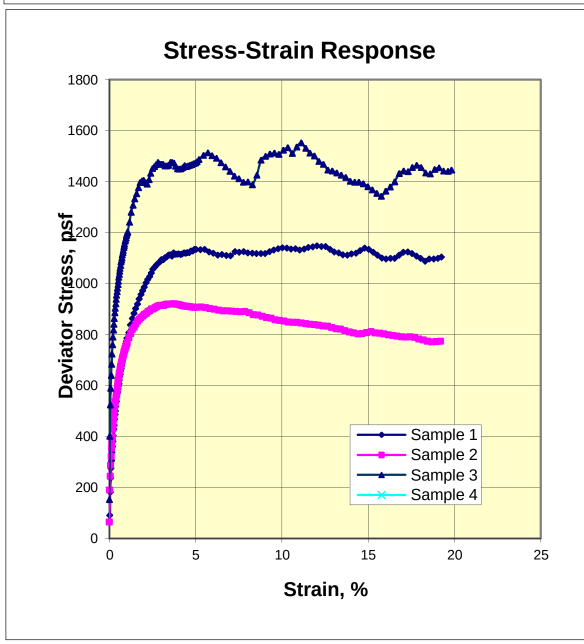
Job No.:	020-209	**Boring:**	B-06-6	**Run By:**	MD
Client:	AECOM	**Sample:**		**Reduced:**	PJ
Project:	60423372	**Depth, ft.:**	30-32(Tip-3")	**Checked:**	PJ/DC
Soil Type:	Olive CLAY			**Date:**	8/9/2016



Assumed Gs 2.75	Initial	Final
Moisture %:	28.3	26.3
Dry Density, pcf:	95.2	99.5
Void Ratio:	0.804	0.725
% Saturation:	96.7	100.0

Triaxial Consolidated Undrained with Pore Pressure
ASTM D4767





Sample:	1	2	3	4
MC, %	74.6	71.2	65.6	
DD, pcf	53.8	57.0	59.6	
Sat. %	94.6	98.4	97.0	
Void Ratio	2.130	1.954	1.827	
Diameter in	2.87	2.87	2.87	
Height, in	6.11	6.10	6.10	
	Final			
MC, %	75.1	65.9	53.8	
DD, pcf	55.6	60.6	68.7	
Sat. %	100.0	100.0	100.0	
Void Ratio	2.028	1.779	1.452	
Diameter, in	2.83	2.80	2.71	
Height, in	6.10	6.05	5.92	
Cell, psi	62.9	66.0	71.4	
BP, psi	59.7	60.3	59.6	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	1.133	0.906	1.472	
Excess PP	0.176	0.560	1.174	
Sigma 1	1.418	1.175	2.000	
Sigma 3	0.285	0.268	0.528	
P, ksf	0.851	0.721	1.264	
Q, ksf	0.567	0.453	0.736	
Stress Ratio	4.979	4.379	3.787	
Rate in/min	0.0001	0.0001	0.0001	

Total C	0.4	ksf
Total phi	7.6	degrees
Eff. C	0.1	ksf
Eff. Phi	34.2	degrees

©

Job No.:	020-209	Date:	8/12/2016
Client:	AECOM		BY:DC
Project:	Eden Landing - 60423372		
Sample 1)	B-03-1 @ 5-7.5(Tip-1")	Greenish Gray Elastic SILT (Bay Mud)	
Sample 2)	B-02-4 @ 20.5-23(Tip-7")	Greenish Gray Elastic SILT (Bay Mud)	
Sample 3)	B-02-4 @ 20.5-23(Tip-1/2")	Greenish Gray Elastic SILT (Bay Mud)	
Sample 4)			

The strength of sample #2 was the lowest and is shown in order as the second Mohr circle. Interestingly the pore pressure responded as it should have when comparing to the other samples. It is assumed that the strengths didn't plot as expected because sample #1 was a different boring and depth than samples #2 & #3.

APPENDIX E

PRELIMINARY DESIGN MEMORANDUM OF DREDGED MATERIAL PLACEMENT AT SOUTHERN EDEN LANDING

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South Bay Salt Pond Restoration Project

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.

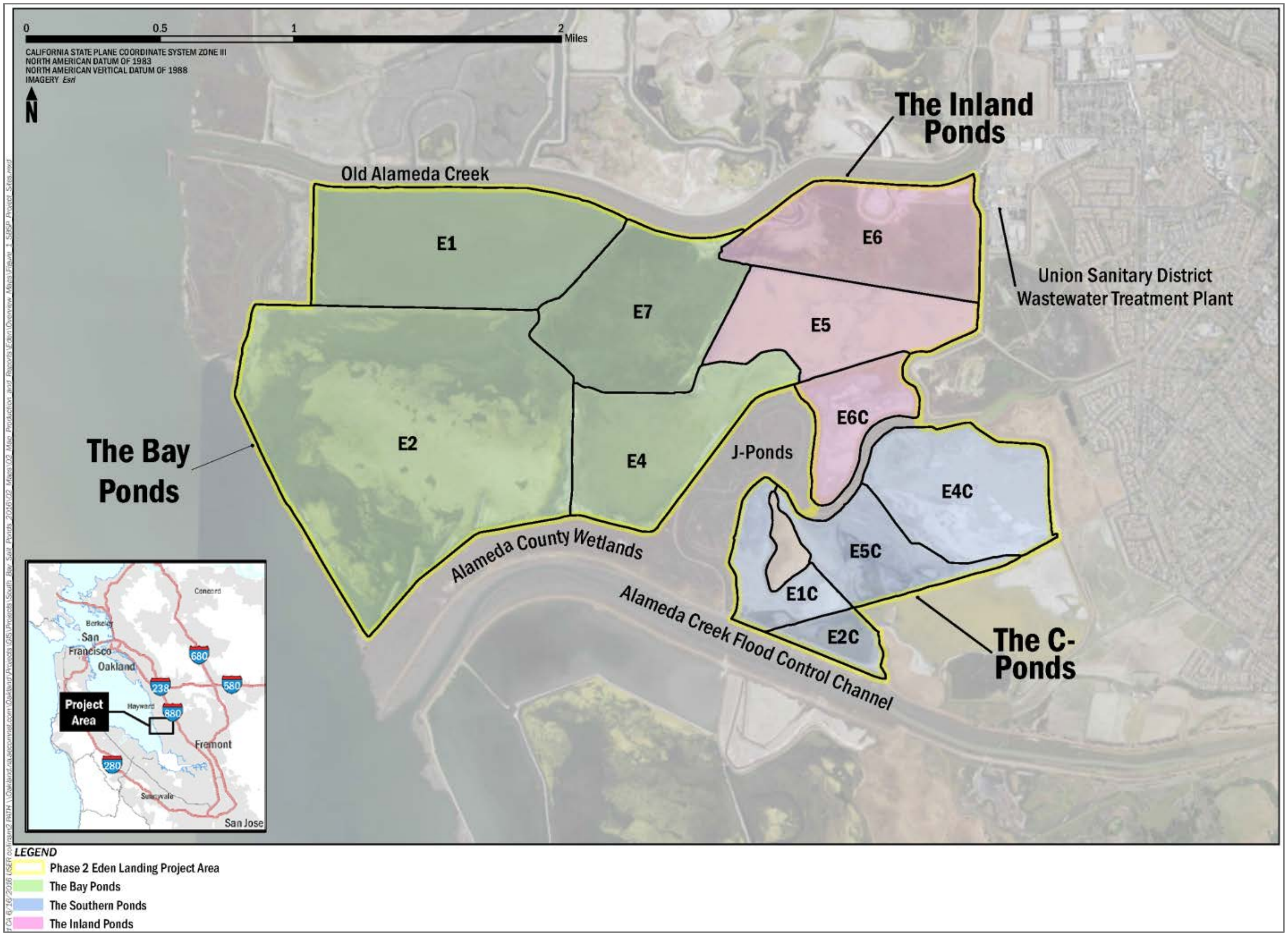

Figure 2.1. Project Area

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 2	48 in.	1.7	Intake/discharge open pipes/combo gates 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)

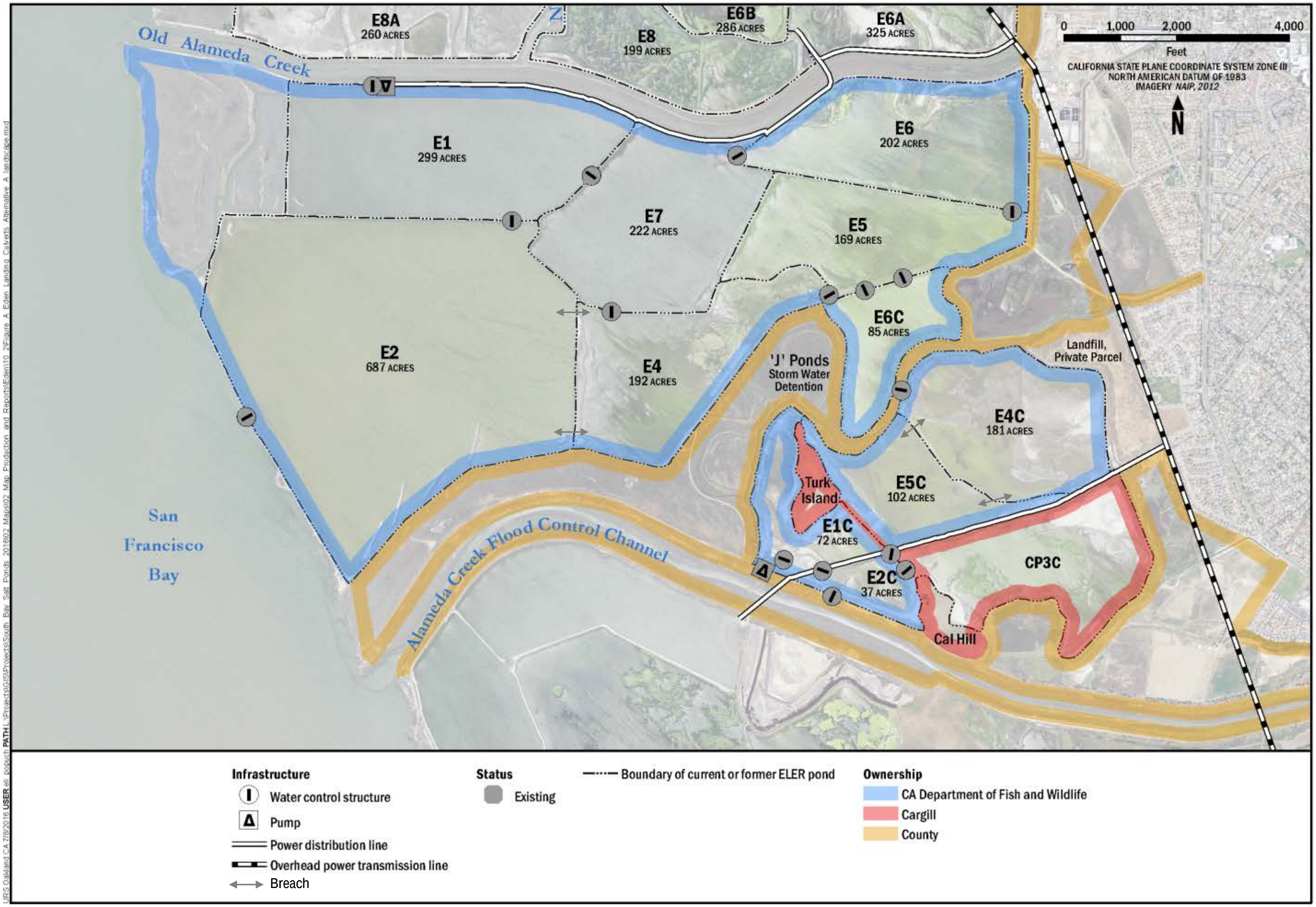

Figure 3.1. Existing Infrastructure

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. Avg. pumping dist. = 23,700 ft. Total of 46,900 ft. of pipe.
Submerged	16,000 ft.	48,000 SF	
Shore (Primary)	14,400 ft.	43,200 SF	
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.	-	

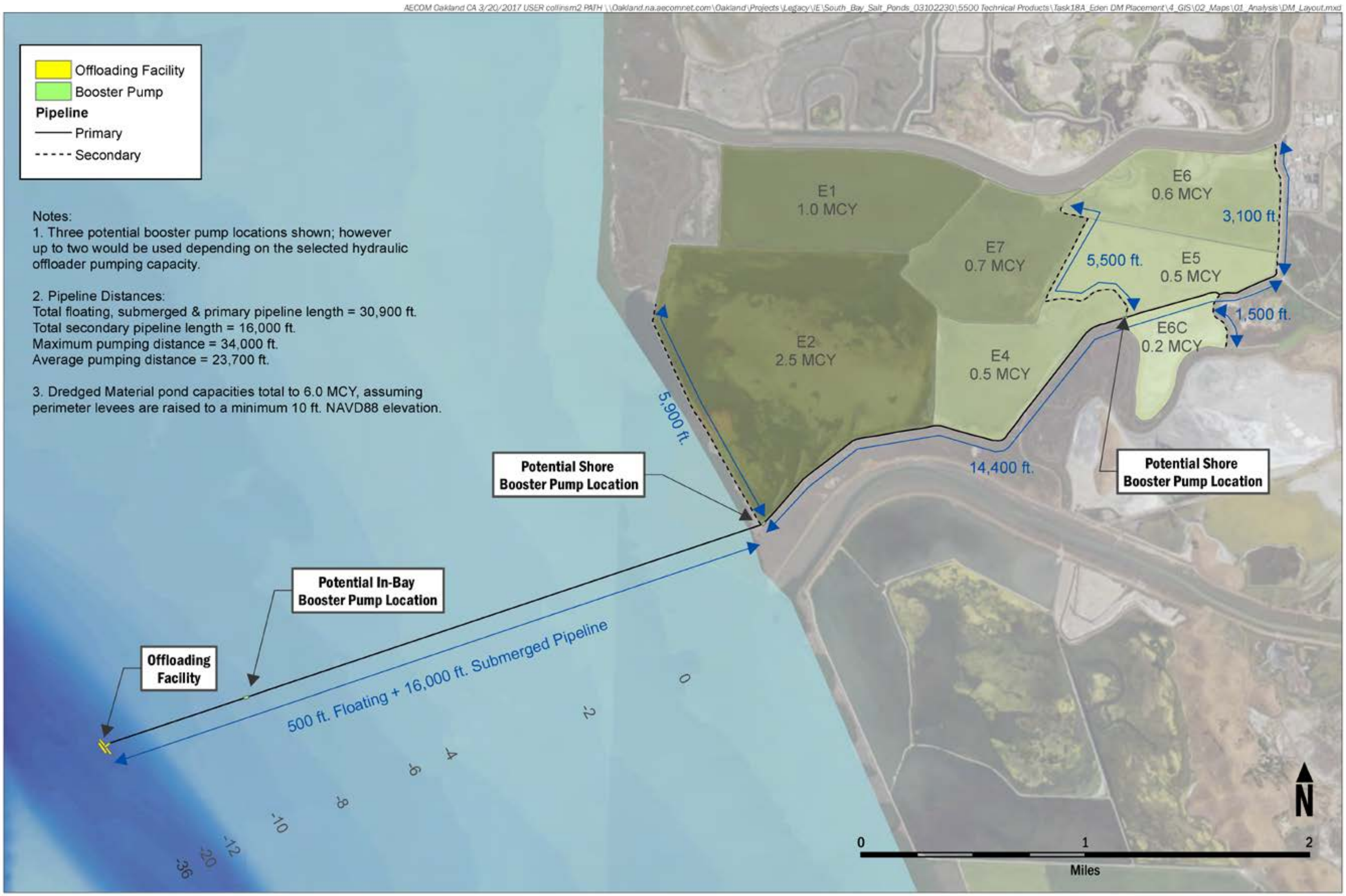

Figure 4.1. Dredged Material Design Components

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.

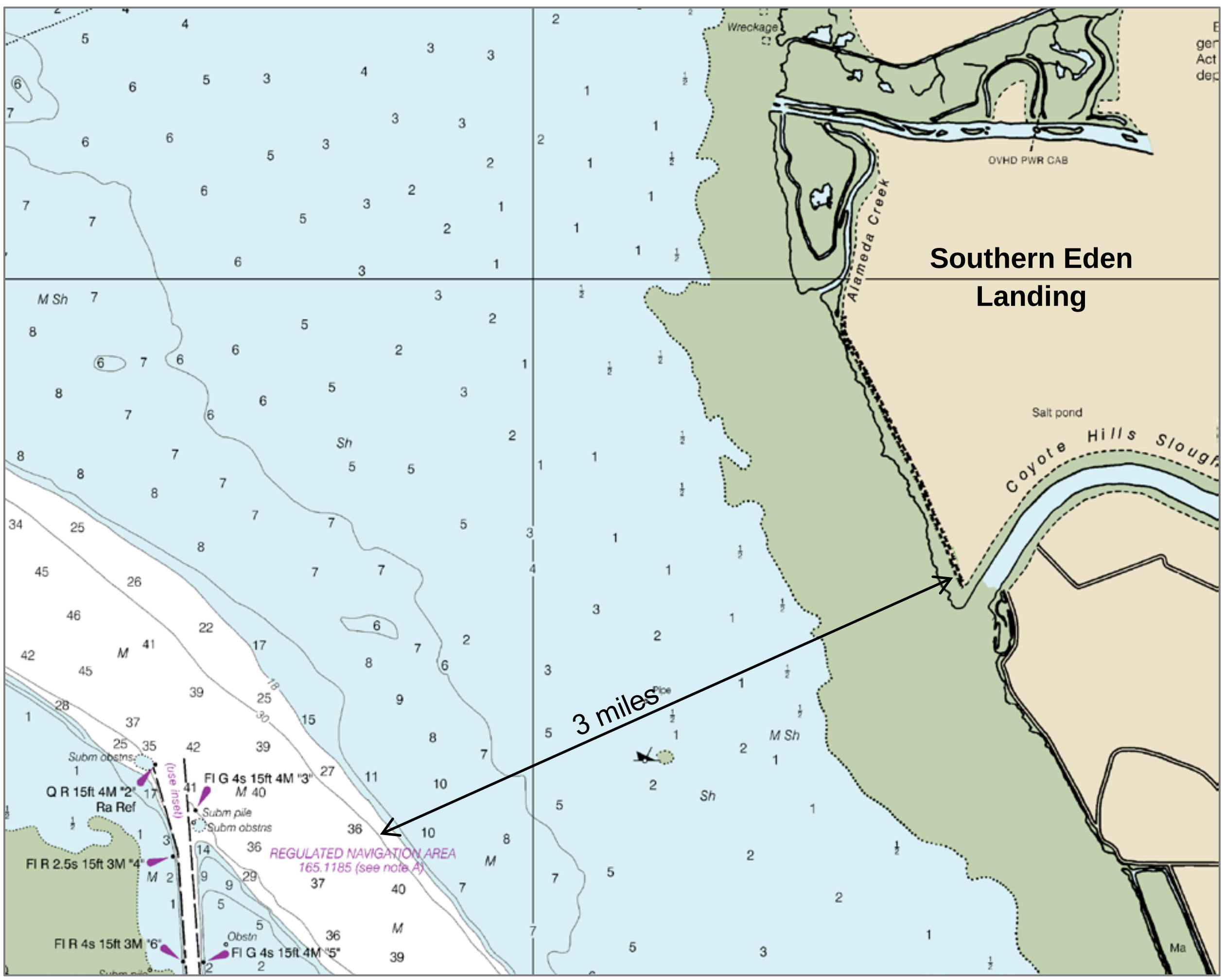

Figure 4.2. NOAA Nautical Chart 18651 San Francisco Bay Southern Part, Soundings in Feet at MLLW

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 <u>Receiving Water Discharge Locations</u>

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.

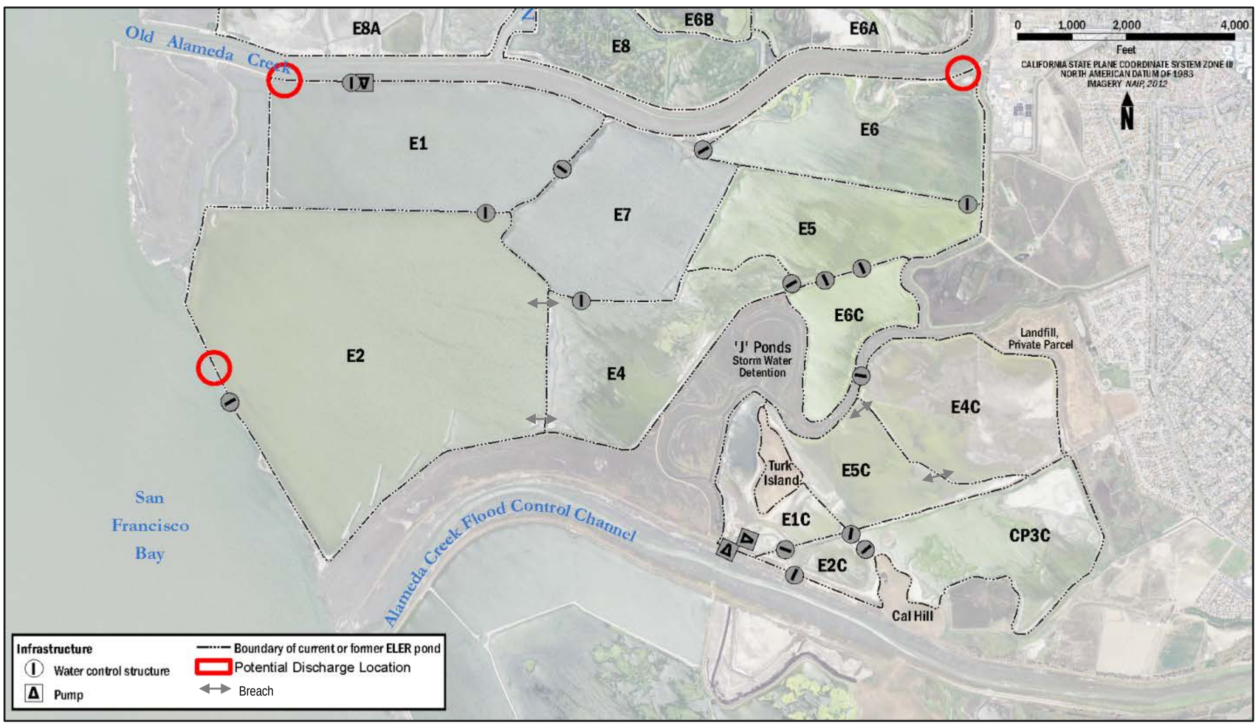

Figure 4.5. Potential Discharge Locations

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.

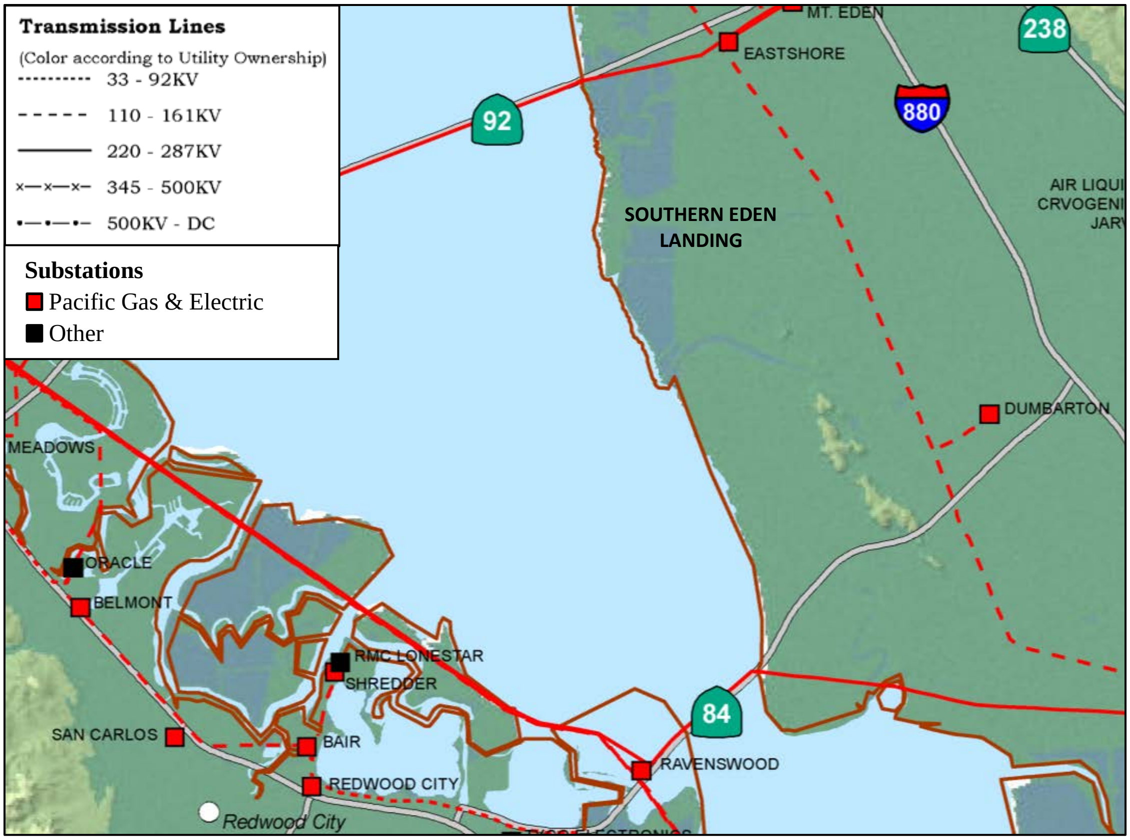

Figure 4.6. Existing Transmission Lines and Substations
Source: California Energy Commission 2015

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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APPENDIX F

SIGNED MEMORANDUM OF UNDERSTANDING

UNITED STATES FISH & WILDLIFE SERVICE AND THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

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MEMORANDUM OF AGREEMENT
BETWEEN THE U.S. FISH & WILDLIFE SERVICE
AND THE
CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING
THE SOUTH BAY SALT POND RESTORATION PROJECT
INCLUDING RESTORATION OF FORMER INDUSTRIAL SALT PONDS TO TIDAL SALT MARSH AND OTHER WETLAND HABITATS, INCLUDING THE FORMER SALT WORKS SITES WITHIN THE ALVISO UNIT ON THE DON EDWARDS SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE AND CALIFORNIA DEPARTMENT OF FISH AND GAME'S, EDEN LANDING ECOLOGICAL RESERVE; ALAMEDA AND SANTA CLARA, COUNTIES, CALIFORNIA

WHEREAS, the South Bay Salt Pond Restoration Project (SBSPRP) is an extensive project that includes approximately 20,000 acres of former industrial salt pond complexes along the shoreline of the San Francisco Bay, south of the San Mateo Bridge. The salt ponds were part of a vast system of salt ponds previously operated by Cargill Salt. In 2003 the Alviso and West Bay salt pond complexes were transferred to the U.S. Fish and Wildlife Service and included in the Don Edwards San Francisco Bay National Wildlife Refuge (DESFBNWR). The Baumberg salt pond complex, now knows as the Eden Landing Ecological Reserve, is owned and managed by the California Department of Fish and Game (CDFG). The SBSPRP is partially on federal property, will require a federal permit, and will use federal funding. Restoration activities will change the salt ponds to salt marsh which alters their function and open water appearance, both of which are contributing characteristics of the historic landscape and has the potential to affect a historic property (Undertaking) (Figure 1 in Attachment 1); and

WHEREAS, the U.S. Fish and Wildlife Service (USFWS) has determined, in consultation with the California State Historic Preservation Officer (SHPO), that the former salt works and evaporative salt industry ponds associated with the Alviso Unit of the DESFBNWR and property owned and managed by the CDFG known as the Eden Landing Ecological Reserve (ELER) are eligible for inclusion in the National Register of Historic Places under Criteria A (historic property) as historic landscapes, including the six eligible archaeological sites identified within the ELER as defined in 36 CFR Part 800, the regulation implementing Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470f). The SHPO concurred with the evaluation on October 12, 2010; and

WHEREAS, the USFWS has determined that altering the former industrial salt ponds in the Alviso and ELER complexes by replacing the controlled flow of water with a tidally influenced marsh environment will adversely affect the character defining elements of the ponds by affecting their function and appearance and may adversely affect the archaeological sites by changing the water system (Adverse Effect); and

WHEREAS, the USFWS has consulted with the SHPO pursuant to 36 CFR Part 800 regarding the Undertaking's adverse effects on historic properties and the USFWS has notified the Advisory Council on Historic Preservation (Council) of the adverse effect pursuant to 36 CFR 800, implementing Section 106 of the National Historic Preservation Act, as amended, 16 U.S.C. 470f (NHPA). The Council has declined to participate in a letter dated December 3, 2010; and

WHEREAS, a portion of the project is on land owned by the CDFG. The USFWS and CDFG have consulted regarding this project and have executed a Memorandum of Understanding (MOU) that determines that the USFWS is the lead agency and defines the relationship and responsibilities of each agency. The CDFG is a consulting party with obligations that are associated with the resolution of the adverse effect, thus they have been invited to concur in this MOA (800.6(c)(3); and

WHEREAS, the USFWS has consulted with interested parties and tribes. The SBSPRP includes a wide variety of partners and agencies. Communication with and input from stakeholders in the community and interested organizations continues to be achieved using public meetings and workshops, a website, a newsletter, press releases, and presentations, to ensure that the public remains informed about the project status and is involved in the planning and implementation process. The USFWS consulted with tribes and tribal members provided by the California Native American Heritage Commission. Consultation was also accomplished through contacts during the public outreach efforts. The Hayward County Historical Society and parties that expressed an interest will continue to be updated as the project is implemented; and

NOW, THEREFORE, the USFWS and the SHPO agree that if the Undertaking proceeds, the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on a historic property and to satisfy the requirements of Sections 106 and 110(b) of the NHPA, and further agree that these stipulations shall govern the Undertaking and all of its parts until this Memorandum of Agreement (MOA) expires or is terminated.

STIPULATIONS

The USFWS and by extension through the MOU, CDFG shall ensure that the following stipulations are implemented:

I. Area of Potential Effect

A. The Area of Potential Effect (APE) is depicted in Figures 2 and 3 (Attachment 1) and includes the Alviso Historic District and ELER Historic District that are located in the southern end of San Francisco Bay. The ELER encompasses 6612 acres divided into 23 ponds. The Alviso Unit encompasses 9677 acres divided into 28 ponds. Within the APE, activities 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. Additionally, archaeological resources within the ELER Historic Landscape that are contributing elements of the landscape may be affected by fluctuating water levels

B. If modifications to the Undertaking take place subsequent to the execution of this MOA that necessitate the revision of the APE, USFWS will consult with the SHPO to facilitate mutual agreement on the subject revisions. If USFWS and SHPO cannot reach an agreement, then the parties will resolve the dispute in accordance with Stipulation III.B of this document. Should the USFWS and SHPO reach mutual agreement on the proposed revisions the USFWS will submit a final map of the revision no later than 30 days following such an agreement.

II. Mitigation of Project Effects to Historic Properties

The USFWS has consulted with the SHPO and has developed a historic properties treatment plan (Attachment 2) that will be implemented, prior to and during the SBSPRP. The mitigation plan follows the *Secretary of the Interior's Standards for the Treatment of Historic Properties* and includes the following elements:

A. Recordation of Historic Properties: The Alviso and ELER salt pond complexes are considered historic landscape districts. The USFWS consulted with the Regional Coordinator for the HALS program at the National Park Service regarding the requirements for photo documentation and recordation of the landscape that is commensurate with the level of adverse effect. NPS-HALS program staff responded with guidance on the requirements for recordation, therefore all recordation and photography documentation requirements will be in accordance with this guidance. The HALS documentation will be submitted to the NPS for transmittal to the Library of Congress. Copies of the HALS documentation will also be maintained at the DESFBNWR, USFWS Cultural Resources Team office, CDFG, and the Hayward County Historical Society.

B. Interpretation of Solar Salt Industry: Interpretive materials will be developed, including at least one interpretive panel and pamphlet that describes the solar salt industry process and landscape features that were associated with the evaporative salt industry. A draft of the interpretive materials will be shared with SHPO and interested parties for review and comment. The panel will be installed within the ELER. The timeline for completing the interpretive materials is based on the pace of the restoration project but is estimated to be within 5 years of the date of this agreement

C. Archaeological Resources: Archaeological resources within the ELER that are contributing elements of the historic landscape will be treated according to the Treatment Plan (Attachment 2). Generally, sites will be protected *in situ*.

However, sites that are affected by fluctuating water levels will be documented with photography, GPS mapping, and limited subsurface testing of features and selective surface collection. The sites will then be monitored once a year at a low tide event or summer dry season for five consecutive years from the signing of this MOA. Monitoring will continue until the restoration work is completed. No additional affects are anticipated from the restoration work once the salt marsh habitat has been reestablished, at that point monitoring will cease. If any site appears to be accessible to vandals or the structure of the site changes due to vandalism, then a more substantial data collection procedure will be instituted. There is also the potential for new discoveries to occur and these will be managed by recordation and data collection procedures outlined in the Historic Properties Treatment Plan (Attachment 2).

III. Administrative Provisions

A. Standards

1. Professional Qualifications: All activities prescribed in Stipulations I and II of this MOA shall be carried out under the authority of USFWS by or under the direct supervision of a person or persons meeting at a minimum the *Secretary of the Interior's Professional Qualifications Standards* (48 FR 44738-3, September 29, 1983) in the appropriate disciplines.

B. Dispute Resolution

1. Should the SHPO object to the manner in which the terms of this MOA are implemented, to any action carried out or proposed with respect to implementation of the MOA, or to any documentation prepared in accordance with and subject to the terms of this MOA, the USFWS shall immediately consult with the SHPO for no more than 30 days to resolve the objection. If the objection is resolved through such consultation, the action subject to dispute may proceed in accordance with the terms of that resolution. If, after initiating such consultation, the USFWS determines that the objection cannot be resolved through consultation, the USFWS shall forward all documentation relevant to the objection to the Council, including the USFWS proposed response to the objection, with the expectation that the Council will within 45 days after receipt of such documentation:

    a. Advise the USFWS that the Council concurs in the proposed response to the objection, whereupon the USFWS will respond to the objection accordingly; or

b. Provide the USFWS with recommendations, which the USFWS will take into account in reaching a final decision regarding its response to the objection; or

c. Notify the USFWS that the objection will be referred for comment to the Council pursuant to 36 CFR 800.7, and proceed to refer the objection and comment. The USFWS shall take the resulting comment into account in accordance with 36 CFR 800.7(c)(4) and Section 110 (1) of the NHPA.

2. Should the Council not exercise one of the above options within 45 days after receipt of all pertinent documentation, the USFWS may assume the Council's concurrence in its proposed response to the objection.

3. The USFWS shall take into account any Council recommendation or comment provided in accordance with this stipulation with reference only to the subject of the objection. The USFWS responsibility to carry out all actions under this MOA that are not the subjects of the objection will remain unchanged.

4. At any time during implementation of the measures stipulated in this MOA should an objection pertaining to such implementation be raised by a member of the public, the USFWS shall notify the SHPO and take the objection into account, consulting with the objector and, should the objector so request, with the SHPO to address the objection. The time frame for such consultation shall be reasonably determined by the USFWS.

5. The USFWS shall provide to the SHPO, the Council when Council comments have been issued hereunder, and any parties that have objected pursuant to paragraph B.4., above, with a copy of its final written decision regarding any objection addressed pursuant to this stipulation.

6. The USFWS may authorize any action subject to objection under this stipulation to proceed after the objection has been resolved in accordance with the terms of this stipulation.

C. Amendments

Either signatory may propose that this MOA be amended, whereupon the signatories will consult for no more than 30 days to consider such amendment. The amendment process shall comply with 36 CFR 800.6(c)(1) and 800.6(c)(7). This MOA may be amended only upon the written agreement of the signatories. If it is not amended, this may be terminated by either signatory in accordance with Stipulation D., below.

D. Termination

1. If this MOA is not amended as provided for in paragraph C. of this stipulation, or if

either signatory proposes termination of this MOA for other reasons, the signatory proposing termination shall in writing notify the other signatory, explain the reasons for proposing termination, and consult with the other signatory for at least 30 days to seek alternatives to termination. Should such consultation result in an agreement on an alternative to termination, then, the signatories shall proceed in accordance with the terms of that agreement.

2. Should such consultation fail, the signatory proposing termination may terminate this MOA by promptly notifying the other signatory in writing. Termination hereunder shall render this MOA null and void. If this MOA is terminated hereunder and if the USFWS determines that the Undertaking will nonetheless proceed, then the USFWS shall either consult in accordance with 36 CFR 800.6 to develop a new MOA or request the comments of the Council pursuant to 36 CFR Part 800.

E. Duration of the MOA

Unless terminated pursuant to paragraph D. of this MOA, or unless it is superseded by an amended MOA, this MOA will be in effect until the USFWS, in consultation with the SHPO, determines that all of its stipulations have been satisfactorily fulfilled. The duration of this MOA will not exceed seven (7) years, because of the restoration phases that require up to five years to complete, unless the signatory parties agree to an extension. Upon a determination by USFWS that all of the terms of this MOA have been satisfactorily fulfilled, this MOA will terminate and have no further force or effect. The USFWS will promptly provide the SHPO and CDFG with written notice of its determination and of the termination of the MOA. Following provision of such notice, this MOA will be null and void.

F. Effective Date

This MOA will take effect when it has been executed by both the USFWS and the SHPO. Execution of this MOA by the USFWS and the SHPO, its transmittal by the USFWS to the Council in accordance with 36 CFR 800.6(b)(1)(iv) and subsequent implementation of its terms, shall evince pursuant to 36 CFR 800.6(c), that this MOA is an agreement with the Council for purposes of Section 110(1) of the NHPA, and shall further evince that the USFWS has afforded the Council an opportunity to comment on the Undertaking and its effects on historic properties, and that the USFWS has taken into account the effects of the Undertaking on historic properties. The CDFG is a concurring party to the MOA as represented by their signature.

U.S. FISH and WILDLIFE SERVICE

By: G. Mendel Stewart Date: 5/25/12

Mendel Stewart, Project Leader, San Francisco Bay NWR Complex, Region 8

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

By: Milford Wayne Donaldson Date: 28 JUN 2012

Mr. Milford Wayne Donaldson, FAIA: California State Historic Preservation Officer

Concurring Party
CALIFORNIA DEPARTMENT OF FISH AND GAME

By: Scott Wilson Date: 6/12/12

Mr. Scott Wilson, Acting Regional Manager, Bay Delta Region

Attachments:
Attachment 1: Figure 1. Project Location Map.
Figure 2. Alviso Unit APE.
Figure 3. ELER APE.

Attachment 2: Historic Properties Treatment Plan

South Bay Salt Pond Restoration Project

Alviso Unit APE Map

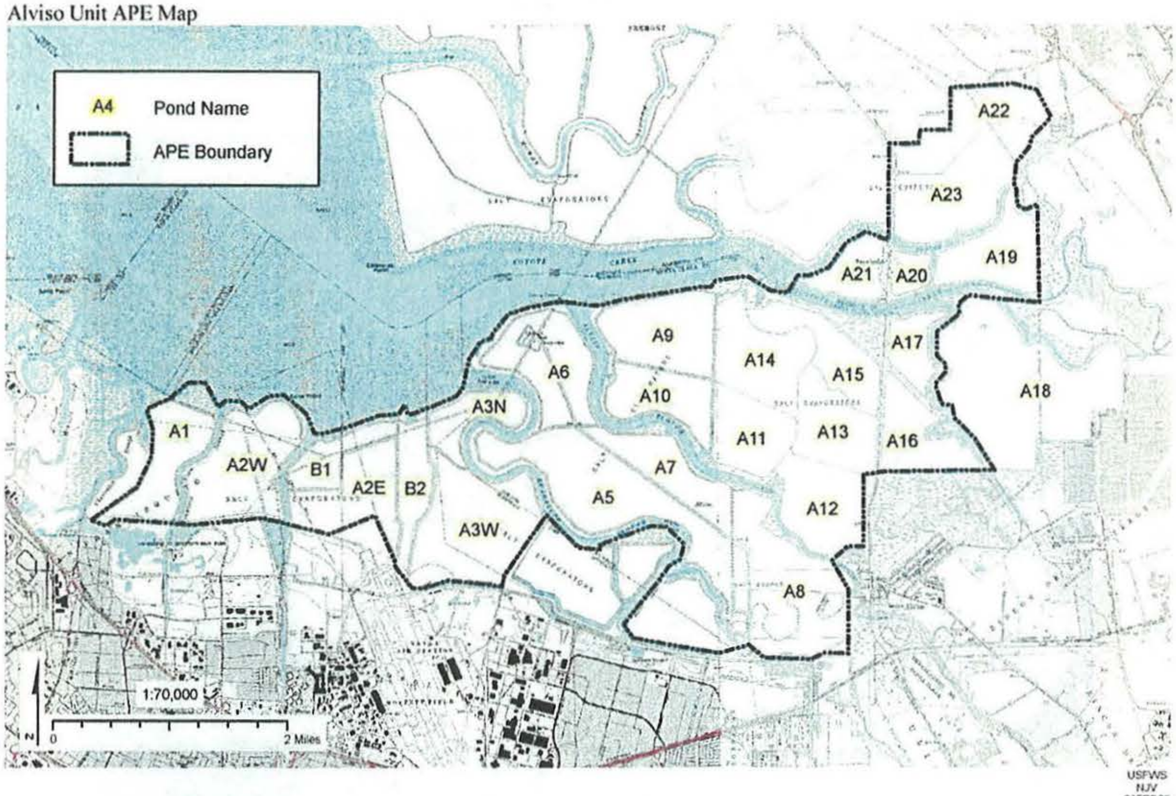

Figure 2. Alviso Unit APE.

South Bay Salt Pond Restoration Project
Eden Landing Unit APE Map

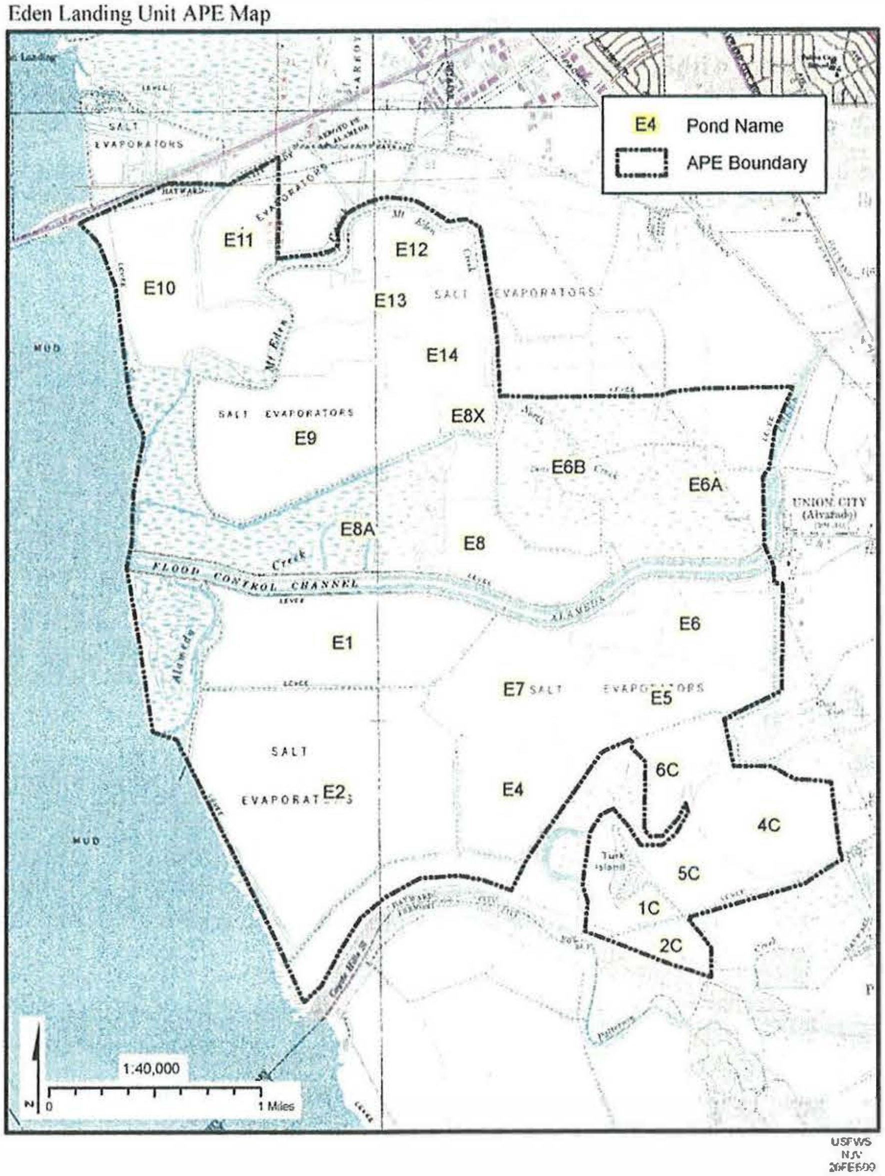

Figure 3. ELER APE.

ATTACHMENT 2.

U.S. Fish and Wildlife Service Project #FWS040721A
Historic Properties Treatment Plan
for the
Salt Works within the South Bay Salt Pond Restoration Project at the
Alviso Unit, Don Edwards San Francisco Bay National Wildlife Refuge,
and the
Eden Landing Ecological Reserve, California Department of Fish and Game
Alameda and Santa Clara counties, California
January 14, 2011/revised May 4, 2012

Introduction
The South Bay Salt Pond Restoration Project (SBSPRP) will restore the former industrial salt production ponds in South San Francisco Bay to a more natural mix of tidal wetland habitats and managed ponds. The restoration comprises former salt ponds located at the southern end of San Francisco Bay. The SBSPRP encompasses property managed by the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG). The agencies are working together along with the California State Coastal Conservancy (Conservancy) and U.S. Army Corps of Engineers (USACE) and other project partners. The SBSPRP is composed of three noncontiguous units, including the Eden Landing Ecological Reserve (ELER or Eden Landing) on the east side of the Bay near the San Mateo bridge; the Alviso unit at the southern end of the bay; and the West Bay-Ravenswood unit located on the west side of the Bay near the Dumbarton Bridge (Figure 1).

In 2010 the salt works at the Alviso Unit and ELER were evaluated and determined to be eligible to the National Register of Historic Places (NRHP) as historic landscapes that encompass a range of condensing ponds, archaeological resources, and features associated with solar salt production and processing. This historic properties treatment plan has been developed to mitigate for the adverse effects associated with converting the salt ponds back to a native salt marsh habitat.

Undertaking
The SBSPRP is an extensive project that includes nearly 20,000 acres of former industrial salt ponds that were part of a vast system of salt ponds previously operated by Cargill Salt. The USFWS is the lead agency for complying with the National Historic Preservation Act. The Alviso Unit is managed by the USFWS and the ELER salt ponds are owned and managed by the CDFG. The SBSPRP is partially on federal property, will require a federal permit, and will use federal funding. Restoration activities will change the salt ponds to salt marsh which alters their function and open water appearance, both of which are contributing characteristics of the historic landscape and has the potential to affect a historic property

South Bay Salt Pond Restoration Project

Project Overview and APE Map

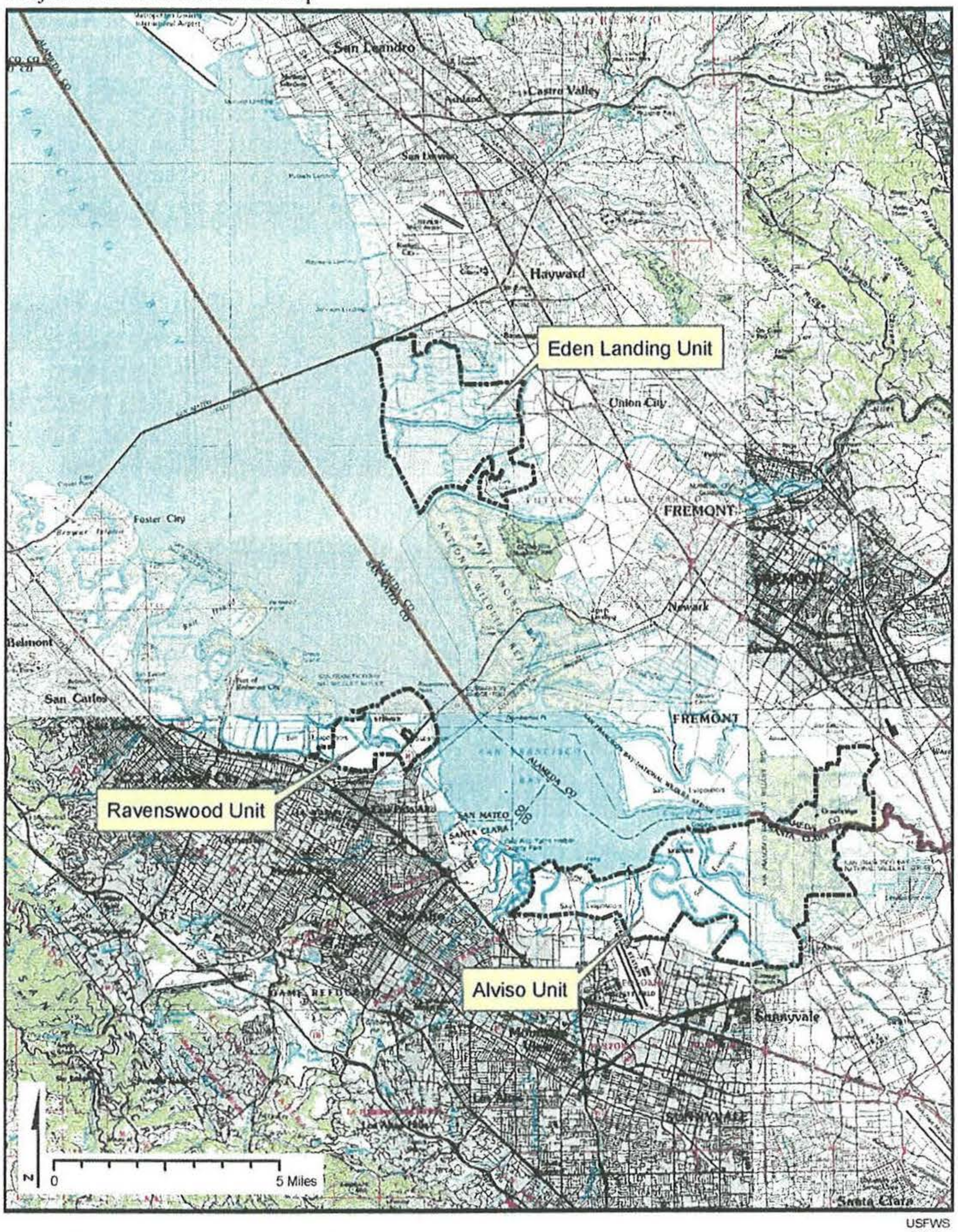

Figure 1. Project location map.

Area of Potential Effects

The Area of Potential Effect (APE) is depicted on Figure 1 and includes the Alviso Historic District and ELER Historic District that are located in the southern end of San Francisco Bay (See Figures 2 and 3). The ELER encompasses 6612 acres divided into 23 ponds, in Alameda County. The Alviso Unit encompasses 9677 acres divided into 28 ponds, within Alameda and Santa Clara counties. Within the APE, activities 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. Additionally, archaeological resources within the ELER Historic Landscape that are contributing elements of the landscape may be affected by fluctuating water levels

The Alviso Unit is drained, from east to west, by Mud Slough, Coyote Creek, Alviso Slough, Guadalupe Slough, Stevens Creek, Mtn View Creek, and Charleston Slough. The boundaries of the Alviso Salt Works Historic Landscape are established by legal ownership and natural features. The Eden Landing Unit is drained by Mt. Eden, North, and Old Alameda Creeks, the Alameda Federal Flood Control Channel marks the southern boundary of the district. The boundaries of the Eden Landing Salt Works Historic Landscape are established by legal ownership and natural features.

Alviso Salt Works Eligibility to the National Register of Historic Places:

The Alviso Salt Works Historic Landscape meets eligibility standards under criterion A because it is associated with the twentieth century period of industrialization when one operator created a vast network of evaporation ponds to produce the large amount of brine necessary to meet production demands. The SHPO has concurred with the eligibility determination (Donaldson to Mruz, October 12, 2010). Interpreting the Alviso Salt Works landscape offers a different view of the salt industry than the Eden Landing area. The Alviso Salt Works clearly reflects the industrial zenith and development of huge tracks of salt marsh for salt brine production. The large exterior levees and vast ponds are the signature features of the Alviso Unit solar salt landscape.

Alviso Salt Works Historic Properties Description

The history of solar salt production in Alviso dates from the 1920s. In Alviso, the salt industry did not develop from small, family-owned salt farms, but rather, began as an industrial-level enterprise. Only two salt companies, the Alviso Salt Company (that included Continental Salt and Chemical Company) and Schilling's Arden Salt Company are associated with the Alviso unit. Both companies appear to have built levees, developed salt ponds, and harvested salt from these lands during the 1920s. Arden acquired Alviso Salt in 1929, including its plant near the town of Alviso. Leslie Salt became the sole operator after 1936, until Cargill's acquisition in 1978 (EDAW 2005:14).

The Alviso Salt Works is characterized by vast evaporation ponds, large levees, and robust water control devices. The pattern of spatial organization has changed only slightly from the 1950s when the operation was controlled by the Leslie Salt Company. The Alviso Unit was developed for brine production there were no crystallizing ponds or processing plants within the unit.

One archaeological site, one townsite, and a bridge have been recorded within the Alviso Salt Works, none of which are related to salt production (Table 1). Only two of the three resources within the Alviso Salt Works are potentially eligible properties but they do not contribute to the Alviso Salt Works Historic Landscape. The town of Drawbridge (P-01-003291) and site CA-ALA-338 (P-01-002057) have been reviewed but no formal determination of eligibility has been completed. Site CA-ALA-338 was originally noted in 1909 by Nels C. Nelson as a shell-midden mound site. The site location has been re-visited, but no evidence of the site was identified (Busby 2008; Valentine 2009). Site CA-ALA-338 appears to have been completely destroyed by salt pond development.

The town of Drawbridge (P-01-003291) was a small community of cabins that were used for duck hunting and weekend retreats. The isolated location also attracted bootleggers, gamblers, and prostitution in the 1920s and 1930s. Leslie's salt plant diked off parts of the east and west marshes at the southern end of San Francisco Bay, leaving Drawbridge in isolation and causing the ground to subside (Morrow 1984; EIS/EIR 2007 Report). Environmental conditions for the island have not improved since the 1940s and most of the cabins are in serious decline, are threatened by vandalism, or are sinking into the marsh. The community was essentially abandoned by the 1950s with the last resident staying until 1978 when the Don Edwards San Francisco Bay NWR was established. Drawbridge is within the refuge boundaries but a corridor through the center of the island and town is on land owned by the Southern Pacific Railroad and private entities. Access to the island requires permission from the Southern Pacific Railroad to cross on their tracks. Because the Service does not own or manage the primary corridor of the town which is within 50 ft of the tracks along with safety concerns with the access on an active railroad track, the deteriorated condition of the buildings, and the problem of continued subsidence of the island have sidelined a proactive preservation approach and implementation of a 1980s plan to open the site to visitors (Morrow 1984:136-137).

The Coyote Slough bridge was constructed in 2001 as a replacement of an earlier bridge and is ineligible to the NRHP.

Table 1. Recorded cultural resources within the Alviso Works Historic Landscape.

Trinomial Site No.	Primary Site No.	Treatment	Eligibility To the NRHP	Description
CA-ALA-338	P-01-002057	N/A	Unevaluated	Disturbed remnants of shell midden; no surface evidence.
	P-01-003291	Monitor	Unevaluated	Drawbridge townsite
	P-01-010205/P-43-001578	N/A	No	Coyote Slough Bridge-installed in 2001.

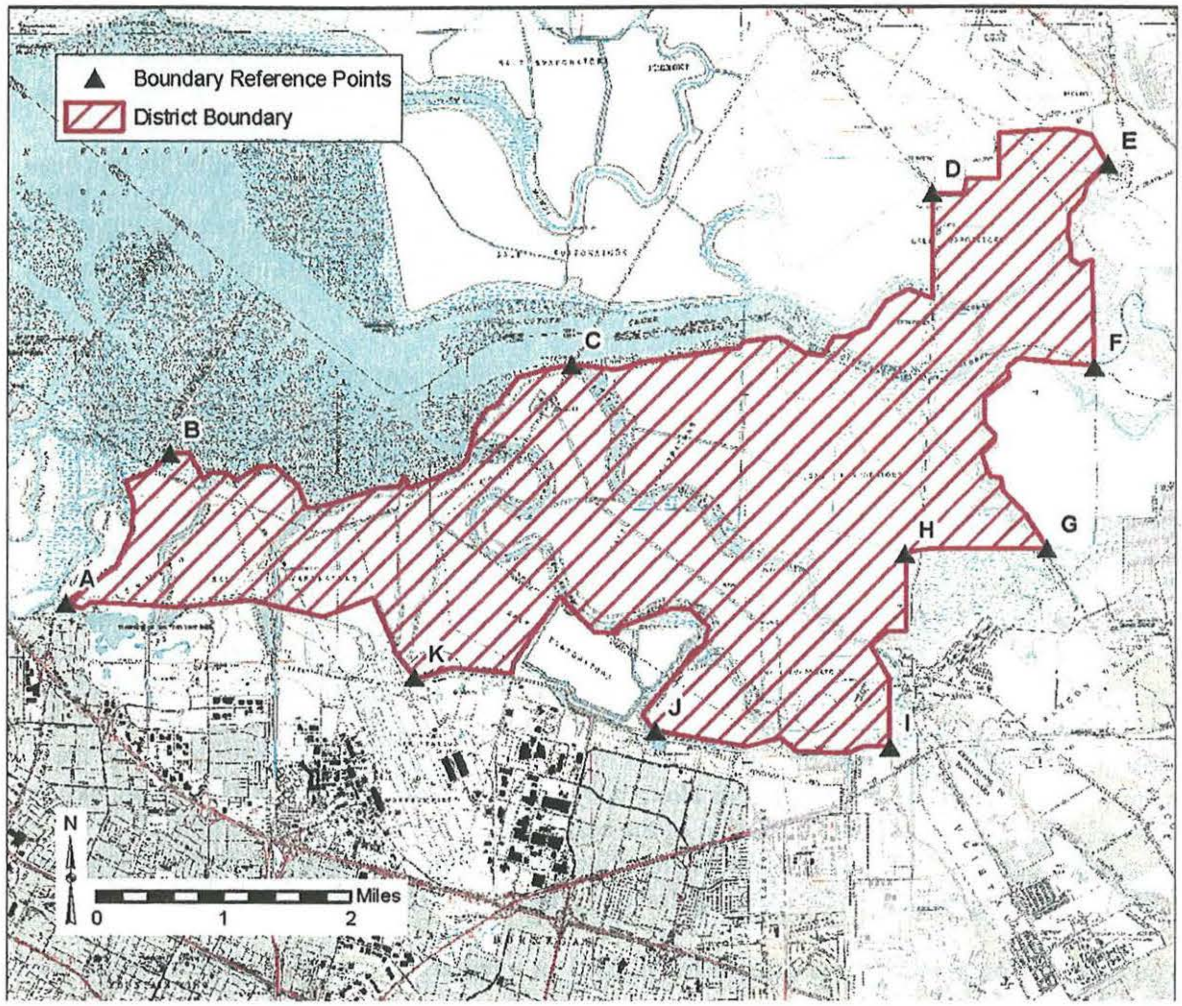

Figure 2. Alviso Salt Works Historic Landscape – Project APE.

Eden Landing Salt Works Eligibility to the National Register of Historic Places:
The Eden Landing Salt Works meets eligibility criteria A and D as defined by the National Register of Historic Places (NRHP) as a historic landscape. The SHPO has concurred with the eligibility determination (Donaldson to Mruz, October 12, 2010). Character defining elements of the historic landscape are the perimeter levees, interior pond divisions, archaeological sites associated with the family-owned processing plants and landings, and the Archimedes screw pumps. The overall Eden Landing Salt Works Historic Landscape provides an opportunity to interpret the evolution of the solar salt industry.

Eden Landing Historic Properties Description

The San Francisco Bay solar salt industry had its beginnings in the Eden Landing area. The initial salt production operations were 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 (EDAW 2005:14). "The Leslie-California Salt Company purchased the Oliver Salt works in 1931" (Ver Planck 1958:110). The small ponds have been altered to meet modern large-scale production needs.

Eleven 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.

Table 2. Recorded cultural resources within the Eden Landing Salt Pond Historic Landscape.

Trinomial Site No.	Primary Site No.	Treatment	Eligibility To the NRHP	Description
CA-ALA-489H, -501H	P-01-000217	Monitor and data collection	Yes	Eden Landing historic shipping station (warehouses, wharves, associated developments)
CA-ALA-494H	P-01-000210	Interpret, monitor	Yes	Oliver Salt Co. piling and foundations
-	P-01-010740	Interpret, monitor	Yes	Archimedes Screw Windmills
CA-ALA-495H	P-01-000211	N/AA	No	Location of former Rocky Point Saltworks – no surface remains.
CA-ALA-496H	P-01-000212	Monitor	Yes	Pilings and foundation of former Union Pacific Salt (ca. 1872-1927)
CA-ALA-497H	-	N/A	No	Peterman's Salt Works -- no surface remains
CA-ALA-498H	P-01-214	N/A	No	Salt works, not relocated
CA-ALA-499H	P-01-215	N/A	No	Modern refuse scatter
-	PF-1	Monitor	Yes	Whisby Salt Works refuse scatter
-	P-01-010834	N/A	No	Union City Alvarado Salt Ponds
-	FWS-07-12-1	Monitor, data collection	Yes	J. Quigely Alvarado Salt Works, domestic refuse scatter

Edens Landing Salt Works Historic Landscape

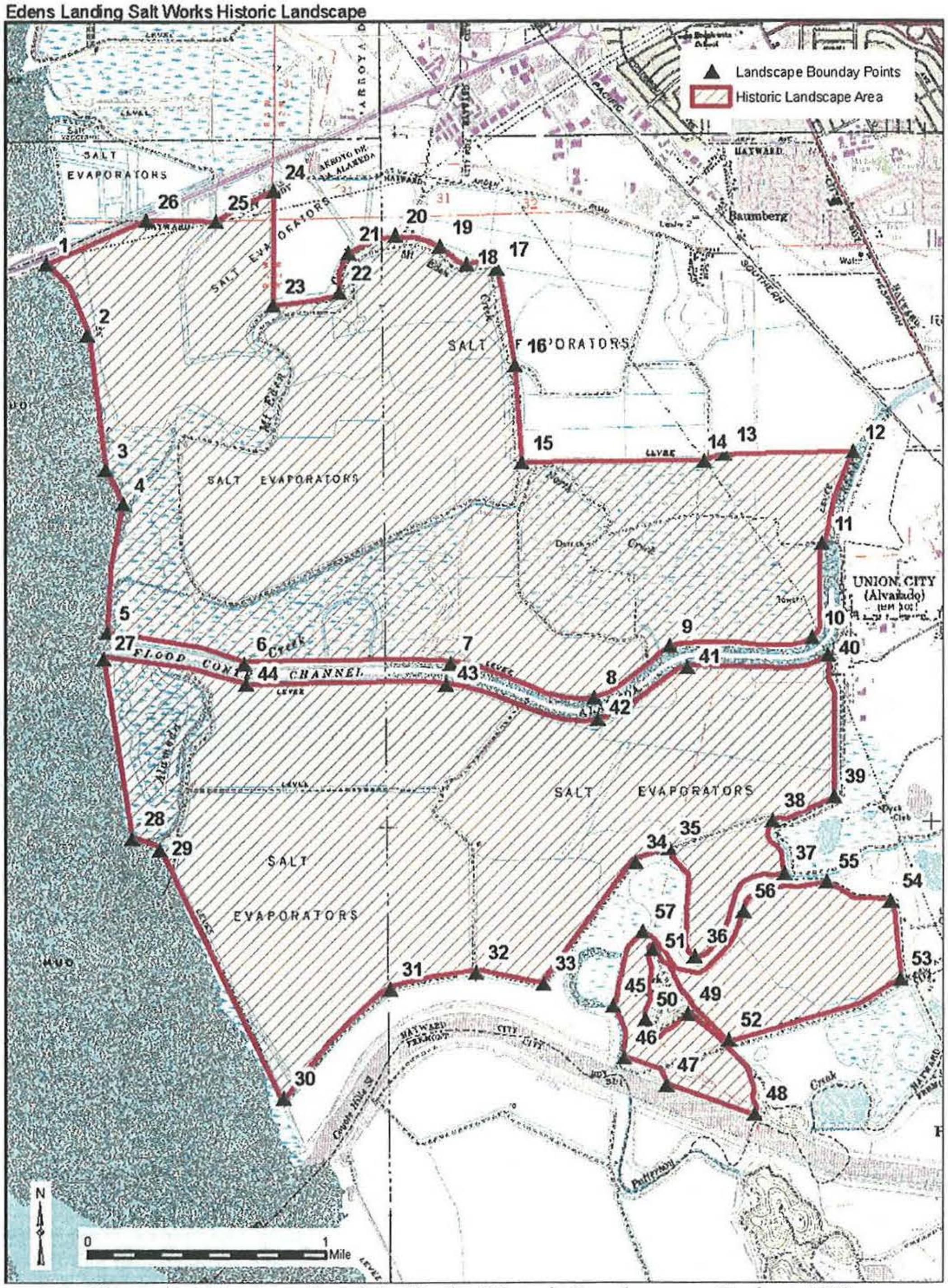

Figure 3. Eden Landing Salt Works Historic Landscape – Project APE.

Character Defining Features of the Alviso and Eden Landing Salt Works Historic Landscape

Character defining features of the Salt Works includes the landscape of levees, open-water ponds, water control structures, roads, and remnant wooden features, and archaeological sites. The initial evaporation ponds were built adjacent to the bay while secondary ponds were larger and protected from inundation from open bay water. Pickling and crystallizing ponds are relatively small and close to the salt processing plant and transportation corridor. The landscape features are engineered but lack distinctive qualities of individual workmanship or materials. The features are important because of their interrelationship and function as an evaporative salt factory. The ponds appearance of open water surrounded by earthen levees is a character defining feature.

The ELER encompasses some of the earliest salt ponds developed for salt production from the naturally suitable tidal salt marsh lands. Remnant features of the salt works of the Oliver family, the Barton family's Union Pacific Salt Works, and J. Quigley's Alvarado Salt Works are represented by archaeological sites that are historic properties. Overprinting by the modern solar salt industry has altered the nineteenth century landscape, raising levees, combining small ponds into much larger evaporation ponds, and changing the flow of water. The levees, water control structures, intakes, and pump stations have all been altered over the years to accommodate the increased production capacity, yet the distinctive pond landscape and remnant features reflect the evolving solar salt production industry.

Assessment of Effects to the Alviso and Eden Landing Salt Works Historic Landscape

The assessment of effects is determined by applying the criteria of adverse effects as provided in 36 CFR 800.5(ii).

> *Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization,. . . that is not consistent with the Secretary's standards for the treatment of historic properties and applicable guidelines.* The *Secretary's Standards* suggest that changes to historic properties should be minimal, follow the original plan, and should be compatible with existing materials or function.

The proposed modifications to remove salt works ponds from salt production will change their function and open water appearance, which are contributing characteristics of the historic landscape. The proposed restoration activities will alter these character defining features of the property which contributes to its eligibility and is an adverse effect as per 36 CFR 800.5(2)(iv). Additionally, altering the water flow from a controlled level to a tidally influenced dynamic flow may affect the six eligible sites within the Eden Landing Salt Works. Only the salt pond landscape will be affected by the restoration activities in the Alviso Salt Works.

Mitigation to resolve the adverse effects of the project activities is directed toward the salt pond landscape and six sites in the ELER.

Treatment Plan Actions
This Historic Properties Treatment Plan will affectively mitigate the effects of the SBSPRP. The USFWS and CDFG will ensure implementation of the treatment plan to include:

1) Documenting the salt works landscape based on consultation with the NPS Regional Coordinator for the Historic American Landscapes Survey (HALS);

2) Submitting the HALS documentation to NPS who will transmit it to the Library of Congress. Additionally, copies of the HALS documentation will be maintained at the DESFBNWR, USFWS Cultural Resources Team office, CDFG, and the Hayward Historical Society;

3) Protecting archaeological resources *in situ* within the ELER that are contributing elements of the historic landscape. Sites that are affected by fluctuating water levels will be documented with photography, GPS mapping, and limited subsurface testing of features and selective surface collection. The sites will then be monitored once a year at a low tide event or summer dry season for five consecutive years from the signing of this MOA. Monitoring will continue until the restoration work is completed. No additional affects are anticipated from the restoration work once the salt marsh habitat has been reestablished, at that point monitoring will cease. If any site appears to be accessible to vandals or the structure of the site changes due to vandalism, then a more substantial data collection procedure will be instituted.

4) Monitoring sites will include a site visit by a qualified archaeologist who will prepare a brief condition assessment report with photo-documentation of each site. Photographs will be taken from set photo points, each year, in order to trace any changes to the sites. Photographs will be maintained by the USFWS Cultural Resources Team (CRT). The CRT will evaluate the photographic record annually to provide site protection recommendations to the land managing agency. Reports will be archived with project materials at the CRT office.

5) Developing interpretive materials to be installed within the ELER that introduces the story of evaporative salt production in the San Francisco Bay region, including a boardwalk and interpretive panel at the Oliver Salt Works and Archimedes Screw Windmills.

Summary and Resolution of Adverse Effect
The mitigation measures presented in this Historic Properties Treatment Plan and stipulated in the Memorandum of Agreement will resolve the adverse effect of the South Bay Salt Pond Restoration Project.

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2008 *Cultural Resources Assessment: South San Francisco Bay Shoreline Interim Feasibility Study, Task Order 3*. Report prepared for U.S. Army Corps of Engineers, San Francisco. Report prepared by Basin Research Associates, Inc., San Leandro.

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APPENDIX G

PUBLIC ACCESS AND RECREATION RESOURCES TECHNICAL APPENDIX

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This Appendix provides a summary of the recreation and public access features associated with the South Bay Salt Pond (SBSP) Restoration Project, Phase 2 Eden Landing Ecological Reserve (ELER) area actions, review of applicable plans and policies of regulatory agencies and project stakeholders, evaluation of trail use demand, and identification of key components and design guidelines for recreation and public access facilities that may be completed as part of this project, including strategies for design consistent with stakeholder and regulatory requirements. The project impacts associated with recreation and public access features are presented in Chapter 3.6, Recreation Resources, of the main text.

This Appendix contains information on the following components:

- Regulatory Framework;
- Existing Recreation and Public Access Facilities;
- Recreation Regulatory Permit Requirements;
- Phase 1 Recreation and Public Access Features;
- Phase 2 Recreation and Public Access Alternatives;
- Projected Trail Use; and
- Recreation and Public Access Design Guidelines.

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1. INTRODUCTION

A primary goal of the South Bay Salt Pond (SBSP) Restoration Project is to provide recreation and public access. The vision of the project is to help establish an interrelated trail system, provide wildlife viewing and interpretative opportunities, create small watercraft launch points, and allow for waterfowl hunting.

Phase 1 actions at Eden Landing included identification, design and implementation of trails and other public improvements at locations within each pond complex. This included several miles of new trails, interpretive features, and a kayak launch that were added to the northern half of the Eden Landing Ecological Reserve (ELER or Reserve).

Recreation and public access features to be evaluated as part of Phase 2 Action Alternatives, as well as information regarding uses in the surrounding vicinity were collected through several methods, including: stakeholder meetings and associated project information presentations; review of Geographic Information Systems (GIS) data compiled for this project; personal communications; site tours; research and review of existing plans, policies, regulations, codes, and reports; and baseline information contained in the SBSP Restoration Project Initial Stewardship Plan (ISP) and the SBSP Restoration Project Recreation and Public Access Phase I Existing Conditions Report, which is incorporated by reference.

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2. PHYSICAL SETTING

The Phase 2 project area includes the ponds in the southern half of the Reserve. All of the Eden Landing pond complex ponds are owned and managed by the California Department of Fish and Wildlife (CDFW) as part of the Reserve. In between some of the CDFW-owned lands, the Alameda County Flood Control and Water Conservation District (ACFCWCD) owns a stormwater channel, a stormwater detention basin, and a section of existing high marsh. There are also some private inholdings – including ponds, levees, and other lands –owned by Cargill. To the east, there are other parcels and facilities owned by ACFCWCD, Union Sanitary District, a private landfill operation company, the city of Union City and a mix of other private owners. Some of these lands may be considered for placement of public access facilities as part of Phase 2 actions.

Most of the recreation and public access facilities would be located on existing levees on or adjacent to the Phase 2 area, and would be located on lands owned by CDFW, Cargill, and/or Alameda County.

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3. REGULATORY SETTING

A detailed discussion of the regulatory framework for the SBSP Restoration Project area was provided in the project's Recreation and Public Access Existing Conditions Report. A summary of updated regulations related to recreation and public access is provided herein.

The portions of the SBSP Restoration Project Phase 2 at Eden Landing that are covered in the Draft Environmental Impact Statement/Environmental Impact Report (EIS/R) are primarily governed by the applicable codes, regulations, and policies of the State of California and California Department of Fish and Wildlife (CDFW), with additional regulation by the San Francisco Bay Conservation and Development Commission (BCDC). Together, these entities compose the primary legal and managerial framework with which to guide existing and proposed recreation and public access for the SBSP Restoration Project Phase 2. In some cases, public access facilities may be implemented on lands owned and/or managed by Alameda County Flood Control and Water Conservation District (ACFCWCD), East Bay Regional Park District (EBRPD), or private entities such as Cargill, for which an agreement to operate and manage public access would be needed. Such facilities would be subject to regulatory review by other local agencies, depending on precise alignment.

Additionally, the policies and guidelines of region-wide, recreation-related plans of agencies such as the Association of Bay Area Governments (ABAG) Bay Trail and, as well as county and city recreation and public access plans also influence the development of future recreation and public access facilities on SBSP Restoration Project, Phase 2 area lands; they are also summarized herein.

3.1 Recreation-Related Review and Permits

Proposed recreation components may be subject to various state and federal regulations that would require approvals and/or permits for proposed recreation and public access development.

CDFW will be the primary internal reviewer and approver of public access and regulatory facilities implemented on its lands. There are some options for a trail route that would be placed on lands not owned by CDFW. This includes the trail connection from northern Eden Landing to the Phase 2 area, as well as portions of several trail routes at the perimeter of the Phase 2 area. For those routes to be implemented, the owners of those parcels (e.g., Cargill, Alameda County) would have to sell, donate or enter into an agreement with the lead agency or implementing entity for public access, such as easement, memorandum of understanding or license agreement, for trail construction, use and/or management. The landowners would also review and approve the designs, plans, and other details.

Depending on the location of the proposed recreation and public access facilities located outside of the ELER (e.g., those on private and/or City or County –owned lands), local and regional jurisdictions may have regulatory review authority. In addition, the lead agency may partner with local or regional groups (*e.g.*, EBRPD) to execute specific recreation-related agreements for implementation of public access components . Depending on the location and type of facilities to be built, agencies that may have review and/or permit requirements over proposed recreational components include the cities of Hayward and/or Union City, EBRPD and Alameda County.

Table G-1 provides a summary of the types of permits or agreements that may be required to carry out specific construction or maintenance activities associated with recreation and public access development.

Table G-1. Recreation-Related Regulations and Permit Summary

ADMINISTERING AGENCIES	DESIGN REVIEW/AGREEMENT/PERMIT	REGULATION
USFWS	Issues "no effect" or "not likely to affect" letter.	Consultation with USACE under Section 7
	Protects against destruction of migratory bird nests and possession of migratory bird "parts."	Migratory Bird Treaty Act
	Federal Lead Agency	National Environmental Policy Act
CDFW	State Lead Agency; Project Applicant	California Environmental Quality Act
BCDC	Conducts reviews and issues permits for filling, dredging, substantial change in use, or development activities within the shoreline band, at the salt ponds or managed wetland areas, including recreation-related projects.	McAteer-Petris Act
RWQCB	Issues water quality certification.	Section 401 of the Clean Water Act, Porter-Cologne Water Quality Act
USACE	Issues Nationwide or Individual Permit to perform dredge or fill activities in the Waters of the U.S., including wetlands.	Section 404 of Clean Water Act
	Issues permit to create obstructions or fill of navigable waters of the U.S. (bridges)	Section 10 of the Rivers and Harbors Act of 1899
	Alteration of federal flood control levees (Bridge at ACFCC)	Section 408, Operations and Maintenance
United States Coast Guard	Navigable waterways (bridges)	Section 9, Coast & Harbors Act
EBRPD	Review if project partner for implementation: consultation regarding temporary closure of EBRPD trails, if needed	Master Plan and Trails Plan consistency
Alameda County	Construction of facilities on County-owned land (Responsible Agency)	Grading, encroachment, use agreement
Union City and/ or Hayward	Construction of facilities on land within the City limits that is not within County or State owned lands (Responsible Agency)	Grading, encroachment, use agreement possible design or recreation review

ACFCC = Alameda Creek Flood Control Channel

BCDC = San Francisco Bay Conservation and Development Commission

CDFW = California Department of Fish and Wildlife

EBRPD = East Bay Regional parks District

RWQCB = San Francisco Bay Regional Water Quality Control Board

USACE = United States Army Corps of Engineers

USFWS = United States Fish and Wildlife Service

3.2 Regulatory and Managerial Framework

CDFW is the primary land-owning and managing agency in the SBSP Restoration Project, Phase 2 area.

The San Francisco Bay Conservation and Development Commission (BCDC) will issue a permit for the project.

Union City, Alameda County and EBRPD own adjacent recreation facilities that could be built on or connect directly to trails and recreation facilities that would be constructed as part of the project. Minor encroachment permits may be needed for construction at access or connection points. In addition, there are plans, studies and policy documents for the area in and around Phase 2 of the SBSP Restoration Project that contain guidelines and recommendations for recreation and public access facilities.

3.2.1 CDFW Eden Landing Ecological Reserve

CDFW is the owner of Eden Landing, and as an ecological reserve, the Eden Landing pond complex is governed by laws and directives that guide public use and recreation on State ecological reserves. The State's ecological reserve system was authorized by the California Legislature in 1968 and is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The reserves also provide recreational opportunities for wildlife viewing, outdoor education, hunting, and fishing, subject to regulation. At ELER, bicycles and horseback riding are allowed only on designated trails.

The Phase 1 Eden Landing area (northern ponds) includes the following recreation and public access facilities:

- Approximately 13,000 feet of Bay Trail, installed and managed by EBRPD. This Bay Trail segment is closed ten days per year to accommodate hunting.
- Other trails including 5,000 feet of year round trail, and 8,000 feet of seasonally closed trail, and a spur trail to the Bay shoreline. Part of the loop trail in northern Eden Landing is closed seasonally from March through mid-September to avoid wildlife disturbance.
- Accessible watercraft/kayak launch.
- Interpretive exhibits and signage.
- Benches and site furnishings.
- A paved parking area at the Eden Landing Road trailhead provides 24 parking spaces, of which one is designated for disabled use. The parking area receives consistent use, although no counts or intercept surveys of visitor use have been conducted by CDFW. Trail count data is available for this area from information collected by EBRPD and is summarized in appendix trail counts. There is an overflow parking area of equivalent size that has not been used since completion[1].

Recreation use currently within the Eden Landing Phase 2 area includes the existing Alameda Creek Regional Trail segment at the western end of the Alameda Creek Flood Control Channel (ACFCC) and limited to seasonal waterfowl hunting (currently 10 days per year with written permission from CDFW).

[1] John Krause, Pers. Comm. September 2016.
[2] Trail Count data provided by Sean Dougan, EBRPD email corresp. 9/16

In the overall ELER, CDFW allows hunting in some of the ponds within the ELER. ELER conducts ten hunt days per year, with a capacity of 100 hunters. There has been consistent participation, with 44-130 hunters during each of the 2015-2016 hunt days.

There are several existing hunting blinds dispersed throughout the Phase 2 area. Most of these blinds are remnant facilities that were constructed prior to the property becoming part of the Reserve. CDFW has an informal policy to allow waterfowl hunters to maintain the facilities, as long as they do not interfere with wildlife (such as proximity to nesting areas) but does not actively maintain the facilities. One accessible hunting blind is provided within Pond 5EC. This blind is used consistently by one to four disabled users on hunt days.

Other uses and policies related to recreational use at ELER include:

- Horses could be allowed on "designated" trails within ELER, however, no trails are formally "designated", and no equestrian use is currently allowed.
- Bicycles are allowed only on designated trails.
- Dogs are allowed associated with hunting, and may be allowed on leash.

Relationship to Phase 2 Actions

Hunting. Since the acquisition in 2003, CDFW has permitted limited waterfowl hunting on specified dates (currently 10 days annually between November and January, providing entry by written permission from CDFW at a hunter check station) within the ELER lands in the Phase 2 area, as well as areas north of OAC that were part of the Phase 1 actions. Restoration actions within the Phase 2 area will likely change the use and configuration of the current pond system, affecting the physical area available for such recreation activities, and/or the character of the recreation experience. For instance, managed ponds provide the best conditions for waterfowl hunting, so an increase in tidal ponds may reduce the physical area available for waterfowl hunting.

Only a portion of the southern Eden Landing ponds (those within the "Open Hunt Zone") is currently open to hunting. With implementation of Phase 2 actions, there could be a considerable loss of hunting opportunities in those managed ponds that transition to tidal marsh habitat. Managed ponds at northern Eden Landing would remain, and hunting opportunities would continue to be available in those managed ponds and existing tidal areas. North Creek marsh in northern Eden Landing, which has been open to full tidal action for approximately 10 years, has been a popular waterfowl hunting area, as are fully tidal areas within OAC, and the outboard Whale's Tail Marsh and mouth of Mount Eden Creek areas. More isolated marsh areas are accessed by hunters using small boats or kayaks, while some remaining berms and perimeter levees provide access by foot for hunting along and within such tidal areas.

Where existing blinds are removed to facilitate Phase 2 restoration activities, installation of new blinds (to facilitate hunting) by CDFW would be consistent with Reserve policies in areas where the use or management changes. Should access to the disabled access blind cease due to project design, it would be relocated to a similar location to provide an equivalent recreation experience, where feasible and available. Relocated blinds could reduce hunter access for others or contribute to overcrowding if quotas remain the same.

Public Access. For other recreation facilities added as part of Phase 2 implementation, use and operation would be prescribed by the managing authority and regulatory permit conditions. For instance, for portions of any trail designated as Bay Trail “spine” (the primary segment connecting Pond 20B in north Eden Landing with the Alameda Creek Regional Trail), it is expected that bicycles would be allowed, and the trail would be open year-round with the exception of waterfowl hunt days. As is the current practice, the Bay Trail spine would be closed to general use on waterfowl hunt days (currently 10 days per year) to ensure public safety. In addition, hunters are allowed to drive on portions of the Bay Trail spine to reach areas more remote from the sole entry allowed at the hunter check station. Any other trails (such as those that provide point access) might be similarly subject to seasonal closures or other restrictions. Equestrian use, which is allowed on the EBRPD’s Alameda Creek Regional Trail, may be regulated or restricted within the Phase 2 area. Management of dog use would likely be coordinated with policies on adjacent non-Refuge trails that connect to any new trail constructed for Phase 2.

3.2.2 San Francisco Bay Conservation and Development Commission

BCDC is a California state planning and regulatory agency with regional authority over the San Francisco Bay (or Bay) and the Bay’s shoreline. The McAteer-Petris Act (California Government Code 66600 – 66682) is the key legal provision under California state law that preserves San Francisco Bay from indiscriminate filling and to regulate shoreline public access. The McAteer-Petris Act requires that any person or governmental agency wishing to place fill in, or to extract materials exceeding 20 dollars in value from, or make any substantial change in use of any land, water, or structure within the area of BCDC’s jurisdiction must secure a permit from BCDC.

BCDC administers the *San Francisco Bay Plan* (Bay Plan) for the long-term use of the Bay, reviews applications for projects that fall within BCDC jurisdiction. With respect to the ELER, the Bay Plan states: “The California Department of Fish and Game manages and proposes to restore 5,500 acres of salt ponds and adjacent tidal habitats added to the Eden Landing Ecological Reserve to a mix of tidal and managed pond habitats. The proposed restoration use would be in accord with Bay Plan policies and provides excellent wildlife compatible recreation opportunities.”

Salt Pond Restoration

The BCDC amended the salt pond section of the San Francisco Bay Plan on August 18, 2005. The amendment focuses on the significance of salt ponds to Bay wildlife, on the opportunity for salt ponds to be restored to tidal action, and on the need to maximize recreation and public access opportunities while avoiding significant adverse effects on wildlife. Policy 5 of the amendment addresses the need for comprehensive planning of any development proposal in a salt pond that (1) integrates regional and local habitat restoration and management objectives and plans and (2) provides opportunities for collaboration among different stakeholders (e.g., agencies, landowners, other private interests, and the public). Relevant to recreation resources is the need to incorporate provisions for recreation and public access opportunities appropriate to the land’s use, size, and existing/and/or future habitat values in the planning process.

Public Access Design Guidelines

The San Francisco Bay Plan identifies the *Shoreline Spaces: Public Access Design Guidelines for San Francisco Bay* (handbook) as a guide to siting and designing public access. The handbook, published by BCDC, functions as a design resource for development projects along San Francisco Bay’s shoreline, and includes recommendations for site planning, designing, and developing attractive and usable public access areas. The handbook also covers in-lieu public access and management issues associated with maintenance of public access areas. The handbook discusses general planning principles, and specifies that “the design of public access areas should create a sense of place based on the site’s unique shoreline characteristics, the aesthetic quality of the proposed development, and the intensity and nature of the proposed use” (BCDC 2005). The handbook identifies the following seven public access objectives and provides recommendations on how these objectives could be accomplished:

- Make public access public.
- Make public access usable.
- Provide, maintain, and enhance visual access to the Bay and shoreline.
- Maintain and enhance the visual quality of the Bay, shoreline and adjacent developments.
- Provide connections to and continuity along the shoreline.
- Take advantage of the Bay setting.
- Ensure that public access is compatible with wildlife through siting, design, and management strategies.

The handbook also identifies eighteen public access improvements that could be implemented with any given project. These improvements must be implemented in a manner consistent with the San Francisco Bay Plan’s public access policies, and some are required as part of the BCDC’s permit decisions. Included in these improvements are stormwater management systems, roads and highways along the shoreline, designated public access parking and staging areas, in-car Bay viewing, pedestrian and bicycle bridges, gathering and seating areas, site furnishings, signage/comprehensive sign programs, methods to avoid adverse effects on wildlife, shoreline erosion control, shoreline edge treatments that provide a closeness to the water, trail design, public access across launch ramps, shoreline planting, pedestrian and vehicular railings, fishing facilities, point access at ports and water-related industrial areas, and interpretative elements and public art. Although these are not legally enforceable standards, they are advisory and aimed at enhancing shoreline access and use.

Relationship to Phase 2 Actions

BCDC would have jurisdiction in the Eden Landing Phase 2 recreation and public access components and administer permit conditions related to their authority, as appropriate. As discussed above, a BCDC permit is required for filling, dredging, and substantial change in use of land, water, or structures within the area of BCDC’s jurisdiction. Typical BCDC permit conditions include requirements for public access and other improvements, as related to the construction, installation, use, and maintenance of public access areas. Permit conditions might also include making a commitment to ongoing management and monitoring of public access improvements. Recreation and public access facilities would be evaluated for compliance with the State’s climate change policies, including sea-level rise.

Recreation and public access facilities included in Phase 2 actions would be evaluated by BCDC for compliance with Bay Plan and ABAG Bay Trail Plan and policies. Where a proposed alignment does not fully comply with policies such as sea-level rise, alternate design strategies may be appropriate, and may include features such as:

- Constructing a trail footprint of sufficient width to allow raising the trail in the future (and have a trail with sufficient functional width).
- Reserving additional lands on the sides of unimproved trail for dedicated future trail improvements.
- Dedicating an alternate alignment where the trail would be located in the future. For instance, according to the Reserve Manager, the Mt. Eden Creek spur trail is intended to replace the ABAG Bay Trail planned spur trail along OAC out to the Bay at Whale's Tail Marsh (J. Krause, pers.comm. 2016).

3.2.3 San Francisco Bay Trail (Bay Trail)

The Bay Trail, administered by Association of Bay Area Governments (ABAG), is a planned recreational corridor that, when complete, will encircle San Francisco Bay and San Pablo Bay with a continuous network of bicycling and hiking trails. It will connect the shoreline of all nine Bay Area counties, link 47 cities, and cross the major toll bridges in the region. To date, approximately 310 miles of the alignment – over 60 percent of the Bay Trail's ultimate length – have been completed.

Relationship to Phase 2 Actions

Segments of the Bay Trail are located near the Eden Landing Phase 2 project area, including a segment of the Bay Trail that was added in northern Eden Landing as part of Phase 1 of the SBSP Restoration Project. Many of the public access facilities that would be constructed as part of the project could connect to these existing trail segments. Some new trail segments being considered as part of Phase 2 actions are not currently segments of the Bay Trail but could be considered to become part of the Bay Trail network in the future, if appropriate.

The Bay Trail Plan includes a shoreline spur to the Bay at Old Alameda Creek (OAC), as well as a bridge across ACFCC to access Coyote Hills Regional Park. The spur trail on Mt. Eden Creek, constructed under Phase 1 of the SBSP Restoration Project, was included along the managed ponds in northern Eden Landing to provide a similar experience for trail users and because it was anticipated that a spur trail along OAC would be problematic because of potential tidal breaches and adjacent species conservation concerns.

Although not a regulatory agency, ABAG has an interest in the project as a partner and potential funding source. The Bay Trail Plan has been prepared in consultation with local governments, and is periodically amended and updated in consultation with them. BCDC considers the Bay Trail Plan in making determinations as to whether a project is consistent with their policies on public access.

3.2.4 San Francisco Bay Area Water Trail (Water Trail)

The Water Trail was authorized by the San Francisco Bay Area Water Trail Act, which was signed into state law in September 2005. The Water Trail is a network of access sites (or "trailheads") that enables people using non-motorized small boats or other beachable sailcraft, such as kayaks, canoes, dragon boats, and stand-up paddle and windsurf boards, to safely enjoy single and multiple-day trips around San Francisco Bay.

Relationship to Phase 2 Actions

Non-motorized boat launch facilities constructed in the Phase 1 actions at northern Eden Landing are designated as existing Water Trail sites; they have launch facilities that are used for non-motorized small boat access and are open to the public. No additional Water Trail facilities are planned for Phase 2.

3.2.5 East Bay Regional Park District (EBRPD)

The East Bay Regional Park District (EBRPD) is a system of public parks and trails in Alameda and Contra Costa counties. The EBRPD owns and manages over 120,000 acres of open space, protected habitat, and other parklands. The 2013 District Master Plan provides the guidance for future expansion of parks trails and services. On the Master Plan, the Project Area is labeled Alvarado Wetlands, and potential trails 1B (San Francisco Bay Trail - Coyote Hills to Hayward Shoreline) and 11 (Old Alameda Creek Trail) are within the site. Policies related to trail development include:

- PRPT9: Regional Trails will connect regional parks or trails to each other, to parks and trails of other agencies, or to areas of unusual scenic beauty; vista points, San Francisco Bay, Delta or lake shoreline, natural or historic resources, or similar area of regional significance…
- PRPT10: The District encourages the creation of local trail networks that provide additional access points to the regional parklands and trails in order to provide loop trail experiences and to connect the regional system to the community. The District will support other agencies in completing local trail networks that complement the Regional Trail system and will coordinate with local agencies to incorporate local trail connections into District brochures.
- PRPT11: Regional trails may be part of a national, state, or Bay Area regional trail system. The District will cooperate with other agencies and organizations to implement these multi-jurisdictional efforts.
- PRPT18: The District will coordinate with other agencies and organizations involved in planning for jointly managed regional trails or trails that extend beyond the District's jurisdiction. When applicable, the District will use planning and environmental studies done by or in cooperation with other agencies for trail planning and development.

EBRPD is the owner and operator of Coyote Hills Regional Park, located south of Eden Landing, and Hayward Regional Shoreline, located north of Eden Landing. EBRPD also operates the Alameda Creek Regional Trail under an agreement with the ACFCWCD and manages the Bay Trail "spine" in the northern Eden Landing area, but not the "spur" trails and non-motorized launch.

Relationship to Phase 2 Actions

At the present time, no formal arrangements exist between CDFW and EBRPD for maintenance and shared responsibility of trails and other public access features in the Phase 1 or Phase 2 project area.

3.2.6 Alameda County Flood Control and Water Conservation District (ACFCWCD)

ACFCWCD is part of Alameda County Public Works Agency, responsible for maintaining the area's flood control facilities, including channels, levees, pumps and infrastructure related to flood control and stormwater management. The ACFCWCD provides planning, design and inspection of flood control projects, maintains flood control infrastructure, reviews new developments and supports watershed enhancement and education. ACFCWCD does not construct or manage trails, and would need to enter into an agreement with another entity for trail management, making them responsible for construction, maintenance, and operations of the trail, including patrol policing and emergency response. Flood control channels and creeks in the Phase 2 project area are in Zone 3A.

Relationship to Phase 2 Actions

Some of the proposed trail route options are located on County lands, including levees, access roads, ponds and the 20-tide gate structure crossing on OAC.

3.2.7 Cargill, Inc.

Cargill Inc. owns and operates lands in the Phase 2 project area including Pond Cargill Pond 3C (CP3C), Cal Hill and Turk Island. Proposed Trail Route 2 would be located on the existing Cargill owned levee only if an agreement with Cargill and all stakeholders were reached, or if they no longer owned the property.

Relationship to Phase 2 Actions

In order to proceed, an agreement with Cargill would be needed for construction, operation and management to open these lands to public access.

3.2.8 City of Hayward

ELER is within the city limits of Hayward, as are portions of County-owned lands west of Westport Way. Facilities that are located within the Reserve would not be subject to regulation by the City, since they are state lands.

Relationship to Phase 2 Actions

There are no existing or proposed recreation or public access facilities in the area that conflict with adopted City of Hayward plans.

3.2.9 City of Union City

The eastern and southern part of the Eden Landing Phase 2 project area, including County and Cargill-owned lands is within the Union City limits. In 2004, Union City (Alta Planning 2004) commissioned a study analyzing the feasibility of a Bay Trail segment from the EBRPD trail in northern Alameda County to the Alameda Creek Regional Trail (**Figure G-1**). Some of the trails proposed for the Phase 2 actions include portions of the trail segments analyzed as part of this study, including the northern Eden Landing segment along OAC, and portions of Trail Route Option 3.

In addition to access at Union City Blvd., the study identified five Community Connecters, “an important part of the Bay Trail system, ensuring that residents of neighborhoods located near the primary Bay Trail alignment have ready access to the regional trail network.” These community connecters were located at OAC south levee, Horner Street, Whipple/Benson Road, Mariner Park, and Westport Way. These routes have been incorporated into the City’s Bicycle and Pedestrian Plans, as well as those of Alameda County.

Figure G-1. Union City Bay Trail Feasibility Study Preferred Alignment (source: Alta Planning, 2004)

Figure 3-3
Preferred Alignment Map

Relationship to Phase 2 Actions

Depending on the alignment selected, recreation and public access improvements completed as part of the project (but outside the boundaries of the Reserve) may be subject to review and approval by the City of Union City.

3.2.10 Alameda Countywide Bicycle and Pedestrian Plans

The Alameda County Transportation Commission (ACTC) plans, funds and delivers transportation programs to expand and improve access and mobility in Alameda County. They administer funds from local state and federal funding sources, including Measures B and BB, vehicle registration, Clean Air funds, State Transportation Improvement Program and federal programs.

The Countywide Bicycle and Pedestrian Plans (2012), adopted by the ACTC identify specific investments and strategies to maintain, manage, and improve the non-motorized transportation network in Alameda County. The bicycle and pedestrian plans incorporate the ABAG Bay Trail components (ACTC central and south) within the Eden Landing Phase 2 area, including the Bay Trail spine (with notation that final alignment is to be determined), a spur trail on OAC, and a bridge across ACFCC. The plans also include a new connection to the city street network in the general vicinity of the 20-tide gate structure.

Relationship to Phase 2 Actions

Coordination with ACTC would be needed if the project partnered with them for funding of bicycle and pedestrian improvements. .

3.2.11 Other Planning Efforts

Other plans that guide or influence development of recreation and public access facilities for the SBSP Restoration Project area are summarized below.

The CDFW and USFWS published the South Bay Salt Pond Restoration Project Interim Stewardship Plan (ISP) in June 2003[2]. The ISP described the interim operation and maintenance of the former Cargill ponds prior to the development of the long-term plan. A Draft Environmental Impact Statement / Environmental Impact Report (EIS/R)[3], published in December 2003, was conducted to evaluate the environmental impacts that could occur with implementation of the ISP. The Final EIR/EIS for the ISP was published in March 2004.

The ISP summarized relevant regional plans that support open space, recreation, and public access uses. It did not provide policies or regulations associated with management of recreation or open space; rather, it references those documents that provide guidance on wetland restoration and address recreation and public access. The ISP indicates that many of the land use and open space elements for the county and cities are outdated, and land use planning documents and programs often supersede the documents and programs of local jurisdictions with respect to planning, protection, and restoration of lands within the Estuary. The ISP reviewed versions of the respective plans including BCDC's San Francisco Bay Plan[4], the San Francisco Estuary Project's (SFEP) Comprehensive Conservation Management Plan (CCMP)[5],

[2] Life Science!, June 2003, *South Bay Salt Pond Restoration Project Initial Stewardship Plan*.

[3] EDAW, Et. al., December 2007, *South Bay Salt Pond FEIS/R*.

[4] San Francisco Bay Conservation and Development Commission, 1968, amended October 2006, *San Francisco Bay Plan.*

[5] San Francisco Estuary Project, 2007, *Comprehensive Conservation Management Plan*.

the Baylands Ecosystem Habitat Goals Report[6], the San Francisco Bay Joint Venture (SFBJV) Implementation Strategy[7], and the Bay Trail Plan[8] for their wetland restoration goals and objectives, some of which include support for recreational opportunities. The ISP was eventually integrated into and superseded by the programmatic planning process for the SBSP Restoration Project as a whole, which included a separate join NEPA/CEQA process and environmental document. This Final EIS/R was published in 2007 and included the program-level environmental impacts and mitigation measures as well as those for the Phase 1 project actions.

These early plans, as well as others that provide guidance on development of recreation and public access components in or near the SBSP Restoration Project's Eden Landing Phase 2 area are summarized in **Table G-2** and should be considered during implementation of recreation and public access features to ensure consistency and coordination between projects.

Table G-2. SBSP Restoration Project Public Access Plans and Projects Considered in ISP

RELATED PLANS	AGENCY IN CHARGE	PLAN ESSENCE AND RELEVANCE TO RECREATION
Baylands Ecosystem Habitat Goals Report (1999)	San Francisco Bay Area Wetlands Ecosystem Goals Project	The Report is a guide for restoring the Baylands and adjacent habitats of the San Francisco Estuary. It recommends the types, extent, and distribution of habitats needed to sustain healthy wetlands ecosystems in the South Bay and the assessment of opportunities and constraints for public access during the design phase of all restoration activities.
SFBJV Implementation Strategy (2001)	SFBJV	The Strategy builds on the science-based recommendations of the Goals Project and establishes acreage goals for wetlands restoration, including bay habitats, seasonal wetlands, and creeks and lakes. The Implementation Strategy recognizes the contribution of recreation activities at wetlands.
Public Access and Wildlife Compatibility Staff Report, 2008	BCDC	A study to review the effects on wildlife from recreation and public access with strategies for minimizing adverse impacts through siting, design and management of public access.
The Bay Trail Plan	Association of Bay Area Governments (ABAG)	The Plan proposes to develop 500 miles of regional hiking and bicycling trails around San Francisco Bay and San Pablo Bay that connect more than 90 parks and publicly accessible open spaces and future water trails. (Portions of the proposed Bay Trail shown near the Phase 2 area are shown as conceptual alignments to be analyzed prior to final design.)
Wildlife and Public Access Study Preliminary Findings	Bay Trail Project	Scientific investigation of the potential effects of recreational trails on shorebirds and waterfowl that use mudflat foraging habitat adjacent to San Francisco Bay.

Note: Please refer to the South Bay Salt Pond Restoration Project Recreation and Public Access Existing Conditions Report.

3.2.12 Accessibility Regulations

Access to project facilities by people of all abilities is subject to regulations and standards set forth by the United States Access Board (https://www.access-board.gov/). The United States Access Board is an independent federal agency that promotes equality for people with disabilities, and develops and maintains design criteria for the built environment. The United States Access Board has developed standards for facilities as part of the Americans with Disabilities Act (ADA), which ensures access to the built environment for people with disabilities.

[6] Monroe, M. et al, SFEI, 1997, *Baylands Ecosystem Habitat Goals Report*.
[7] San Francisco Bay Joint Venture (SFBJV), 2001, *Implementation Strategy*.
[8] Association of Bay Area Governments, 1999, *Bay Trail Plan*.

Americans with Disabilities Act

The United States Congress enacted the Americans with Disabilities Act (ADA) in 1990 to address discrimination against individuals with physical and mental disabilities. The ADA Standards establish design requirements for the construction and alteration of facilities subject to this law. These enforceable standards apply to places of public accommodation, commercial facilities, and state and local government facilities.

Title 24, California Building Code

The State of California has adopted a set of design regulations for accessible facilities that incorporate state mandates and federal ADA guidelines. These provisions are contained in the California Code of Regulations, Title 24, Part 2, California Building Code (CBC)[9]. CBC contains general building design and construction requirements relating to fire and life safety, structural safety, and access compliance. The 2016 CBC will become effective on January 1, 2017 and is updated every three years.

Relationship to Phase 2 Actions

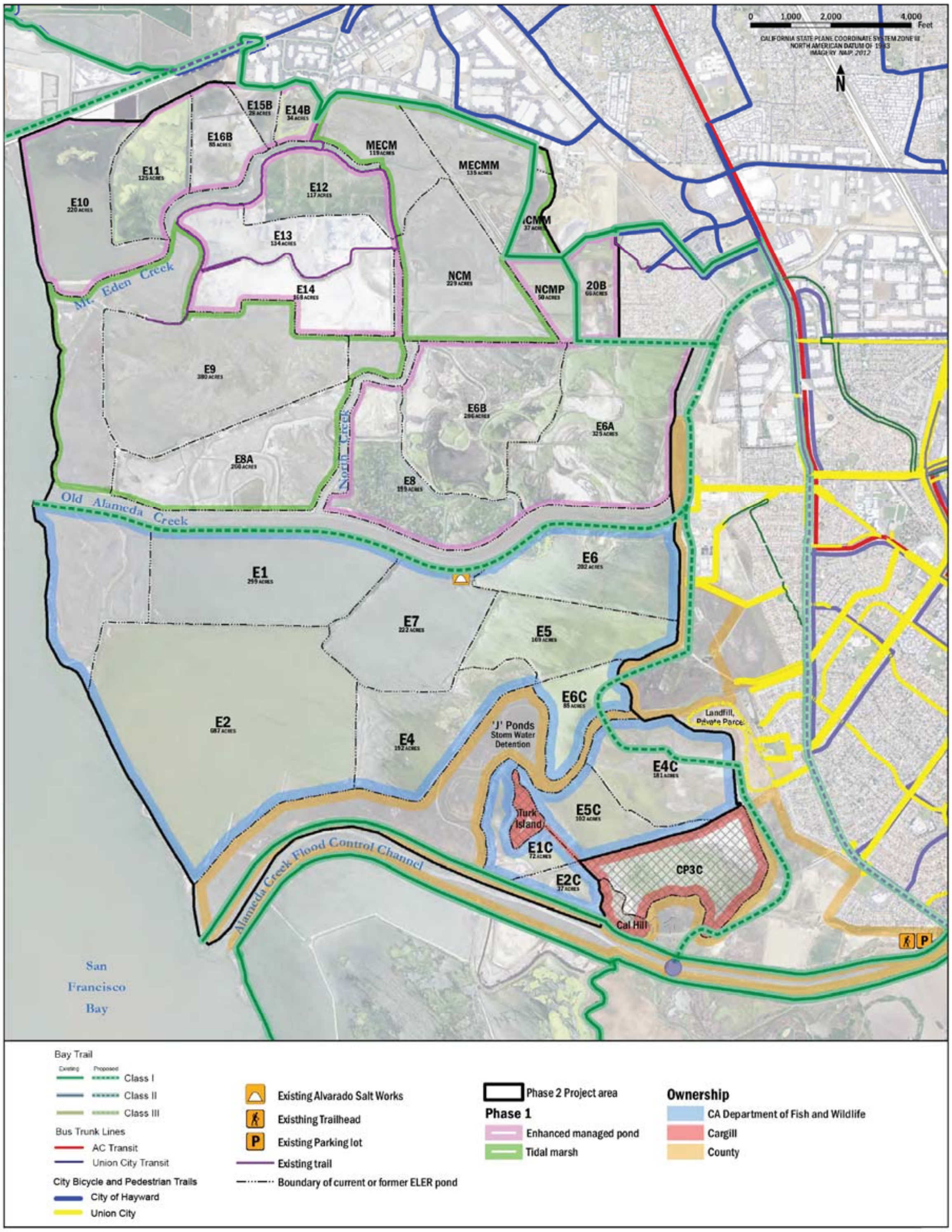
Recreation and public access facilities that are built as part of Phase 2 will need to comply with Title 24 and ADA accessibility regulations. This will be reviewed as part of permitting actions for project construction.

3.3 Existing Recreation and Public Access Facilities

The existing recreation and public access facilities in and near the Eden Landing Phase 2 ponds are shown on **Figure G-2**. Existing recreation and public access facilities in and near the project area (as well as facilities proposed by projects or general, master, or recreation plans other than the SBSP Restoration Project) are described in **Table G-3**. This list is not meant to be comprehensive or exhaustive of every public access opportunity or recreational resource, but it is intended to give a sense of the existing conditions regarding recreation and public access in the vicinity of Eden Landing.

[9] California Code of Regulations, Title 24 Part 2, July 2016.

Figure G-2. Recreation and Public Access in the Vicinity of the Phase 2 Area



AECOM South Bay Salt Pond Restoration Project
EDEN LANDING
Alameda County, CA

Table G-3. Existing Public Access and Recreation at or near Eden Landing

RECREATIONAL FEATURES	NEARBY LOCATIONS
Trails	▪ Phase 1 of the SBSP Restoration Project added year-round and seasonal trails inside of northern Eden Landing (a Bay Trail spur). ▪ The nearest segment of the Bay Trail on open space is in northern Eden Landing over a mile to the north of the Phase 2 project area. City streets used for Bay Trail access are approximately 0.5 mile to the east. ▪ The Alameda Creek Regional Trail is an EBRPD-managed pair of trails on both levees of the ACFCC, one of which is on the southern border of Eden Landing. ▪ The Coyote Hills Regional Park is to the south of the ACFCC and includes several trails.
Boating	Phase 1 of the SBSP Restoration Project added a launch for non-motorized boats (e.g., kayaks) along Mt. Eden Creek, which drains into San Francisco Bay from northern Eden Landing.
Access Points and Staging Areas	Northern Eden Landing ▪ The Phase 1 actions (trails and non-motorized boat launch in northern Eden Landing) are connected to the existing Bay Trail parking lot and staging area. Alameda Creek Regional Trail ▪ There is a parking area and a trail access point on the north side of the Alameda Creek Regional Trail east of the Phase 2 project area. This access includes equestrian staging. Eden Shores Access ▪ Bay Trail connector via Eden Shores neighborhood, Hayward
Historic Features	▪ Oliver Salt Works at the northwest end of Pond E13 ▪ Union City Salt Works at the northwest end of Pond E6
Waterfowl Hunting	CDFW allows limited waterfowl hunting, currently 10 annually specified days within the season, by issuing written permission at a hunter check station for certain portions of Eden Landing.
Dog Use	Dogs are allowed for retrieval use in hunting areas during waterfowl hunting season. Dogs are allowed on leash on the Alameda Creek Regional Trail. Dogs are precluded from certain sections of the Bay Trail, including areas within Eden Landing, per EBRPD regulations.
Equestrian Use	Horses are allowed on Alameda Creek Regional Trail.
Fishing	Fishing by boat is allowed in the Bay and sloughs and from shore in areas designated by CDFW.
Active Recreation	▪ Gordon E. Oliver Eden Shores Park, Hayward, located 1,000 feet east of a project proposed trail, has basketball, tennis, playfields, parking area and picnic facilities ▪ Sea Breeze Park, Union City, located 700 feet east of the project proposed Route 3 and 3,000 feet east of Routes1 and 2, has ball fields, play area, picnic facilities and parking area.

4. RECREATION AND PUBLIC ACCESS ALTERNATIVES

4.1 Overview

The 2007 Final EIS/R valuated potential recreation impacts of three long-term program-level alternatives. Programmatic Alternative A would be the No Action Alternative. Programmatic Alternative B would be a 50/50-percent mix of tidal marsh and enhanced managed ponds, which was named the Managed Pond Emphasis, and Programmatic Alternative C would be a 90 percent tidal marsh/10 percent managed pond mix called the Tidal Habitat Emphasis.

Some of the recreation and public access features identified in previous planning efforts are within or adjacent to the Phase 2 project areas, and certain features were identified as being interchangeable, depending upon managed pond or tidal emphasis, and adaptively managed during implementation. Descriptions of recreation and public access alternatives are contained in the Final 2007 EIS/R, Chapter 2, Description of Alternatives; Chapter 3.7, Recreation Resources; and the following 2007 EIS/R figures (**Figure G-3**):

Figure A-7. Programmatic EIS/R Alternative B: Managed Pond Emphasis, and

Figure A-8. Programmatic EIS/R Alternative C: Tidal Habitat Emphasis

Figure G-3. Phase 1 Programmatic Recreation and Public Access Alternatives

Figure A-7. Programmatic EIS/R Alternative B: Managed Pond Emphasis

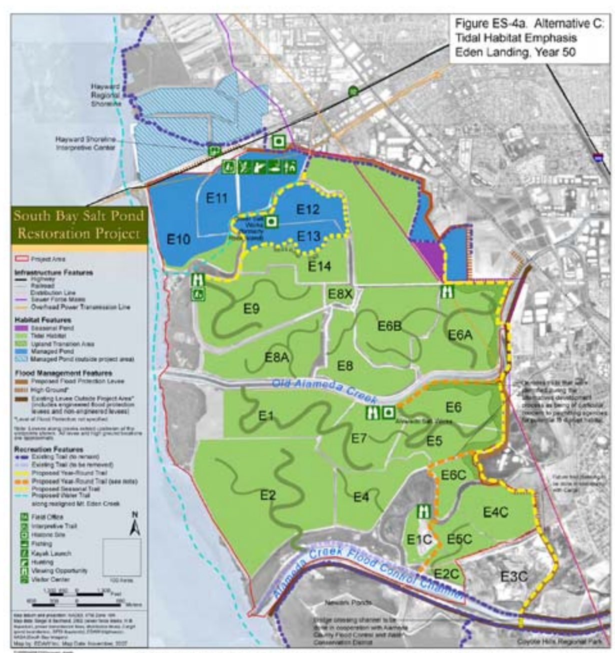


Figure A-8. Programmatic EIS/R Alternative C: Tidal Habitat Emphasis

The programmatic portion of the 2007 EIR/S contained descriptions of potential recreation and public access features within the Phase 2 project area at Eden Landing. Some of the trail segments identified in prior planning were of concern to regulatory agencies or stakeholders, and a notation was made on the figures for these segments: "Denotes trails that were identified during the alternatives development process as being of particular concern to permitting agencies for potential to disrupt habitat." This means that certain trails shown on the maps in the 2007 EIS/R might not be feasible to implement in consideration of the project's wildlife habitat-related goals.

4.2 Managed Pond Emphasis

Recreation and public access components. This alternative included continuation of the Bay Trail spine generally along the eastern edge of ELER, including a bridge over ACFCC. This alternative included two loop trail segments, at OAC (including a bridge) and south of Pond E4C. A neighborhood connector was included at Westport Way. Recreation facilities included three viewing platforms: at the northeastern edge of Pond E6A, at OAC and Pond E2C.

4.3 Tidal Habitat Emphasis

Recreation and public access components. This alternative included completion of the Bay Trail spine, generally along the eastern edge of ELER, including a bridge over ACFCC. One loop trail segment through the southern ponds, and a spur trail to the Alvarado Salt Works was proposed. Recreation facilities included three viewing platforms: at the northeastern edge of Pond E6A, at the Alvarado Salt Works, and overlooking the J-Ponds.

4.4 Programmatic Public Access Features Not in Phase 2

The programmatic portions of the 2007 EIS/R included the following recreation and public access features that were not included in Phase 1 and are not included in the current plans for the Phase 2 actions, although some of these features could be included, depending on final design:

- Wildlife viewing platform at the northwest corner of Pond E6A (in northern Eden Landing).
- Wildlife viewing platform within the Southern Ponds.
- Bay trail access connection to Union City in the vicinity of Westport Way (this is included as part of Route 3).
- Potential trail alignments along the north and west side of Pond E6C, rather than only on the south side.
- Bay Trail alignment along the east side of Pond E4C and Cargill CP3C (instead, one proposed alignment has shifted further west and wraps around the Southern Ponds; another stays east and terminates at Westport Way).

Note that the Action Alternatives under consideration for Phase 2 at Eden Landing include substitutes for many of these features that were not included in these alternatives. For example, there is a proposed wildlife viewing platform along the Alameda Creek Regional Trail adjacent to the Southern Ponds and not far from the location on the map of Programmatic Alternative C. Similar adjustment to the various portions of the Bay Trail spine through southern Eden Landing have been made to resemble the trail options shown in the 2007 EIS/R. Adjustments to portions of the Bay Trail spine through southern Eden Landing have been made to reflect restoration options and are equivalent to those shown in the 2007 EIS/R.

5. PHASE 2 EDEN LANDING RECREATION AND PUBLIC ACCESS ALTERNATIVES

5.1 Overview

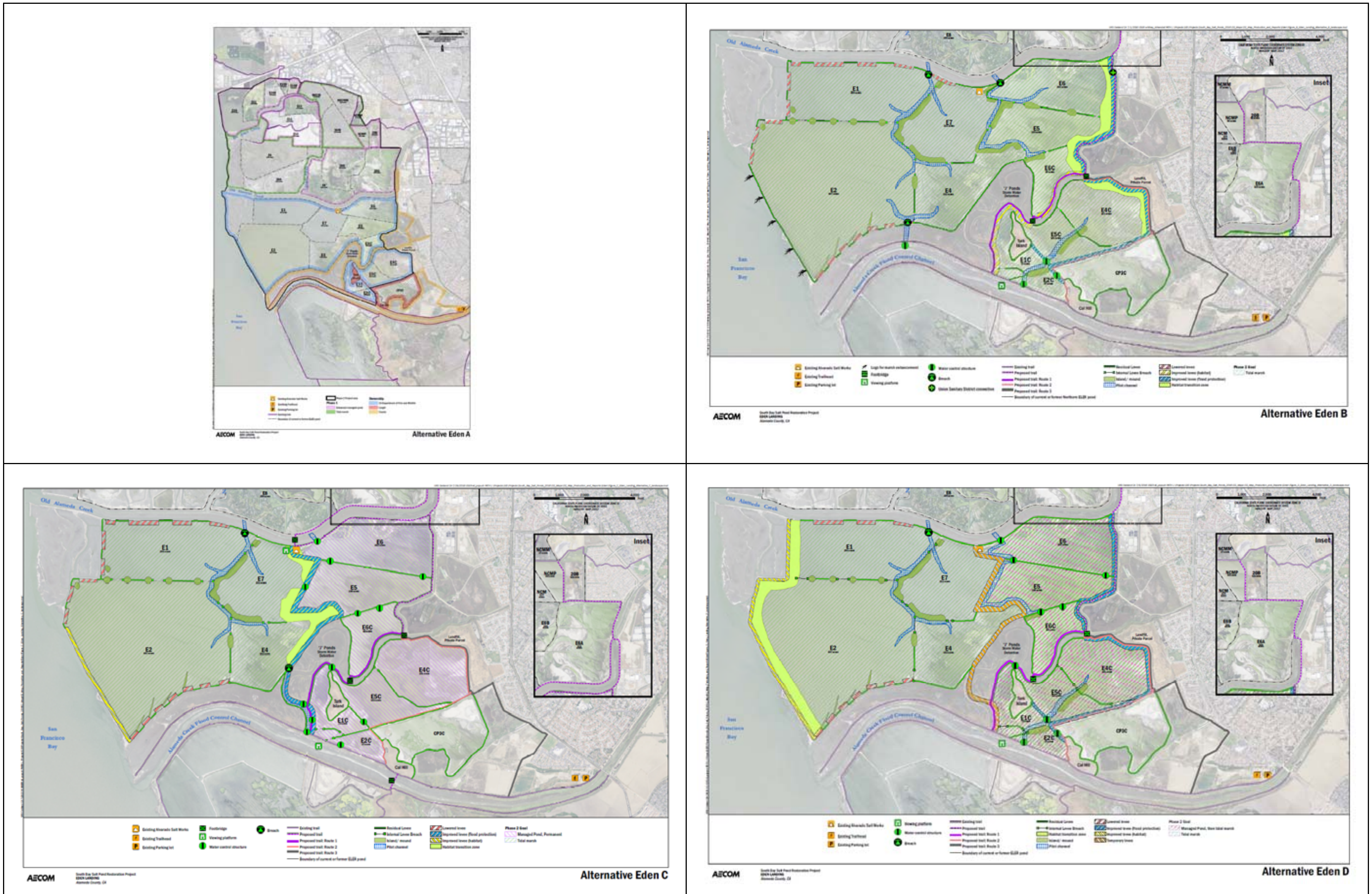
The Phase 2 project area at Eden Landing includes all eleven CDFW-owned ponds in the southern half of Eden Landing; the levees surrounding each pond; the fringing marsh outside of these levees; the ACFCWCD-owned storm water detention ponds and high marsh, portions of the OAC channel, the northern levee of the ACFCC, and some Cargill-owned levees bordering CDFW's ponds. Also, a Union Sanitary District outflow pipe and East Bay Discharge Authority (EBDA) treated wastewater force main immediately adjacent to the border of Eden Landing is also included in the project area, as well as connections to Alameda County Water District's (ACWD) Aquifer Reclamation Program (ARP) wells. Existing Pacific Gas and Electric (PG&E) power transmission and distribution lines are also included in the project area. Recreation and public access facilities are also evaluated that would be located on lands owned by ACFCWCD and Cargill, as well as construction access that would occur across land owned by Union Sanitary District, City of Union City, and Alameda County.

The Eden Landing Phase 2 Action Alternatives propose restoration, flood management, and recreation/ public access activities in the southern half of Eden Landing. Existing trails, trailheads, access points and viewing platforms in the surrounding areas that are not within the project area would remain unchanged; however, some existing trail facilities may be subject to temporary closure or relocation during project construction. The Action Alternatives focus on different restoration and flood risk management options: (1) restoring the entire area to predominantly tidal marsh; (2) restoring a mix of tidal marsh and managed ponds; and (3) a two-stage restoration that would restore the area to tidal marsh through an adaptive management process. Three recreation and public access route options are also evaluated within the context of the Action Alternatives. The proposed recreation and public access features would construct a segment of the Bay Trail spine through southern Eden Landing to close an existing gap in the Bay Trail. The recreation and public access features would provide access to existing parks and trails by adding two local connector trails, and would also provide interpretive amenities. The new recreation and public access facilities would provide access to CDFW lands that would not occur without the project. At a minimum, the Action Alternatives include construction of a Bay Trail spine segment to provide partial-to-complete closure of a gap in the Bay Trail. This trail is proposed along one of three routes being evaluated in the Action Alternatives. Additional spur trails could also be implemented, as shown in Alternative Eden C; these trails would not be considered the primary Bay Trail spine.

Two construction access points have been identified to accommodate site construction, via the Horner/Veasy Street access, and via Westport Way in the vicinity of Sea Breeze Park. The SBSP Restoration Project intends to coordinate with EBRPD, the City of Union City, and other adjacent landowners (including Union Sanitary District and ACFCWCD) regarding these access points as "community connections" that would provide ongoing public access connections through agreement with the underlying property owners. Although physical improvement of the access roads or trails for construction purposes (such as leveling, widening and/or surfacing) may be necessary, it is anticipated that physical improvements needed to convert this access for trail use would be minimal, such as surfacing, signage and entry gates.

The proposed recreation and public access features are shown in Chapter 2 – Alternatives of the Draft EIR/S and reproduced in **Figure G-4.**

Figure G-4. Eden Landing Phase 2 Alternatives



5.2 Alternative Eden A (No Action)

Under Alternative Eden A, no new public access or recreation features would be completed. Existing trails, the non-motorized boat launch, and other features in northern Eden Landing would be retained and managed by CDFW, as would the EBRPD's Alameda Creek Regional Trail along the north and south ACFCC levees. The latter of these would continue to be separately maintained by EBRPD. Seasonal hunting in portions of Eden Landing would continue. The existing Bay Trail spine would continue to have a gap between the current trail near the Eden Shores development (along the eastern edge of northern Eden Landing) and the Alameda Creek Regional Trail adjacent to ACFCC and Coyote Hills Regional Park.

5.3 Recreation and Public Access Components Included in all Action Alternatives

Each of the Action Alternatives includes extending the Bay Trail from the existing trail in northern Eden Landing near the Eden Shores development to the southeast corner of Pond E6C. The Bay Trail would extend approximately 16,000 feet from the junction of Pond NCMP and Pond 20B, south and east along the border of ELER, across the 20-tide gate structure in the OAC channel and on the ACFCWCD levee near Veasy Street and USD into southern ELER. It would then continue on CDFW levees to the southeast corner of Pond E6C. There would be no restoration, levee improvements or flood risk management measures implemented in the northern ponds associated with completion of this trail segment. Fencing, infrastructure or other improvements may be needed to protect ACFCWCD facilities, as discussed in Appendix G**.**

The existing levees in this portion of northern Eden Landing are at elevations 7 to 9 feet (North American Vertical Datum of 1988 or NAVD88) for interior levees, and 10 feet along OAC, with a crest width of 9 to 12 feet. The USD/ACFCWCD levee is at elevation 14 to 16 feet (NAVD88) with a surfaced width of 12 feet or more. Levees on the east side of Ponds E5 and E6 are at elevations 12 feet (NAVD88) and above, with a minimum crest width of at least 12 feet, and the east side of Pond E4C is at elevation 11 feet (NAVD88) with a surfaced width of 6 feet or less.

Trail Route Options. From this location, the trail would continue on one of three routes:

- Route 1: CDFW Property only; 7,400 linear feet; to be placed on existing or improved levees.
- Route 2: CDFW & Cargill Property (subject to sale, easement, or use agreement with CDFW or another cooperating partner); 10,500 linear feet; to be placed on the eastern and southern levees of the Southern Ponds, where they wrap around the CP3C and Cal Hill or provide access to Turk Island.
- Route 3: CDFW & Alameda County Property; approximately 5,200 linear feet; to be placed on the CDFW-owned levee on the eastern side of Pond E4C and then route onto County lands to the east onto existing sidewalks in Union City at Westport Way. The eastern portion of this trail would be located on 1,000 feet of existing 10 to 12 foot-wide access road to be improved for trail use, terminating at Westport Way, at approximate elevation 7 to 8 feet.
- Each of the Action Alternatives would include one new viewing platform on the Alameda Creek Regional Trail.

- Each of the Action Alternatives would include improvements to the project construction access roads at two locations to allow neighborhood access to the trail.

This section describes each of these route options within the context of the restoration and flood management alternatives being evaluated.

Route 3 Modifications. During the scoping process for the Phase 2 project at southern Eden Landing, an additional trail segment for Route 3 was under consideration. As discussed above, Route 3 includes a segment that connect from the bridge over the ACFCWCD channel, around Pond E4C, and then along the 1,000 feet of improved access road to Westport Way. From there, however, an additional trail segment would have turned south through County-owned lands located behind houses on Monterey Drive, and wrap around to Union City Boulevard. The trail would have used Union City Boulevard sidewalks for about 700 feet, and then ACFCWCD access roads (at elevation 9 feet [NAVD88], with a width of at least 8 to 10 feet) for about 3,000 feet until it connected with the Alameda Creek Regional Trail.

This route was identified as the preferred alignment in the Union City Bay Trail Feasibility Study, with the caveat that this segment could be one of the most challenging, with potential wetland/biological impacts, berm/fill geotechnical and structural issues, right of way ownership, and cost, including either extensive fill and retaining wall, or construction of a boardwalk behind Monterey Drive (estimated at 1.4 to 2.9 million in 2005 dollars). Due to the range of potential environmental issues and costs associated with this segment, Route 3 was subsequently shortened to terminate at Westport Way. The additional trail segment (south of Westport Way) would not be precluded if implemented as a future, separate project by local agencies, but would not be implemented as part of Phase 2 actions.

5.4 Alternative Eden B

Alternative Eden B focuses on restoring much of the Phase 2 area to tidal marsh. In this alternative, the existing levee along the eastern edge of the project area would be raised and improved, as would the levees along the northern and western edges of CP3C. Levees would also be improved for habitat separation purposes along the western edge of Pond E1C and the southern edge of Pond E6C. Trails south of OAC would be located on levees improved for habitat or flood risk management purposes, and would be constructed of sufficient width to comply with Bay Trail guidelines, with a minimum top width of 18 feet.

Recreation/Public Access Alternative Eden B, Route 1

Minimum trail width: 18 feet (south of OAC) **Trail elevation:** minimum 12 feet (south of OAC)

Route B1 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 7,400 feet southwesterly on the improved habitat levees, terminating at the Alameda Creek Regional Trail east of the J-ponds. One 300-foot long pedestrian bridge would be constructed crossing the J-ponds at the southwestern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along the Alameda Creek Regional Trail.

Anticipated shoreline views would be predominantly of tidal marsh, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

Recreation/Public Access Alternative Eden B, Route 2

Minimum trail width: 18 feet (south of OAC)   **Trail elevation:** minimum 12 feet (south of OAC)

Route B2 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 10,500 feet south and west along Pond E4C improved levee, west/south along CP3C levee and connect with the Alameda Creek Regional Trail on the west side of Cal Hill (owned by Cargill). One 250-foot long pedestrian bridge would be constructed crossing the J-ponds at the southeastern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Anticipated shoreline views would be predominantly of tidal marsh, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

Recreation/Public Access Alternative Eden B, Route 3

Minimum trail width: 8 to 10 feet (south of OAC)   **Trail elevation:** 7 to 8 feet

Route B3 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue south along Pond E4C improved levee, then east along an existing access road that terminates at Westport Way. No new Bay Trail facilities would be built south of Westport Way. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Anticipated shoreline views would include tidal marsh, managed lands, and landscaped urban areas, with water views expected at OAC and along the Alameda Creek Regional Trail.

5.5 Alternative Eden C

Alternative Eden C focuses on a combination of tidal marsh and permanently managed ponds. This would be accomplished by constructing a mid-complex levee bisecting the project area, with a habitat separation levee along a portion of the existing Bay shoreline. Trails would be located on existing and unimproved levees at current widths and elevations, except for a 1,000-foot long section west of Pond E1C. Where the trail is located adjacent to managed ponds or other habitat areas, operations and maintenance (O&M) agreements would be used to permit routine maintenance (J. Krause, pers. comm. 2016), however, the ability to provide maintenance and reconstruction may be constrained in the future due to potential wildlife or habitat disruption.

Alternative Eden C includes several features for improved recreation and public access; these would be completed in addition to any of the Alternative Eden C trail route options:

- A 600-foot long bridge over ACFCC near Pond E2C to connect with the existing Bay Trail that continues to the south. This bridge would be high enough in the center to allow periodic channel dredging as well as high enough over its entire length to allow 100-year floods to pass beneath the bridge. The bridge would be intended to be accessible to pedestrians and bicycles and not necessarily by maintenance vehicles.

- A new Bay Trail spur trail to the former site of the Alvarado Salt Works. This spur trail would run along the northern edge of Pond E6 to a viewing platform and interpretive feature that would be included there to explain the history and the remnant structures there. The mid-complex levee would be built to the west of the former salt works site so that its degradation would not be accelerated. From this point, a 500-foot long bridge would cross over the OAC channel, and a parallel trail would run eastward, back to the Bay Trail spine, along the southern levees of Pond A8 and E6A to form a loop. The total length of this trail loop is approximately 13,500 feet.

Recreation/Public Access Alternative Eden C, Route 1

Minimum trail width: 8 feet (south of OAC) **Trail elevation:** minimum 8 to 9 feet

In addition to the recreation features described above, Route C1 includes continuation of the Bay Trail from its current trail within the Phase 1 area on CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 7,400 feet southwesterly on an existing levee, terminating at the Alameda Creek Regional Trail east of the J-ponds. One 300-foot long pedestrian bridge would be constructed crossing the J-ponds at the southwestern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Trail improvements would include clearing, grading, and/or surfacing the existing levee surface as needed to be appropriate for trail use, but no levee reconstruction, widening or raising for the trail elevation would be completed, except for a 1,000-foot long section to be located on the improved levee west of Pond E1C. This route would be protected from flooding and sea-level rise impacts by the improved levee further west.

In some areas, the trail would be located on unimproved levees that may deteriorate over time, necessitating maintenance such as topping or reconstruction to provide usable trail width and elevation.

Anticipated shoreline views would be predominantly of managed ponds and the improved levee, with water views expected on the 1,000-foot long segment of improved levee, at OAC and at the Alameda Creek Regional Trail terminus.

Recreation/Public Access Alternative Eden C, Route 2

Minimum trail width: 8 to 10 feet (south of OAC) **Trail elevation:** minimum 8 to 9 feet

In addition to the recreation features described above, Route C2 includes continuation of the Bay Trail from its current trail within the Phase 1 area on CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 10,500 feet south and west along Pond E4C existing levee, west/south along the existing CP3C levee and connect with the Alameda Creek Regional Trail on the west side of Cal Hill (owned by Cargill). One 250-foot long pedestrian bridge would be constructed crossing the J-ponds at the southeastern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Trail improvements would include clearing, grading, and/or surfacing the existing levee surface as needed to be appropriate for trail use, but no levee reconstruction, widening or raising for the trail elevation would be completed. This route would be protected from flooding and sea-level rise impacts by the improved levee further west.

In some areas, the trail would be located on unimproved levees that may deteriorate over time, necessitating maintenance such as topping or reconstruction to provide usable trail width and elevation.

Anticipated shoreline views would be predominantly of managed ponds, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

Recreation/Public Access Alternative Eden C, Route 3

Minimum trail width: 8 to 10 feet (south of OAC) **Trail elevation:** 7 to 8 feet

In addition to the recreation features described above, Route C3 includes continuation of the Bay Trail from its current trail within the Phase 1 area on CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue south along Pond E4C improved levee, then east along an existing access road that terminates at Westport Way. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail. This option would also include the bridge across ACFCC.

Trail improvements would include clearing, grading, and/or surfacing the existing land surface as needed to be appropriate for trail use, but no levee widening or raising for the trail would be completed. This route would be protected from flooding and sea-level rise impacts by the improved levee further west.

Anticipated shoreline views would include managed ponds, lands and landscaped urban areas, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

5.6 Alternative Eden D

Alternative Eden D provides a two-stage approach to tidal restoration, to be accomplished by constructing an improved habitat levee at the existing Bay shoreline, as well as a temporary levee bisecting the project area. In this alternative, the Inland and Southern Ponds are intended to eventually become salt marsh subject to tidal action but may be retained as managed ponds, if ongoing Adaptive Management Plan (AMP) monitoring of pond-associated wildlife shows that it is necessary. A new habitat levee and habitat transition zone would be built at the existing Bay shoreline, but the existing levees that currently provide access to the western side of Eden Landing would be breached, and no public access or recreation facilities would be provided in that area.

Recreation/Public Access Alternative Eden D, Route 1

Minimum trail width: 8 feet (south of OAC) **Trail elevation:** minimum 8 to 9 feet

Route D1 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 7,400 feet southwesterly on an existing levee, terminating at the Alameda Creek Regional Trail east of the J-ponds. One 300-foot long pedestrian bridge would be constructed crossing the J-ponds at the southwestern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Trail improvements would include clearing, grading, and/or surfacing the existing land surface as needed to be appropriate for trail use, but no levee reconstruction, widening or raising for the trail elevation would be completed.

In some areas, the trail would be located on unimproved levees that may deteriorate over time, necessitating maintenance such as topping or reconstruction to provide usable trail width and elevation.

Anticipated shoreline views would include managed ponds transitioning to tidal marsh, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

If Alternative Eden D1 is selected for implementation, it is likely that portions of the route along the existing J-ponds and E6C levees will eventually be lost due to settlement, deterioration and sea-level rise. The portion of the trail that is located on the temporary levee could be retained as a spur trail (this portion of the levee would need to be retained), and/or improvements considered to create a loop trail through Turk Island and along the improved levee along E1C.

Recreation/Public Access Alternative Eden D, Route 2

Minimum trail width: 18 feet (south of OAC) **Trail elevation:** minimum 12 feet

Route D2 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue an additional 10,500 feet south and west along Pond E4C improved levee, west/south along CP3C levee (owned by Cargill) and connect with the Alameda Creek Regional Trail on the west side of Cal Hill (Cargill). These levees would be improved for flood risk management. One 250 foot long pedestrian bridge would be constructed crossing the J-ponds at the southeastern tip of Pond E6C. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Anticipated shoreline views would be predominantly of managed ponds, transitioning to tidal marsh, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

Recreation/Public Access Alternative Eden D, Route 3

Minimum trail width: 8 to 10 feet (south of OAC) **Trail elevation:** 7 to 8 feet

Route D3 includes continuation of the Bay Trail from its current trail within the Phase 1 area on existing CDFW and Alameda County facilities 16,000 feet to the southeast corner of Pond E6C.

From there, it would continue south along Pond E4C improved levee, then east along an existing access road that terminates at Westport Way. One viewing platform with interpretive exhibits would be constructed along Alameda Creek Regional Trail.

Anticipated shoreline views would include managed lands transitioning to tidal marsh, and landscaped urban areas, with water views expected at OAC and at the Alameda Creek Regional Trail terminus.

5.7 Other Recreation Features Considered in Phase 2

Other recreation and public access features were included in the Phase 1 and programmatic analyses, and are also considered some of the Phase 2 alternatives:

- Alternative C, described above, includes a 600-foot bridge over the ACFCC at the Alameda Creek Regional Trail to connect with the Bay Trail within Coyote Hills Regional Park. This bridge is not now included in all of the route options, but potentially could be included in any of the implementation scenarios, as it would be located on an existing improved levee with no restoration or flood risk management actions that would preclude implementation.

- The loop/Bay Trail spur to Alvarado Salt Works would not be feasible under Alternative B due to the proposed levee breaches and reconfiguration, but could be implemented as a trail spur. This loop could be completed as part of Alternatives Eden C or Eden D, but no levee improvements on either side of OAC are proposed in those alternatives.

- Community Connector to allow neighborhood access from Union City to the Bay Trail would be completed as part of the project and all of the Route options.

5.8 Consistency with Public Access Policies

Table G-4 outlines the Action Alternatives for consistency with recreation and public access policies of the three primary reviewing agencies with public access policies applicable to the project: BCDC, ABAG's Bay Trail, and EBRPD. In this table, the different route options are evaluated against those policies and evaluated as being consistent (Y), not being consistent (N), or whether the policy or standard does not apply (N/A). The asterisks with the "N" conclusions refer to further explanations in the notes below the table.

Table G-4. Phase 2 Consistency with BCDC, Bay Trail and EBRPD Recreation and Public Access Policies

POLICY		TRAIL ROUTE OPTIONS								
	EDEN A	EDEN B			EDEN C			EDEN D		
	--	1	2	3	1	2	3	1	2	3
BCDC										
1. Maximum feasible public access	N	Y*	Y*	N*	Y	Y	N	Y*	Y*	N*
2. Maximum feasible access to waterfront, except where inconsistent with public safety or significant use conflicts	N	Y*	Y*	N*	Y	Y	N	Y*	Y*	N*
3. Provide public access to natural areas and consult with agencies for appropriate location and type of access	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
4. Site, design and manage access to prevent significant adverse effects on wildlife	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y
5. Site, design and manage access to avoid significant adverse impacts from sea-level rise ***	N/A	Y	Y	Y	Y	Y	Y	N	Y	Y
6. Permanently guarantee public access and make viable in event of sea-level rise or provide equivalent access	N	Y	Y	N**	Y	Y	N**	N	Y	N**
7. Public access should be consistent with environment, encourage diverse Bay-related activities, be barrier-free, and maintained	N	Y	Y	N**	Y	Y	N**	Y	Y	N**
8. Fill may be allowed if necessary for	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y

POLICY	TRAIL ROUTE OPTIONS									
	EDEN A	EDEN B			EDEN C			EDEN D		
	--	1	2	3	1	2	3	1	2	3
public access in some areas										
9. Access to and along the waterfront should be provided and connect to the nearest public thoroughfare. Provide diverse and interesting public access experiences	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
10. Roads near water edge should be scenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11. Cooperate to provide appropriate regional trail system, such as Bay Trail	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y
12. Use Public Access Design Guidelines in project review	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y
13. Integrate public access early in restoration projects	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y
14. Support scientific study on public access effects on wildlife	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y
ABAG Bay Trail										
1. Locate the Bay Trail as close to the Bay shoreline as feasible	N/A	Y	N	N	N	N	N	N	N	N
2. Create a Bay Trail that provides views of the Bay and/or a "Bay" experience	N	Y	N	N	N	N	N	N	N	N
3. Design a Bay Trail that is physically separated from streets and roadways in order to provide a safe trail experience for users.	N	Y	Y	N	Y	Y	N	Y	Y	N
4. Align the Bay Trail to provide usable and logical connections with shoreline parks	N/A	N*	N*	N*	Y	Y	Y	N*	N*	N*
EBRPD										
PRPT9. Connect regional trails to parks, shorelines and other areas of regional significance	N	N*	N*	N*	Y	Y	Y	N*	N*	N*
PRPT 10. Create local trail networks that provide additional access points to regional parks and trails	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
PRPT11. Cooperate with other agencies to implement multi-jurisdictional efforts.	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y

Y = Yes; N = No; N/A = Not Applicable

* This option does not include shoreline access via an ACFCC bridge, but does not preclude future implementation by another entity. Shoreline access would be precluded along OAC in Alternatives B and D due to levee breaching.

** This option includes public access on lands that are not owned by the Project Lead Agency. While no agreement between such a project proponent and respective landowners currently exists for permanent trail implementation, this project does not preclude the possibility of such a project from being developed and implemented.

*** This consistency analysis focuses on Phase 2 action alternatives. Levee improvements to existing levees in northern Eden Landing may also be needed to address sea-level rise as part of the common trail improvements proposed for all trail route options.

Consistency with recreation and public access goals and policies, especially as they relate to the provision of shoreline or waterfront access, may vary depending on the habitat or flood risk management alternative ultimately selected. Many of these policies include considerations for implementation feasibility, avoiding adverse impacts on wildlife, the selection of appropriate locations for public access features, or other constraints. Selection of recreation and public access features must be balanced with other project goals, and an alternative could be consistent with these policies even while not providing every public access feature shown in previous project documents and would not prevent implementation in future phases. In addition, trail route options on lands that are not part of the Reserve may be precluded if permanent access agreements or easements are not obtained, in which case, an alternate alignment would need to be provided in order to fully meet Project and regulatory goals and policies for recreation and public access, including completion of the Bay Trail spine.

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6. PROJECTED TRAIL USE

The purpose of this section is to provide an estimate of the expected usage of the proposed project trail system and recreational facilities within and immediately adjacent to the Phase 2 ELER. The trail segment options proposed for Phase 2 include implementation of a segment of the Bay Trail spine with one alternative also containing a recreational spur trail and providing a bridge over ACFCC, to link the trail network in Eden Landing to the Bay Trail spine south of the ACFCC. The Bay Trail and associated recreational amenities would serve several purposes, as they would provide a non-motorized transportation connection from one neighborhood location to another in the Hayward-Union City area, and would also provide additional access to facilities for hiking and exercise, wildlife viewing, and other activities within ELER.

Based on a trail user satisfaction survey completed for the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) to the south of ELER (Sokale and Trulio 2013), recreational trail users who would be expected to use the ELER trails are likely to be primarily local (live within 5 to 10 miles of the trail), and may drive or bicycle to the trailhead parking from where they live. In addition, a small but significant percentage of the potential recreational facility users would work in the immediate area and would likely use the trail system during work hours, such as lunch time or after work walks.

The Sokale and Trulio 2013 trail user satisfaction survey found slightly higher trail use during weekends than during week days, and slightly higher trail use during the late spring, summer, and early fall months when weather is good, rather than during the late fall and winter months when weather is more likely to be cool or wet. The trail user survey also found that trail user priorities included keeping the trail clean and well maintained with good signage and facilities such as parking, restrooms, and benches. The 568 visitors who completed surveys were less interested in historical and natural history interpretive signs and panels, and overlooks than in facilities for active hiking.

Some Refuge trail use information applicable to the Phase 2 actions at Eden Landing is also reported in the Sokale and Trulio trail user satisfaction survey, which allows for extrapolation and a rough approximation of the number of new trail users expected as a result of the ELER project public use improvements. Between 750,000 and 900,000 people were estimated to have visited the Refuge annually between 2009 and 2011, and a majority of these visitors used the 30 miles of trails within the 30,000-acre Refuge, especially the trail system near the Visitor Center and Environmental Education Center (EEC) parking areas (Sokale and Trulio 2013). This equates to approximately 25 to 30 visitors annually per acre of Refuge, or about 25,000 to 30,000 visitors annually per mile of trail. This information does not consider that a disproportionate amount of trail use likely occurs in the 1 or 2 miles of trail immediately surrounding the main visitor center in Fremont and the EEC in Alviso, but, along with other sources of information, provides a rough guide that can be used to gauge Phase 2 ELER trail use.

Important points to make in comparing the Refuge with the ELER is that the Refuge is considerably larger, has more miles of trails, and has a Visitors Center with exhibits and interpretive information, while no visitor center is proposed at Eden Landing. However, ELER does provide facilities such as a kayak launch platform, while a comparable facility is not provided at the Refuge. There is a small boat launch at the Alviso Marina, very near the Refuge’s EEC, however.

In addition, as noted earlier, the Phase 2 trails within ELER will be part of the Bay Trail and available for both recreational uses and commuter bicycle use, although without the ACFCC bicycle/pedestrian bridge, the link between adjacent areas is not as direct and is more circuitous than on-street bicycle/pedestrian travel routes between Hayward and Union City.

For general discussion purposes, if trail users at Don Edwards are computed on a per mile of use intensity and spread out equally each day throughout the year, there would be a daily use of about 68 to 82 people per day per mile of trail. Each of the three Bay Trail spine routes being considered has different amounts of trail that would be completed. Consistent with the ELER project construction cost estimate, this analysis used 10,000 linear feet or about 2 miles of trail. Based simply on extrapolating trail mileage, this equates to about 136 to 164 recreational trail users per day. Considering that recreational trail use would be more concentrated during the better-weather months of the year, with slightly more trail use on weekends, daily recreational trail use is likely to be in the range of 150 to 250 people per day during periods of highest use, with average daily use throughout the year in the range of 100 to 125. Annual recreational trail use would be in the range of 36,500 to 40,000 users.

Another way of extrapolating the Refuge trail use estimates and applying them to Eden Landing is based on facility size. The total area of the Refuge is about 12 times larger than ELER. At a use rate of 25 to 30 persons per acre per year, the annual usage at Eden Landing would be in the range of 62,500 to 75,000.

Actual trail count data are available from EBRPD for the Phase 1 project at northern Eden Landing (S. Dougan, EBRPD, email with trail database attachment, Sept. 2013). This traffic count data was obtained using a TRAFx automated trail traffic counter system, with the sensor/counter embedded under the trail surface (www.trafx.net). Trail count data for a portion of the Bay Trail located near the Gordon E. Oliver Eden Shores Park in Hayward, in the southeast corner of the Phase 1 area, indicated average daily use of about 19 trail users (2012 data). Recorded monthly trail use at this location ranges from 252 to 2195, with average daily use of 19 trail users (2012 data). Trail use is much higher near the Phase 1 parking lot, located near the intersection of Eden Landing Road and Arden Road, with monthly totals ranging from 1460 to over 2,000 and averaging 126 users per day (2012 data). Trail use was slightly higher on weekdays than on weekends, and with the highest use periods in the spring and early fall months. The majority of use was between 10 AM and 2 PM, but some use extended until after 7 PM during the spring and summer months.

Importantly, these counts were done before the completion of the Phase 1 actions at Eden Landing, and use of those Phase 1 amenities (the spur trail to the viewing platform, the seasonal loop trail, the interpretive features, and the kayak launch). Anecdotally, usage of and visitation to northern Eden Landing has increased since these features were opened to the public, but no new quantitative data is available.

Trail count data available from EBRPD for recreational trails at Hayward Marsh show average daily uses in the range of 150 to 200 (2012 & 2013 count data) , at Hayward Landing in the range of 120 to 150 (2012 & 2013 data) and at the San Lorenzo Trail Bridge of 145 to 160 users per day (2012 & 2013 data).

Based on a review of all of the above information, it is reasonable to expect between 100 and 150 recreational trail users per day.

In addition to a recreational trail use component, the Bay Trail through ELER will also provide a transportation component, as an alternative and more pleasant mode of transportation between two neighborhoods, or a travel destination. This use also needs to be accounted for in the overall Trail Use Estimate.

ACTC has been conducting bicycle and pedestrian counts along major streets for all of the cities and major unincorporated areas in the County since 2002. Although not trail systems, counts conducted along Thornton Avenue and Willow Street in Newark indicate daily travel by bicycle and pedestrians of about 25 people per day. More heavily used bikeways such as Paseo Padre and Mowry Ave in Fremont have counts of about 219 per day and for Decoto Road near Alvarado Niles Road, 107 bicycler users in 2010.

Expected use of this segment of the Bay Trail by bicyclists can also be estimated using US Census and demographic information on bicyclists and residential population estimates with 0.5 to 1.5 miles of a proposed bicycle route, based on a method developed by the National Highway Research Program. This method, (which provides low-range, mid-range and high-range estimates) was 31,057 per year, or 85 per day for the mid-range estimate.

Based on reviewing all of the above, an estimated 50 to 100 bicyclists may use the Bay Trail as a transportation route between Hayward and Union City on a daily basis, with slightly more on weekends. Added to the recreational trail use estimate of 100 to 150 users per day, this would put total daily usage of the new facilities at Eden Landing in the range of 150 to 250 daily users.

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7. RECREATION AND PUBLIC ACCESS DESIGN GUIDELINES

This section provides guidance regarding the physical design of recreation and public access features, such as trails, viewing platforms, signage, and site furnishings. This section also identifies construction protocols that will be implemented as part of the project to minimize disturbance to adjacent areas and avoid disruption of sensitive species during construction. Trail design issues include:

- Design strategies to comply with BCDC public access policies
- Accessibility
- San Francisco Bay Trail Design Guidelines and Toolkit
- Community Connectors
- ACFCWCD Facilities
- Recreation and Public Access Facilities

Where feasible, all recreation and public access facilities must be designed to be accessible. In addition, BCDC policy requires that public access facilities be designed to be viable in the event of future sea level rise or flooding, or equivalent access consistent with the project should be provided nearby.

7.1 Design Strategies to Comply With BCDC Public Access Policies

BCDC review of public access facilities will likely focus on three areas: design to maximize shoreline access, resilient design of public access facilities, and design to minimize wildlife conflicts.

Design to Maximize Shoreline Access

Phase 2 actions would essentially move the Bay shoreline to the east, eventually replace some or all managed ponds with tidal marsh. Point access to the shoreline will continue to be provided in all alternatives via the Alameda Creek Regional Trail, as well as the trail spur that was added as part of Phase 1.

Design Strategies to Address Sea Level Rise for Public Access Facilities

For this project, which is likely to be affected by future sea level rise and storm activity during the life of the project, BCDC requires that public access facilities:

- Be set back far enough from the shoreline to avoid flooding;
- Be elevated above expected flood levels;
- Be designed to tolerate flooding; or
- Employ other means of addressing flood risks.

Trails on Improved Flood Risk Management or Habitat Levees. As described in the Alternatives Figure 4.2 of the Phase 2 Design Memorandum, proposed levees to provide flood risk management or habitat enhancement are to be a minimum elevation of 12 feet NAVD88 with a 12-foot crest width, with 4:1 side slopes. If these improved levees also have trail improvements, the crest width at this elevation should be at least 24 feet to accommodate a twelve-foot trail at year 2100, this would allow sufficient width for topping to raise the trail elevation in the future with sufficient width. This may require steeper side slopes, use of retaining walls, rails or other features in the future to ensure trail user safety (**Figure G-5**).

Figure G-5. Typical Improved Trail Section

Design:

- Top elevation: Raised levees will have a minimum crest elevation of 12 feet NAVD88.
- Top width: Raised levees will have a minimum crest width of 12 feet.
- Side slope: The improved levees will have side slopes of 4:1 (H:V).

A typical cross-section of the proposed levee raising is shown in Figure 4.2.

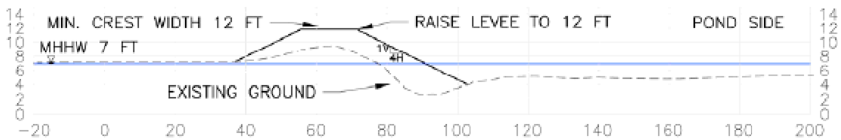


Figure 4.2. Proposed Levee Raising – Typical Section

Trails on Existing Pond Levees. The existing pond levees are generally underlain by former tidal marsh and were created beginning in the early 1900’s by dredging and placing Bay Mud soils on the drained and diked lands to create the berms to prevent tidal waters from entering the salt production areas, and are generally at an elevation of 8 to 10 feet[10], though many of the levees around the external border of the pond complex are higher (in the range of 11 to 12 feet elevation). Portions of the proposed trail extension in northern Eden Landing, Trail Route Option D1, and the OAC levee loop trail would be located on such pond levees. (Trail Route Option C1 would also be located on an unimproved levee, but would be protected by a habitat levee further west). If design resilience is a project design goal, trail segments that are subject to flood influence and sea level rise would need to be built at a minimum elevation of 12 feet and/or designed to accommodate future overtopping. The trail would need to have the following width at construction to allow a 12-foot wide trail during the facility’s design life (2050), assuming 2:1 side slopes that are geotechnically stable, as shown in **Table G-5**.

Table G-5. Adaptive Management Trail Construction Width

EXISTING LEVEE ELEVATION (FEET NAVD88)	LEVEE ELEVATION YEAR 2050 (FEET NAVD88)	TRAIL CONSTRUCTION WIDTH (FEET)	YEAR 2050 TRAIL WIDTH (FEET)
8	12	28	12
9	12	24	12
10	12	20	12
11	12	16	12
12	12	12	12

If the trail is intended to meet the 18-foot wide Bay Trail guidelines (Option D2), or if 3:1 or 4:1 side slopes are implemented, then additional width should initially be reserved for future remedial actions. For example, in Option D1, some berms are currently a maximum of 10-12 ft. wide at elevation 7- 8, so a future trail could not be accommodated within the current berm footprint, and adjacent habitat would preclude future adaptive actions.

[10] SBSP Levee Assessment, Geomatrix 2005.

Consideration should be given to locating the Bay Trail spine and other public access features on improved levees (such as in Alternative Eden B, or on the flood risk management levee in Alternative Eden C) to avoid the temporal width and elevation challenges described herein.

Geotechnical issues related to the placement of public access facilities on these unimproved levee berms is discussed in Section 3.2 – Hydrology and Section 3.4 – Geology and Soils.

Design to Minimize Wildlife Conflicts

An important component of providing public access near sensitive wildlife areas is to limit the potential impact of human intrusion and trespass into sensitive areas. The selection of public access alternatives to be considered as part of project evaluation has included extensive input from regulatory agencies as well as site-specific studies. All proposed trails are located on existing levees, and several project alternatives include the creation of habitat transition zones to increase habitat diversity, but these features would also provide a buffer between trails and areas that may become habitat to sensitive species in the future.

A study conducted in 2014 to determine the effects of human disturbance on waterbird nesting at SBSP Pond SF2 concluded there was no pattern of disturbance associated with public access facilities, including trails, viewing platforms, restrooms, and interpretive elements, which are all located at least 300 feet from nesting habitat features.

In 2013, the SBSP Restoration Project sponsored an experimental study of shorebird response near trails. Recommendations from that study that could be applied to project design include:

- Locate trails 150 feet from foraging habitat where feasible.
- Incorporate wide borrow ditches in the restored areas to provide a buffer between levees.
- Place trails in areas of high human demand, rather than areas with infrequent use.
- Provide consolidated areas without trails.
- Increase the quantity and quality of forage in restoration areas that are not near trails.

A similar study conducted in 2012 focused on human disturbance in proximity to nesting western snowy plover habitat, and concluded that flushing was seven times higher than background flushing; however, the consequences of this flushing were unknown. Other conclusions were that locating trails 500 feet from nesting habitat reduced flushing to background levels, and that bird response could vary depending on whether the trails were new or existing trails.

The Phase 2 Action Alternatives were developed with a focus on flood risk management and habitat enhancement. Of the more than 2,000 acres at southern Eden Landing site, recreation and public access features range from 7 to 10.8 acres (if all options shown in Alternative C are implemented)[11]. This represents less than one-half of one percent of the Phase 2 area, and less if recreation and public access improvements are built on the off-site route options. Additionally, several public access features shown in the 2007 EIS/R were eliminated, which would further reduce potential wildlife impacts due to human use.

[11] Eden Landing Phase 2 Preliminary Design Memorandum, August 2016.

7.2 Accessibility

To meet the Federal Accessibility criteria, trails must provide a firm and stable surface, with sufficient width, gradient and vertical clearance for unobstructed passage. Trails that connect facilities such as parking areas, restrooms, and viewing platforms are considered “Outdoor Recreation Access Routes”, with a minimum 48-inch clearance width with additional passage (60-inch minimum width at 200 foot intervals) in California. A minimum of 60 inches unobstructed tread width is typical for public access facilities to meet accessibility. The trail section must have a firm and stable surface with no gaps or obstructions of more than one-half inch. Typical trail surfaces may include concrete, asphalt, or compacted aggregate to meet accessibility requirements.

The trail must have maximum cross slope of 2 percent and 5 percent longitudinal grade. Short ramps are allowed for up to 30-inch rise to accommodate grade transitions. Since the site is relatively flat, all trails should be built in compliance with accessibility guidelines without design exceptions.

Site furnishings such as benches, viewing scopes, and interpretive panels must be designed and oriented to avoid creating an obstacle and to facilitate the intended use.

Recommendations

New trail segments that are to be considered part of the Bay Trail should be designed (where feasible) in compliance with Bay Trail Guidelines. These guidelines were substantially updated with the new version released in June 2016. (www.baytrail.org/pdfs/BayTrailDTK_082616_web.pdf)

The trail should be surfaced with a durable material that complies with universal access needs. Paving designs should be selected that provide permeability, where appropriate, and that fit with the shoreline setting. In some locations, it will be appropriate to remain as “natural” as feasible, using permeable materials and construction methods. Trails in segments that will be routinely utilized by motorized vehicles for access and maintenance should be paved.

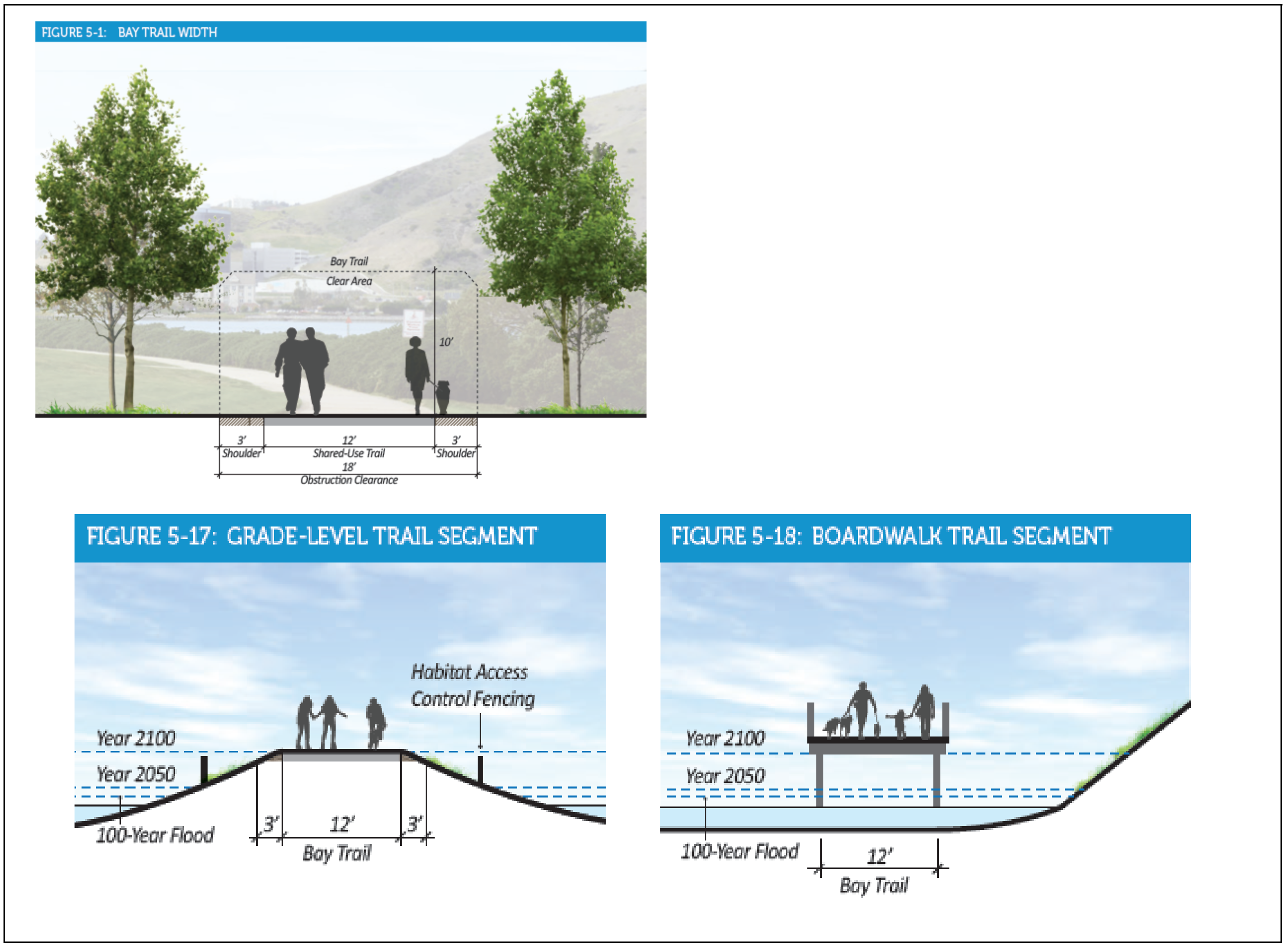
The trail should generally be elevated slightly above the adjacent grade to allow construction of a uniform trail surface without obstacles. During the design of each trail segment, the design of facilities should consider levee slope stability, erosion potential, and pathway drainage. In general, trails on levee segments should be crowned to minimize erosion risk.

7.3 Bay Trail Design Guidelines

Consistency with the Bay Trail Plan design guidelines will be needed for segments that are incorporated into this regional trail system. Guidelines adopted in June 2016 for the Bay Trail emphasize that *“Bay Trail users should be able to enjoy a Bay experience.”* and recommend a minimum 18-foot wide trail commitment consisting of a 12-foot wide trail surface with three-foot shoulders (wider in high use areas). Due to the length and lack of community trail connections, this width should be sufficient. The guidelines further recommend that the elevation of the Bay Trail should be elevated to accommodate future sea level rise.[12] See **Figure 5-6** for examples.

[12] Bay Trail Design Guidelines and Toolkit, 2016

Figure G-6. Bay Trail Guidelines (source: Bay Trail Design Guidelines and Toolkit, 2016)



The Bay Trail Design Guidelines and Toolkit contains strategies for design of recreation and public access facilities to minimize public access and wildlife compatibility conflicts. This includes:

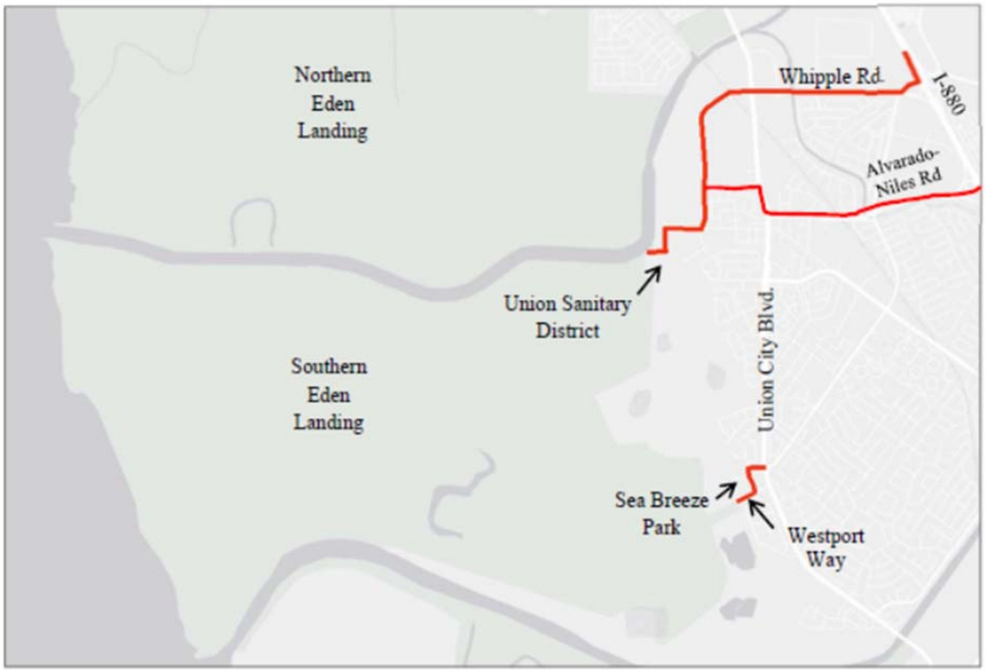
- Alignment, to provide a fulfilling, varied and interesting access experience
- Parking and staging area siting
- Education, such as interpretive signs
- Observation Points at strategic locations
- Reducing opportunities for raptor perching
- No/minimal lighting
- Physical and visual separation, such as:
  - Wildlife friendly fencing
  - Upland buffers
  - Moats and wetlands
  - Strategic vegetation buffers

Many of these strategies have been incorporated into the preliminary Phase 2 designs, and additional features may be incorporated into the precise design to sensitively incorporate public access into the restoration.

7.4 Community Connectors

Several of the adopted community and regional plans highlight the need for neighborhood connections to the trail (**Figure G-7**). The two existing trailheads that serve this area are over six miles apart, with one existing connector that serves the Eden Shores neighborhood.

Figure G-7. Project Construction Access Roads, Community Connectors



Two construction access points have been identified to accommodate site construction, via the Horner/Veasy Street access, and via Westport Way in the vicinity of Sea Breeze Park. The SBSP Restoration Project intends to coordinate and enter into agreements with the underlying property owners such as EBRPD, the City of Union City, and other adjacent landowners (including Union Sanitary District and ACFCWCD) to formalize these access points as Community Connectors that would provide connections to the Bay Trail. . Since physical improvement of the access roads or trails for construction purposes (such as leveling, widening and/or surfacing) may be necessary, it is anticipated that physical improvements needed to convert this access for trail use will be minimal, such as surfacing, signage and entry gates.

7.5 ACFCWCD Facilities

Some segments of the proposed trail would occur on Alameda County lands. This section excerpts portions of the Union City Bay Trail Study that identified specific design strategies (**Figure G-8**) to address ACFCWCD concerns regarding access and public safety around their facilities. Although some of this information may be dated, it is included for reference so that these issues can be addressed during the later stages of project design.

20-Tide Gate Structure

Issues identified in the Union City Bay Trail Feasibility Study related to the 20-Tide Gate structure include:

- Edge treatment to warn trail users away from the structure edge
- Address risk and liability concerns
- Facilitate maintenance
- Provide safety features without structural elements
- Allow for ease of maintenance, operations, and heavy vehicle use of structure by ACFCWCD.

The preliminary design strategy developed in 2004 included striping, pavement detectors, curbing and collapsible bollards. These issues and design options should be revisited as part of final project design to meet current construction, accessibility and safety standards.

Figure G-8. Trail Design on ACFCWCD Structures

Source: Alta Planning 2004

Trails on ACFCWCD Levees

In addition to the 20-Tide Gate structure preliminary design, the 2004 feasibility study also discussed the use and design of trails on ACFCWCD levees, which are used by heavy equipment to transport dredge materials. This discussion identified the following design issues that should be addressed as part of final project design (applies only to ACFCWCD levees):

- Gravel surfacing of levees for drainage and public access
- Installation of security fencing and controlled access at the Alvarado Pump Station

- Construction of bridges for maintenance vehicle access[13]
- Modification of existing vehicle gates at trail entry points to facilitate bicycle and pedestrian access, including modification of access gates at other connecting levees

7.6 Recreation and Public Access Facilities

Bridges and Boardwalks

Several of the trail route options would necessitate bridges to provide a complete trail connection. Depending on the location, these might be used by ACFCWCD, EBRPD, and/or Alameda County Mosquito Abatement District. These agencies have requested that any bridges be designed to accommodate light duty vehicles. The project presently proposes pedestrian and bicycle access only on the bridges over the ACFCC and the OAC, but the bridges over the ACFCWCD-owned channel to the J-ponds would be designed to accommodate access by maintenance and emergency vehicles. Any bridges should be designed for the marine environment. Detailed foundation and structural recommendations as part of a comprehensive geotechnical investigation and structural analysis would be completed as part of the final construction plans.

EBRPD also noted that ACFCWCD requires bridges across channels that they maintain to be designed to accommodate dredging equipment, such as a removable center section. Such bridges have been constructed across Sulphur Creek and San Lorenzo Creek within Hayward Regional Shoreline.. A bridge over ACFCC would need to conform to regulations for federal flood levees.

If a boardwalk is constructed for any of the trail routes under consideration, it should be built using strong and durable materials requiring a minimum of maintenance and capable of supporting lightweight vehicle loads. Non-corrosive piers or pilings and connector would likely be needed for the boardwalk foundation system, and coated or sealed to avoid leaching of material into adjacent aquatic environment.

<u>Bridge location and connectivity</u>. The Action Alternatives presented in the Phase 2 analysis represent preliminary design concepts that will be refined and finalized as part of the project design and implementation process. The precise location of bridges and other structures to provide trail connections should be determined based on optimal resource use (placement of levees for flood risk management or habitat enhancement), minimizing wildlife conflicts, and placement of structures at the narrowest crossing location that will otherwise meet project goals. For the Pond E6C bridges, shifting the bridge crossing to the narrowest channel crossing, and providing short levee improvements on the opposite side could reduce bridge length (and cost) significantly, especially since geotechnical improvements will be necessary on both sides of the channel for abutments and access.

For a bridge across ACFCC, consideration could be given to locating the bridge crossing further east, where the channel is more trapezoidal with a narrow channel transition zone. In this area, the overall bridge length could be reduced to approximately 400 feet, with significant cost and habitat savings. This alignment would necessitate utilizing some of the Alameda Creek Regional Trail to make a direct connection, but could be considered as a viable choice for effectively meeting Project goals.

[13] EBRPD identified the need for vehicle access on any project bridges, although the project currently proposes access for pedestrian/bicycle loads only.

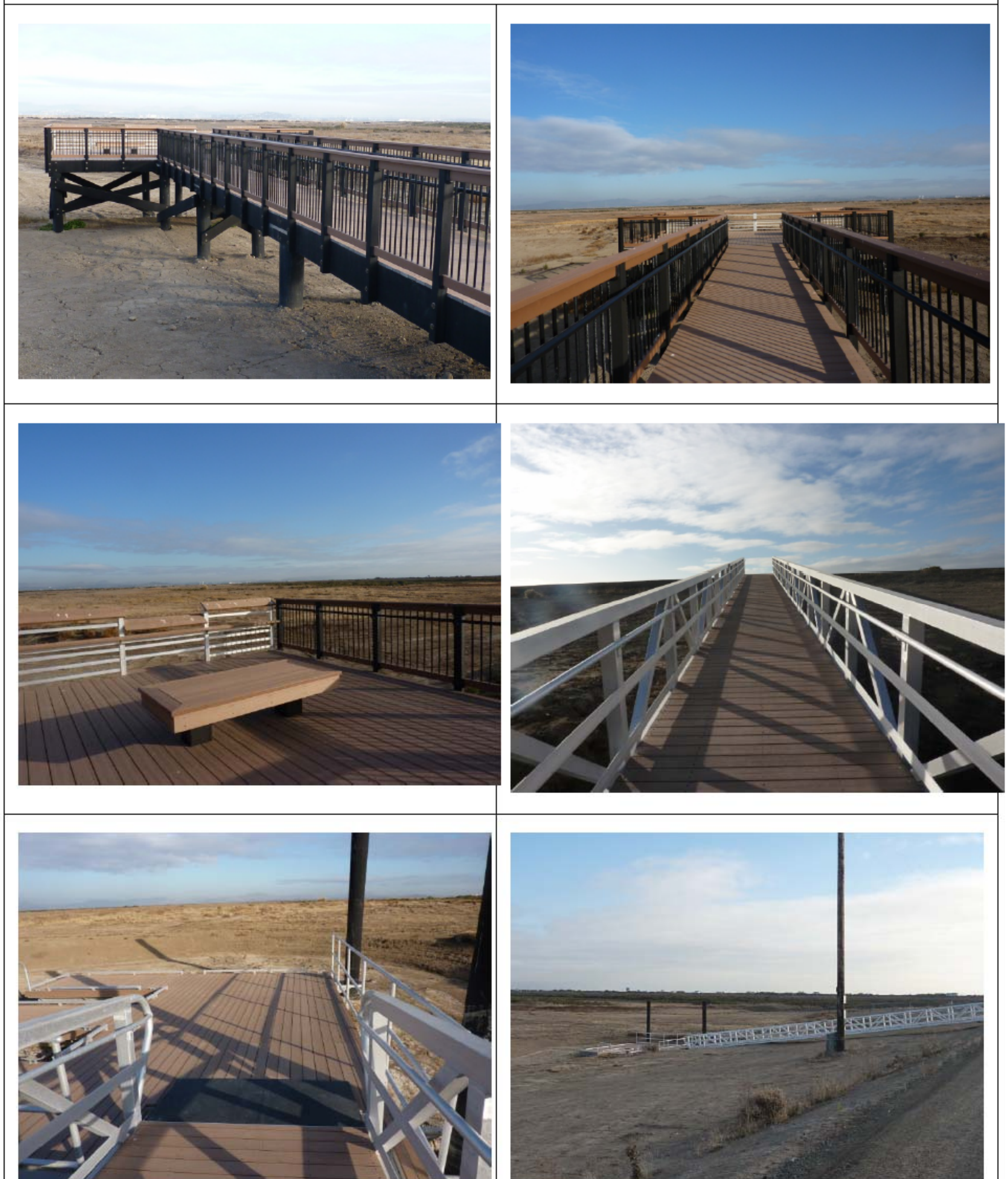
Viewing Platforms

At least one viewing platform is proposed at southern Eden Landing. The viewing platform would generally be constructed within or adjacent to the existing levee/upland footprint. Since the viewing platform would be constructed along the existing Alameda Creek Regional Trail, it would need to be designed to meet current guidelines for Outdoor Recreation Access Routes regarding accessibility. A second viewing platform is under consideration at the site of the Alvarado Salt Works in Pond E6 along the OAC; this feature could be constructed if the spur trail and/or the loop trail from the Bay Trail spine is/are selected. Additional viewing platforms, if included, would also need to meet accessibility guidelines. The final design may include consideration of providing additional viewing platforms, including raised facilities, especially where views of the Bay or tidal areas are obscured by adjacent levees.

Facilities that were installed in fall 2013 at Cullinan Ranch, which is part of San Pablo Bay National Wildlife Refuge, are shown on **Figure G-9**. These facilities include prefabricated aluminum ramps, dock platforms, a viewing platform, a permeable trail, and other facilities that incorporate composite materials and may be appropriate.

Figure G-9. Facilities at Cullinan Ranch, San Pablo Bay National Wildlife Refuge

Typical Boardwalk and Platform Elements[7]



[7] Cullinan Ranch, San Pablo Bay National Wildlife Refuge, January 2014

Signage, Wayfinding and Site Furnishings

Signs, interpretive elements, benches, viewing scopes and other built features must be located to provide adequate usable space as well as vertical clearance. These elements should not be placed within the area designated as a trail or access route.

Caltrans' *California Manual on Uniform Traffic Control Devices* (Caltrans 2014) includes advisory, warning, directional, and informational signs for bicyclists, pedestrians, and other users. Signage for the project should be consistent with all regulatory agencies.

Sign design should be consistent throughout the project, and sign elements should be grouped and designed to minimize visual intrusion. Sign elements may include more than one agency's signs as well as directional and informational elements. In accordance with accessibility regulations, it may be appropriate to provide information about a trail's length, running slope, width, cross-slope, and other characteristics to enable people to make informed decisions about using trails based on the characteristics of the trails. Signs along the levee tops should be minimized to avoid creation of raptor perches.

In general, all signs should be located 2 to 4 feet from the edge of the trail surface, have a minimum vertical clearance of 8.5 feet when located above the trail surface, and be a minimum of 4 feet above the trail surface when located on the side of the trail. All signs should be oriented so that trail users can see them clearly.

Phase 2 site design themes and prototypical site furnishings were developed as part of Phase 1 actions and should be continued, where appropriate, to provide a common design scheme. Typical facilities (developed for and implemented in Phase 1) are shown on **Figure G-10**.

Figure G-10. Typical Recreation and Public Access Facilities

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APPENDIX H

TRAFFIC IMPACT ANALYSIS
EDEN LANDING PHASE 2 EIR

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DRAFT

Traffic Impact Analysis

Eden Landing Phase 2 EIS/R

Prepared by:

AECOM

100 West San Fernando Street, Suite 200
San Jose, CA 95113

October 6, 2016

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FIGURES

TABLES

APPENDIX

I PROJECT DESCRIPTION

The purpose of this traffic analysis is to evaluate the potential traffic impacts resulting from the truck trips required for bringing fill to the project areas shown in Figure 1.

There are three project alternatives, each with a different fill quantity, as well as the no-build scenario. For the purposes of this study, a conservative approach was adopted by assigning outbound trips from the project site equal to the inbound trips to the project site during AM and PM peak hours. As this project is a restoration project, the only project traffic would be generated during the construction period.

II TRAFFIC IMPACT STUDY AREA

The project site is bounded by Union City Boulevard to the west, SR 92 to the north and Alameda Creek to the south. There are two access points to the site, to be used by trucks carrying fill material. The fill material will be transported to the site from I-880 via Whipple Road to Union City Boulevard before accessing the site from Horner Street (North Entrance) and Westport Way (South Entrance). Figure 2 presents the truck route for transporting material.

The study will analyze six study intersections that are also presented in Figure 2:

1. I-880 NB Ramps / Whipple Road / Industrial Parkway (Caltrans, in Hayward)
2. I-880 SB Ramps / Whipple Road / Dyer Street (Caltrans, in Union City)
3. Union City Boulevard / Whipple Road (Union City)
4. Union City Boulevard / Horner Street (Union City)
5. Union City Boulevard / Alvarado Boulevard (Union City)
6. Union City Boulevard / Dyer Street (Union City)

Intersection turning movement volumes were collected in June 2016 during the following time periods:

- 7:00 a.m. to 9:00 a.m. for the AM peak hour
- 4:00 p.m. to 6:00 p.m. for the PM peak hour

Traffic volumes were projected and impacts were assessed for the following conditions during the AM and PM peak hours:

1. Existing Conditions – Traffic conditions were evaluated based on existing lane geometries, traffic controls and traffic volumes; and
2. Existing plus Project Conditions – Traffic conditions were evaluated with proposed project trips added to existing traffic volumes.

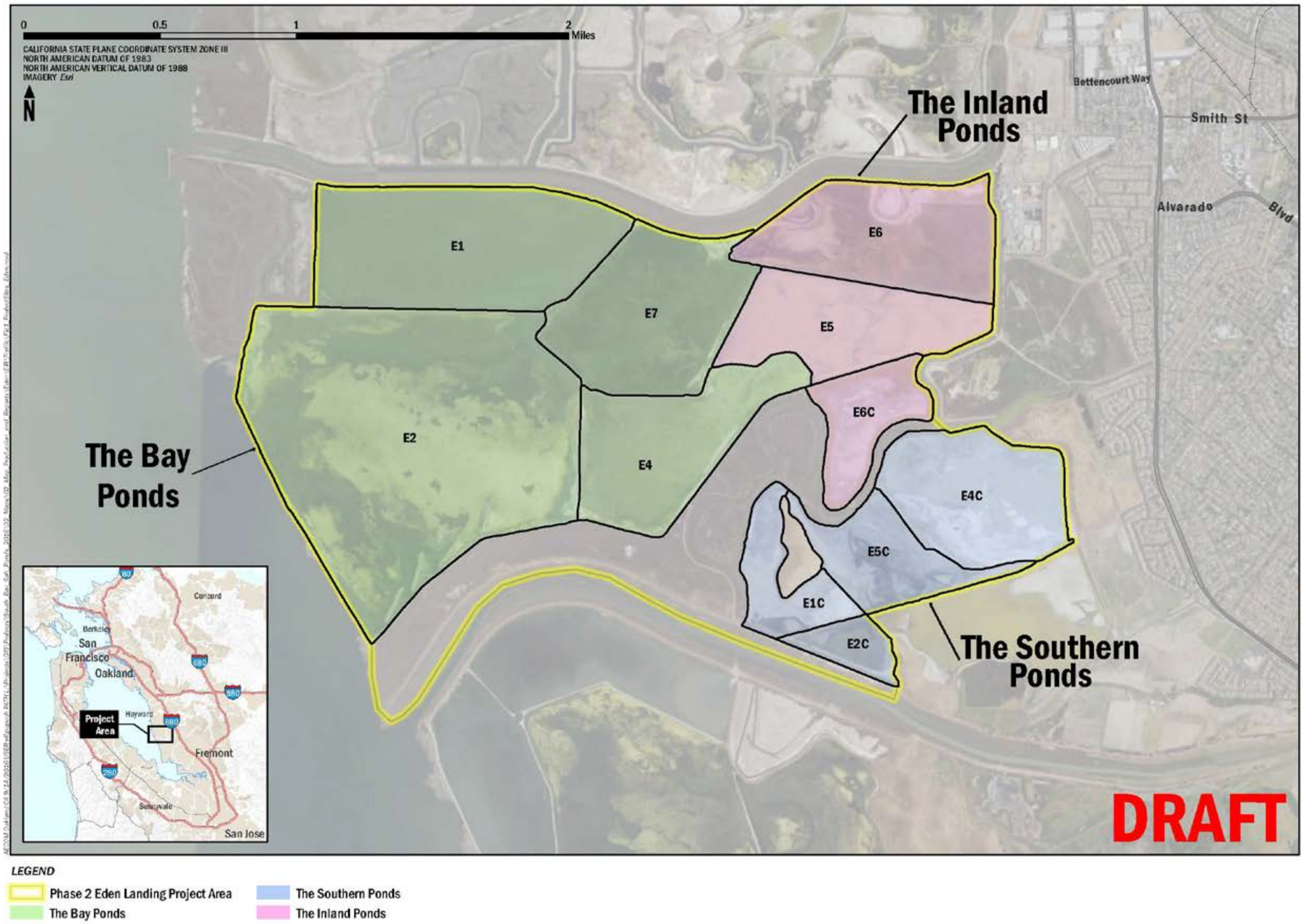


Figure 1 – Project Area Boundary

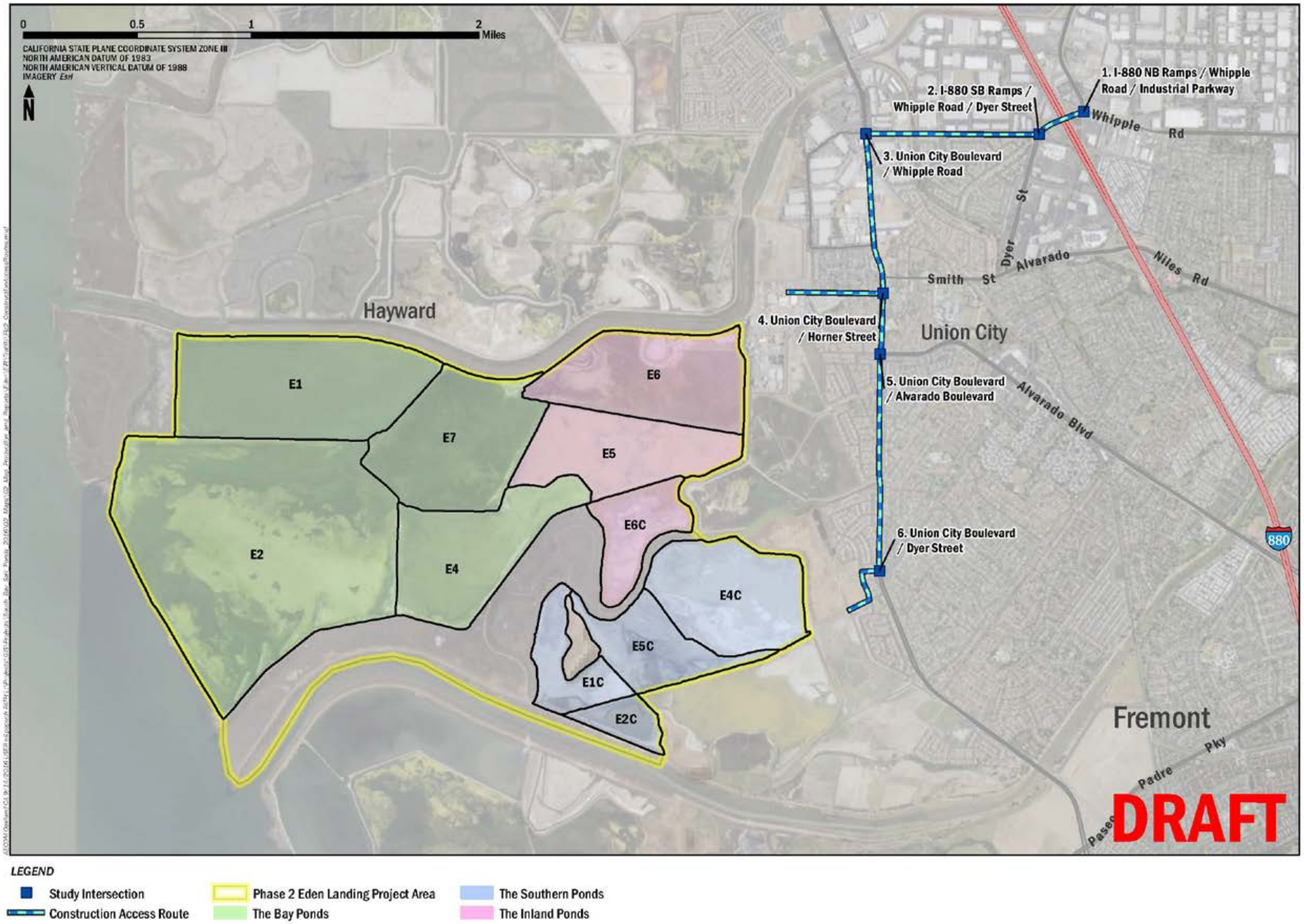


Figure 2– Construction Access Route and Study Intersections

III EVALUATION ANALYSIS

Evaluation Criteria

This section summarizes the methodologies used to perform the peak hour intersection capacity analysis at signalized intersections. Level of service analysis was performed using Synchro 9.0 software package based on the traffic data collected by AECOM according to the methodologies outlined in the Highway Capacity Manual (HCM 2000).

The resulting level of service (LOS) and delays were compared between the no-build and each project alternative. LOS measures traffic operating conditions, which varies from LOS A to LOS F. Table 1 presents a description of LOS and provides associated delays with each LOS letter grade for signalized intersections.

Table 1 – Signalized Intersection LOS Thresholds

Level of Service	Description	Delay (sec/veh)
A	Free-flow speeds prevail. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream.	≤ 10
B	Free-flow speeds are maintained. The ability to maneuver with the traffic stream is only slightly restricted.	>10-20
C	Flow with speeds at or near free-flow speeds. Freedom to maneuver with the traffic stream is noticeably restricted, and lane changes require more care and vigilance on the part of the driver.	>20-35
D	Speeds decline slightly with increasing flows. Freedom to maneuver with the traffic stream is more noticeably limited, and the driver experiences reduced physical and psychological comfort.	>35-55
E	Operation at capacity. There are virtually no usable gaps within the traffic stream, leaving little room to maneuver. Any disruption can be expected to produce a breakdown with queuing.	>55-80
F	Represents a breakdown in flow.	>80

Source: Highway Capacity Manual (Transportation Research Board, 2000)

IV EXISTING CONDITIONS

Existing lane geometries and traffic controls for the 6 study intersections are illustrated in Figure 3.

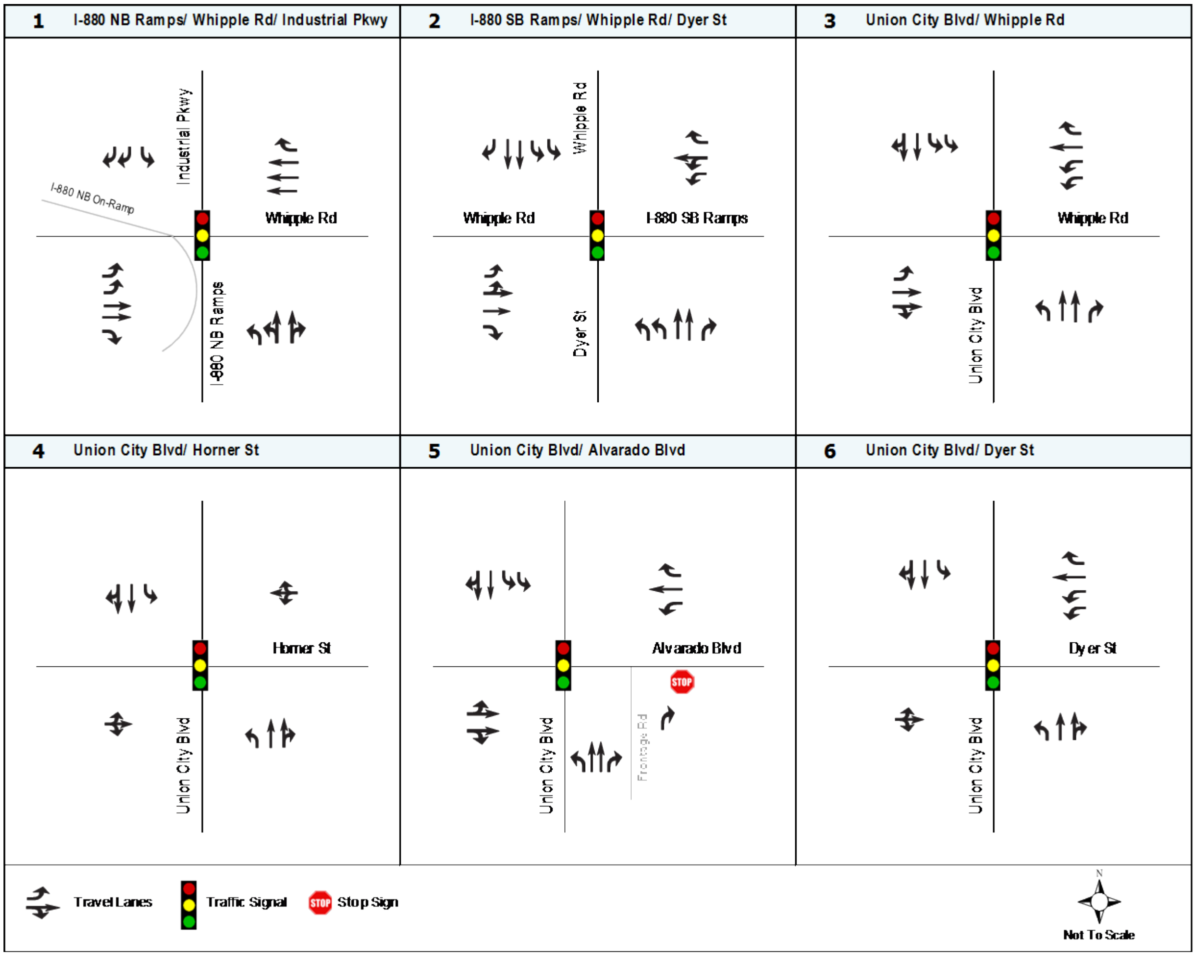


Figure 3 – Existing Lane Geometry

Existing intersection turning movement volumes at the study intersections are illustrated in Figure 4. The detailed counts for the AM and PM peak periods collected are provided in Appendix A.

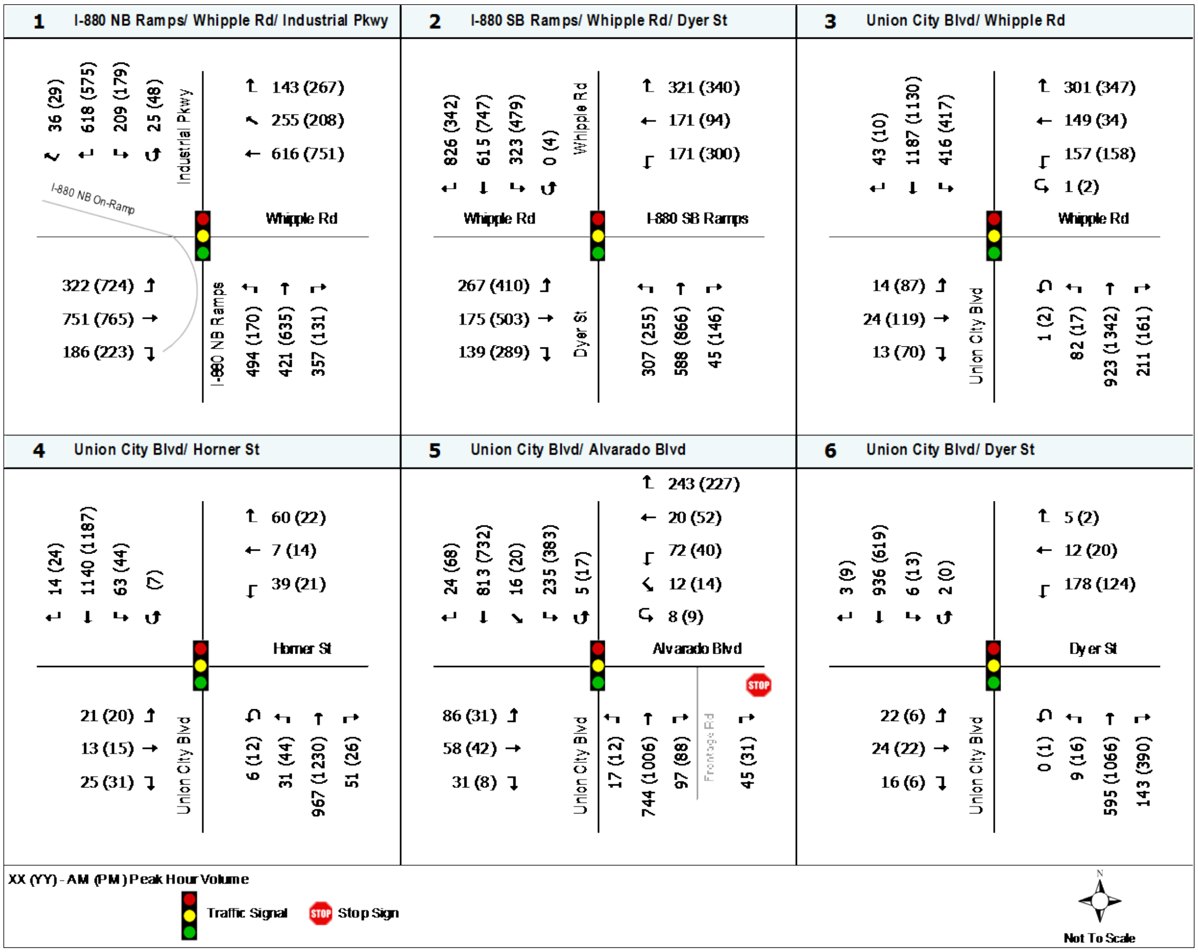


Figure 4 – Existing Peak Hour Turning Movement Volumes

V PROJECT CONDITION IMPACT ANALYSIS

There are two 'with project' scenarios being analyzed. The first scenario is the 'base case' and the second being the 'worst case'. Project trips generated under the 'base case' are dependent on the expected work duration of each project alternative, whereas the 'worst case' project trips are based on the daily maximum number of expected trips that the fill material can be brought to the project site. Details of each scenario are described below.

Trip generation

Base Case:

The estimated project trips using each of the two site accesses are shown in Table 2. It is assumed that each truck would carry 11 cubic yards of fill and the number of outbound trips is equal to the number of inbound trips in the same hour. The expected number of work days for each alternative as well as the number of work hours per day is also included in the table. It is projected that each alternative will generate a total of 10 trips (5 inbound, 5 outbound) in the AM and PM Peak Hours, with Alternatives B and C being expected to generate the same distribution pattern. Alternative D is expected to generate one inbound trip a day at the South Access. This trip is assumed to be made during the peak hour for a conservative calculation. In addition, it is assumed that fill material will be brought to the project site via I-880; 50% from the north and 50% from the south. Figures 5a-b illustrate the proposed project trips at the study intersections for each alternative.

Table 2 – Base Case Trip Generation for Project Alternatives

	Project Alternative	**Site Access**	**Net Import (CY)**	**Total Inbound Truck Trips**	**# of Work Days**	**Inbound Trips / Day**	**Work Hours / Day**	**Inbound Trips / Hour**
A	No Build	-	-	-	-	-	-	-
B	Restore Entire South Eden Landing to Tidal	North	44,000	4,000	209	20	10	2
	Marsh	South	48,000	4,364		21		3
C	Retain Inland and Southern Ponds as	North	18,000	1,634	134	13	10	2
	Managed Ponds	South	41,000	3,728		28		3
D	Staged Implementation of Tidal Marsh	North	152,000	13,819	350	40	10	4
	Restoration	South	2,000	182		1		1*

Source: AECOM 2016
*Assumes trip is made during peak hour for conservative calculation

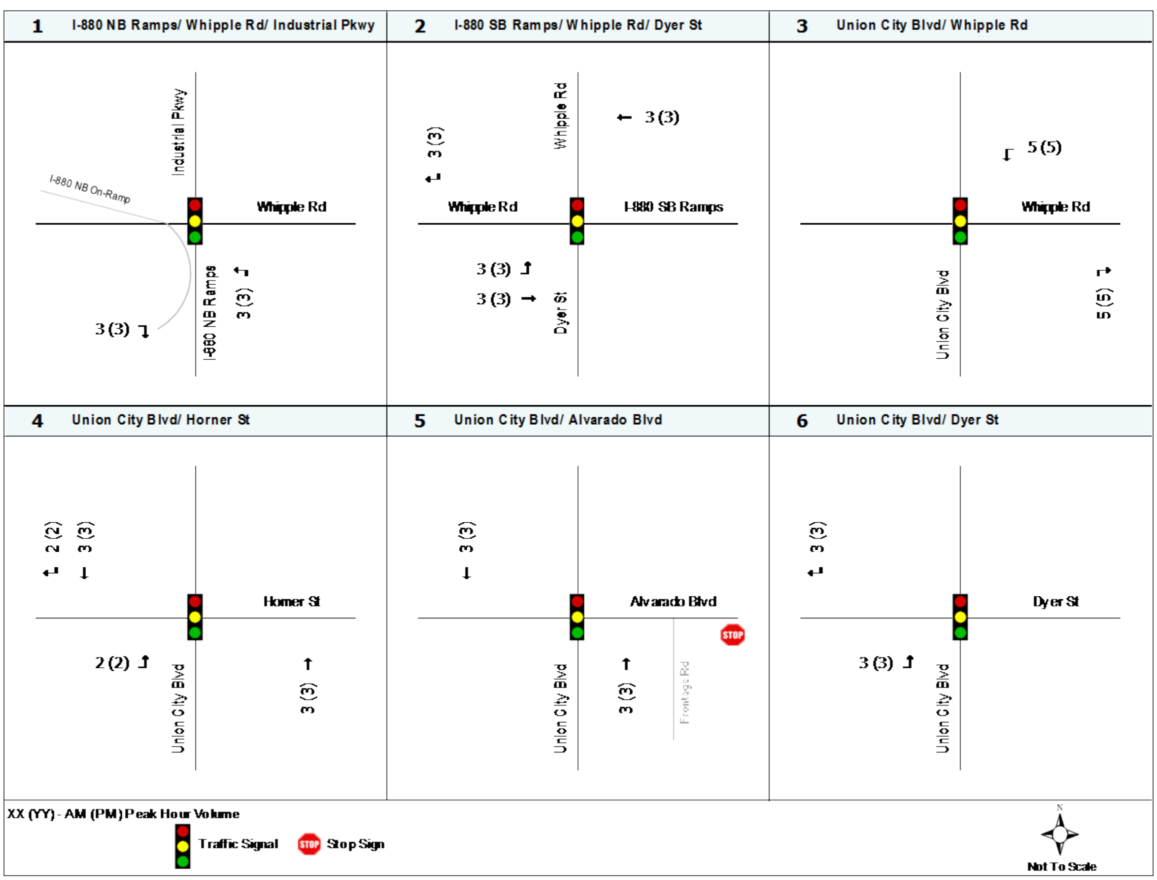


Figure 5a – Base Case Project Alternatives B & C Turning Movement Volumes

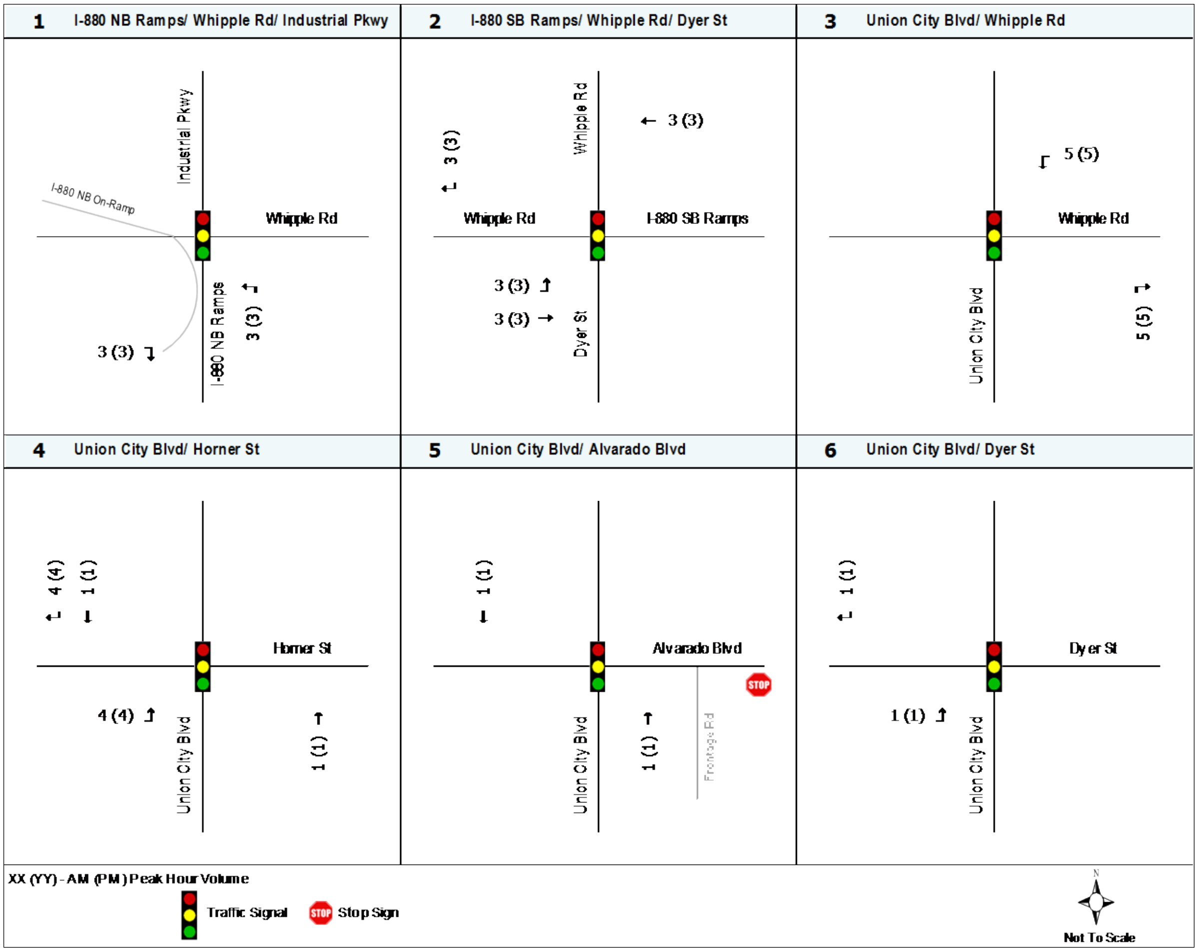


Figure 5b – Base Case Project Alternative D Turning Movement Volumes

<u>Worst Case:</u>

The estimated project trips using each of the two site accesses are shown in Table 3. It is assumed that a daily maximum of 200 trucks would bring fill material to the project site via the two accesses. It is therefore projected that each alternative will generate a total of 40 trips (20 inbound, 20 outbound) in the AM and PM Peak Hours. For a conservative calculation, Alternative B & D are expected to generate one additional inbound trip during the peak hours at the South Access. In addition, it is assumed that fill material will be brought to the project site via I-880; 50% from the north and 50% from the south. Figures 6a-c illustrate the proposed project trips at the study intersections for each alternative.

Table 3 – Worst Case Trip Generation for Project Alternatives

	Project Alternative	Site Access	Access usage	Inbound Trips / day	Work Hours / Day	Inbound Trips / Hour
A	No Build	-	-	-	-	-
B	Restore Entire South Eden Landing to Tidal Marsh	North	48%	96	10	10
		South	52%	104		11*
C	Retain Inland and Southern Ponds as Managed Ponds	North	30%	60	10	6
		South	70%	140		14
D	Staged Implementation of Tidal Marsh Restoration	North	99%	198	10	20
		South	1%	2		1*

Source: AECOM 2016
*Assumes an additional trip for conservative calculation

Figure 6a – Worst Case Project Alternative B Turning Movement Volumes

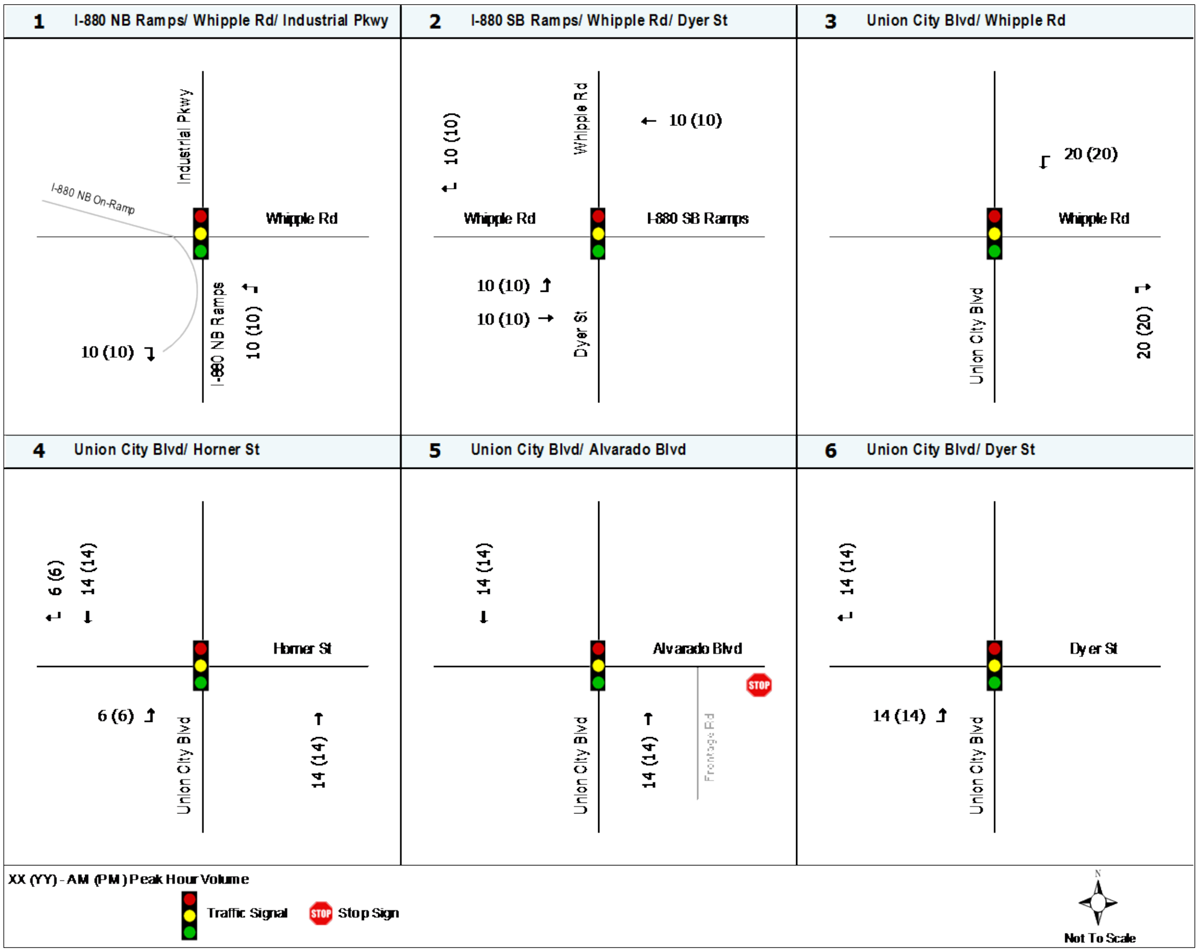


Figure 6b – Worst Case Project Alternative C Turning Movement Volumes

Significant Impact Thresholds

Two of the six study intersections are operated and maintained by Caltrans while the remaining four are operated and maintained by the City of Union City. Caltrans recommend using the corresponding City's significant impact threshold criteria for the two intersections under their charge. One of the Caltrans intersection falls within the city limits of Hayward and the other is in Union City.

For intersection #1 (I-880 NB Ramps / Whipple Road / Industrial Parkway), the City of Hayward thresholds have been considered.

For the rest of the study intersections, the City of Union City thresholds have been considered.

According to the City of Hayward guidelines for signalized intersections,

- LOS E is treated as an acceptable LOS. If the project causes an intersection operating at LOS E or better to fall below LOS E, then the project is projected to be causing a significant impact.

Figure 6c – Worst Case Project Alternative D Turning Movement Volumes

- For an intersection already operating at unacceptable LOS F, if the project increases the average control delay by five (5) seconds or more, the project is projected to be causing a significant impact.

According to the City of Union City guidelines for signalized intersections,

- LOS D is treated as an acceptable LOS. If the project causes an intersection operating at LOS D or better to fall below LOS D, then the project is projected to be causing a significant impact.

Impact Analysis

Analysis was conducted by comparing the 'with' and 'without' project intersection LOS and delay to determine if the project causes a significant impact. Tables 4a-b present the analysis results for the Base Case and Tables 5a-c present the results for the Worst Case.

Base Case:

It can be seen from Tables 4a and 4b that all study intersections, except intersection #2, will continue to operate within acceptable levels of service under all three project alternatives. The LOS for intersection #2, located in Union City, is currently at an unacceptable LOS E during the AM peak hour. It is expected to remain at the same LOS E under all the project alternatives. The average delay at this intersection is expected to increase by 2.2 seconds in the AM peak hour due to the additional project trips. Detailed level of service calculation sheets are provided in Appendix B.

Table 4a – Base Case LOS and Delay for Alternative B & C

Intersection		Peak Hour	No Project		With Project		
			LOS	Avg Delay[1] (sec)	LOS	Avg Delay[1] (sec)	Increase in Avg delay[2] (sec)
1	I-880 NB Ramps / Whipple Road / Industrial Parkway [3]	AM	E	55.4	E	55.9	n/a
		PM	E	73.1	E	73.0	
2	I-880 SB Ramps / Whipple Road / Dyer Street	AM	**E**	**66.9**	**E**	**69.1**	**2.2**
		PM	D	50.7	D	51.1	n/a
3	Union City Boulevard / Whipple Road	AM	C	30.8	C	31.0	n/a
		PM	D	48.1	D	48.1	
4	Union City Boulevard / Horner Street	AM	B	15.3	B	15.4	n/a
		PM	C	22.3	C	22.4	
5	Union City Boulevard / Alvarado Boulevard	AM	C	25.2	C	25.3	n/a
		PM	C	25.2	C	25.2	
6	Union City Boulevard / Dyer Street	AM	B	11.5	B	11.6	n/a
		PM	A	7.6	A	7.6	

Source: AECOM 2016

Bold indicates LOS at unacceptable levels

1. Intersection Control Delay per HCM 2000 methodology
2. Increase in average delay only calculated for intersection at unacceptable level under 'with project' conditions to determine project impact.
3. Intersection #1 in City of Hayward; acceptable LOS is E or better.

Table 4b – Base Case LOS and Delay for Alternative D

Intersection		Peak Hour	No Project		With Project		
			LOS	Avg Delay[1] (sec)	LOS	Avg Delay[1] (sec)	Increase in Avg delay[2] (sec)
1	I-880 NB Ramps / Whipple Road / Industrial Parkway [3]	AM	E	55.4	E	55.9	n/a
		PM	E	73.1	E	73.0	
2	I-880 SB Ramps / Whipple Road / Dyer Street	AM	**E**	**66.9**	**E**	**69.1**	**2.2**
		PM	D	50.7	D	51.1	n/a
3	Union City Boulevard /	AM	C	30.8	C	31.0	n/a

	Intersection	Peak Hour	No Project LOS	No Project Avg Delay[1] (sec)	With Project LOS	With Project Avg Delay[1] (sec)	With Project Increase in Avg delay[2] (sec)
	Whipple Road	PM	D	48.1	D	48.1	
4	Union City Boulevard / Horner Street	AM	B	15.3	B	15.4	n/a
		PM	C	22.3	C	21.8	
5	Union City Boulevard / Alvarado Boulevard	AM	C	25.2	C	25.2	n/a
		PM	C	25.2	C	25.2	
6	Union City Boulevard / Dyer Street	AM	B	11.5	B	11.5	n/a
		PM	A	7.6	A	7.6	

Source: AECOM 2016
Bold indicates LOS at unacceptable levels
1. Intersection Control Delay per HCM 2000 methodology
2. Increase in average delay only calculated for intersection at unacceptable level under 'with project' conditions to determine project impact.
3. Intersection #1 in City of Hayward; acceptable LOS is E or better.

Worst Case:

It can be seen from Tables 5a-c that all study intersections, except intersection #2, will continue to operate within acceptable levels of service under all three project alternatives.

Table 5a- Worst Case LOS and Delay for Alternative B

	Intersection	Peak Hour	No Project LOS	No Project Avg Delay[1] (sec)	With Project LOS	With Project Avg Delay[1] (sec)	With Project Increase in Avg delay[2] (sec)
1	I-880 NB Ramps / Whipple Road / Industrial Parkway[3]	AM	E	55.4	E	56.7	n/a
		PM	E	73.1	E	72.7	
2	I-880 SB Ramps / Whipple Road / Dyer Street	AM	**E**	**66.9**	**E**	**74.9**	**8.0**
		PM	D	50.7	D	52.1	n/a
3	Union City Boulevard / Whipple Road	AM	C	30.8	C	31.3	n/a
		PM	D	48.1	D	49.0	
4	Union City Boulevard / Horner Street	AM	B	15.3	B	15.8	n/a
		PM	C	22.3	C	22.2	
5	Union City Boulevard / Alvarado Boulevard	AM	C	25.2	C	25.4	n/a
		PM	C	25.2	C	25.5	
6	Union City Boulevard / Dyer Street	AM	B	11.5	B	11.8	n/a
		PM	A	7.6	A	7.8	

Source: AECOM 2016
Bold indicates LOS at unacceptable levels
1. Intersection Control Delay per HCM 2000 methodology
2. Increase in average delay only calculated for intersection at unacceptable level under 'with project' conditions to determine project impact.
3. Intersection #1 in City of Hayward; acceptable LOS is E or better.

The LOS for intersection #2, located in Union City, is currently at an unacceptable LOS E during the AM peak hour. It is expected to remain at the same LOS E under all the project alternatives. The average delay at this intersection, under the worst case scenario, is expected to increase by 8.0 seconds in the AM peak hour due to the additional project trips. Detailed level of service calculation sheets are provided in Appendix C.

Table 5b- Worst Case LOS and Delay for Alternative C

Intersection		Peak Hour	No Project		With Project		
			LOS	Avg Delay[1] (sec)	LOS	Avg Delay[1] (sec)	Increase in Avg delay[2] (sec)
1	I-880 NB Ramps / Whipple Road / Industrial Parkway [3]	AM	E	55.4	E	56.7	n/a
		PM	E	73.1	E	72.7	
2	I-880 SB Ramps / Whipple Road / Dyer Street	AM	**E**	**66.9**	**E**	**74.9**	**8.0**
		PM	D	50.7	D	52.1	n/a
3	Union City Boulevard / Whipple Road	AM	C	30.8	C	31.3	n/a
		PM	D	48.1	D	49.0	
4	Union City Boulevard / Horner Street	AM	B	15.3	B	15.6	n/a
		PM	C	22.3	C	21.9	
5	Union City Boulevard / Alvarado Boulevard	AM	C	25.2	C	25.5	n/a
		PM	C	25.2	C	25.5	
6	Union City Boulevard / Dyer Street	AM	B	11.5	B	11.8	n/a
		PM	A	7.6	A	7.8	

Source: AECOM 2016

Bold indicates LOS at unacceptable levels

1. Intersection Control Delay per HCM 2000 methodology
2. Increase in average delay only calculated for intersection at unacceptable level under 'with project' conditions to determine project impact.
3. Intersection #1 in City of Hayward; acceptable LOS is E or better.

Table 5c- Worst Case LOS and Delay for Alternative D

Intersection		Peak Hour	No Project		With Project		
			LOS	Avg Delay[1] (sec)	LOS	Avg Delay[1] (sec)	Increase in Avg delay[2] (sec)
1	I-880 NB Ramps / Whipple Road / Industrial Parkway [3]	AM	E	55.4	E	56.7	n/a
		PM	E	73.1	E	72.7	
2	I-880 SB Ramps / Whipple Road / Dyer Street	AM	**E**	**66.9**	**E**	**74.9**	**8.0**
		PM	D	50.7	D	52.1	n/a
3	Union City Boulevard / Whipple Road	AM	C	30.8	C	31.3	n/a
		PM	D	48.1	D	49.0	
4	Union City Boulevard / Horner Street	AM	B	15.3	B	17.1	n/a
		PM	C	22.3	C	23.1	
5	Union City Boulevard / Alvarado Boulevard	AM	C	25.2	C	25.2	n/a
		PM	C	25.2	C	25.2	

	Intersection	Peak Hour	No Project LOS	No Project Avg Delay[1] (sec)	With Project LOS	With Project Avg Delay[1] (sec)	With Project Increase in Avg delay[2] (sec)
6	Union City Boulevard / Dyer Street	AM	B	11.5	B	11.5	n/a
		PM	A	7.6	A	7.6	

Source: AECOM 2016
Bold indicates LOS at unacceptable levels

1. Intersection Control Delay per HCM 2000 methodology
2. Increase in average delay only calculated for intersection at unacceptable level under 'with project' conditions to determine project impact.
3. Intersection #1 in City of Hayward; acceptable LOS is E or better.

VII MITIGATION MEASURES

No mitigation measures are necessary for study intersections #1, #3, #4, #5 and #6 under both the Base Case and Worse Case scenarios. For intersection #2, it is already operating at an unacceptable LOS under existing (without project) conditions and the City of Union City does not have an impact criterion for such a condition.

Under the Base Case scenario, an additional delay of 2.2 seconds in the AM peak hour is generally considered less than significant (based on impact criteria of other surrounding cities in the Bay Area). It is therefore reasonable to conclude that the project would not cause any significant impact to intersection #2 as well and no mitigation measure would be necessary.

Under the Worst Case scenario, an additional delay of 8.0 seconds in the AM peak hour can be considered significant. Optimizing the timing at intersection #2 would mitigate the impact to less than significant. However, this mitigation is not feasible as intersection #2 is part of a synchronized series of intersections.

VIII CONCLUSION

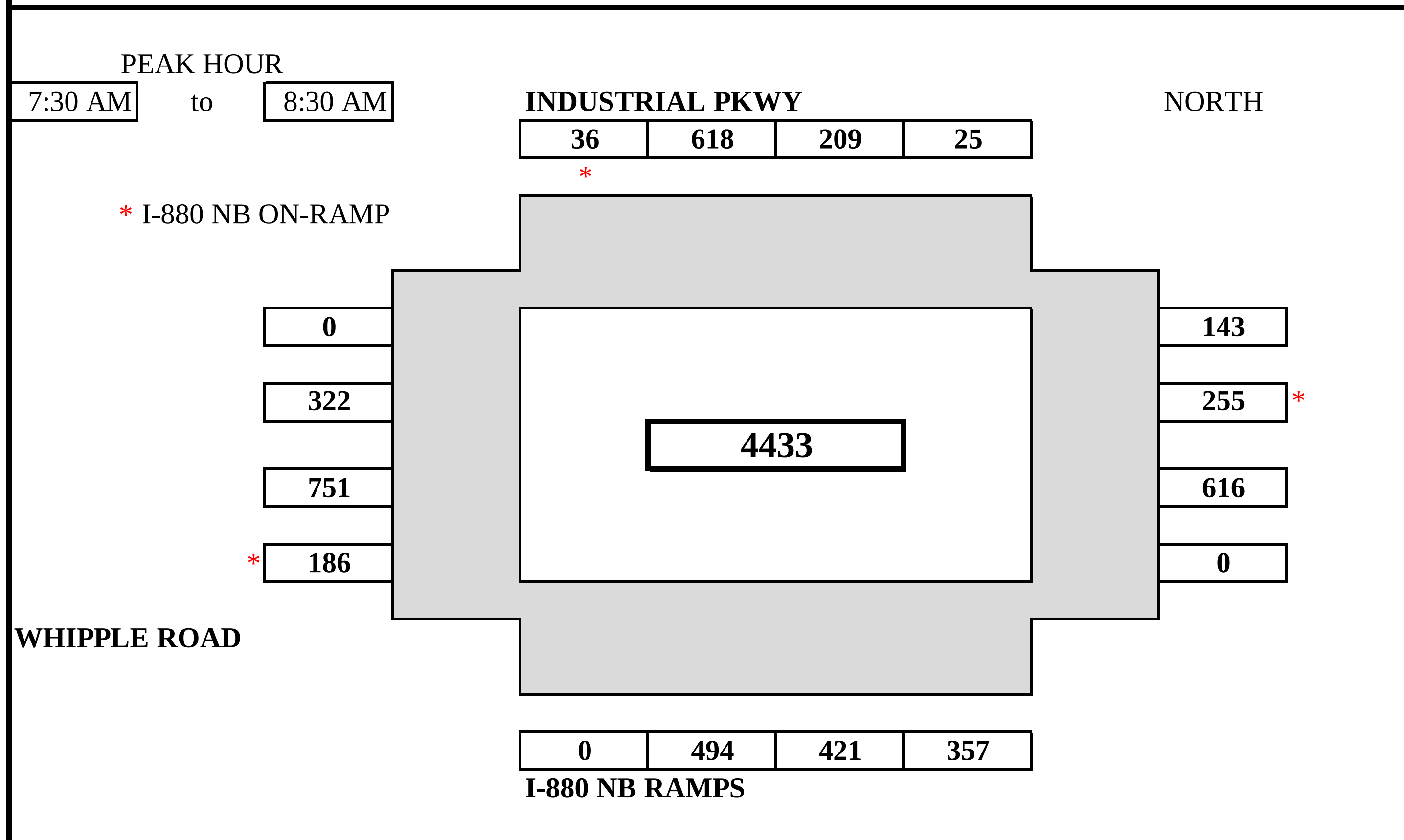
It is determined from the analysis that the project will cause no significant impact to study intersections #1, #3, #4, #5 and #6. For intersection #2 the 'with project' LOS is expected to remain at unacceptable levels during the AM peak hour under both the Base Case and Worst Case scenarios, similar to its existing 'without project' conditions. However, under the Base Case scenario, an additional delay of 2.2 seconds in the AM peak hour can be considered insignificant. As such, intersection #2 will not be significantly impacted under the Base Case scenario. Under the Worst Case scenario, an additional 8.0 seconds of delay in the AM peak hour can be considered significant but there are no feasible mitigation measures available. As such, the project impact at intersection #2 is considered significant and unavoidable under the Worst Case scenario.

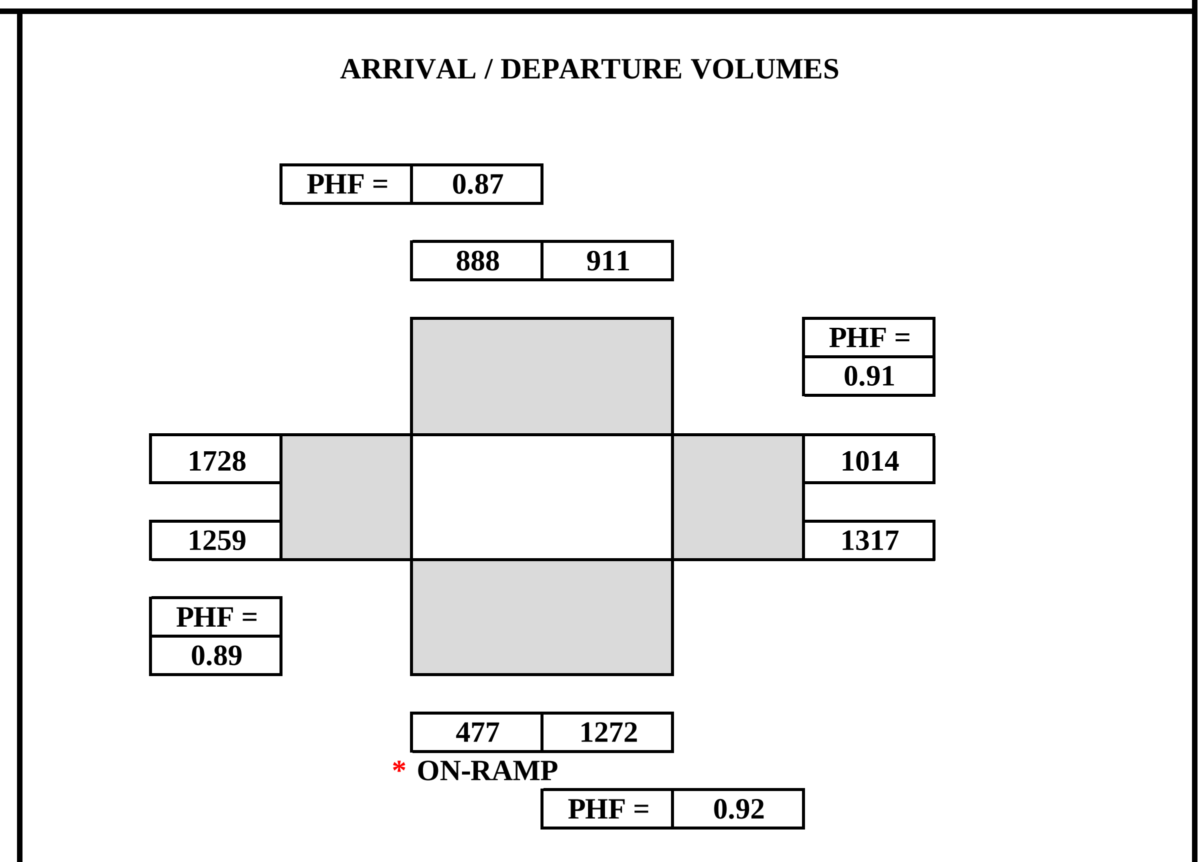
APPENDIX A
DETAILED INTERSECTION TURNING MOVEMENT VOLUMES

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN UNION CITY		SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	I-880 NB RAMPS	- INDUSTRIAL PKWY	SURVEY TIME:	7:00 AM	TO	9:00 AM
E-W APPROACH:	WHIPPLE ROAD		JURISDICTION:	UNION CITY	FILE:	3606057-1AM





TIME From		PERIOD To	NB U-TURN	NB LEFT	NB THRU	NB RIGHT	SB U-TURN	SB LEFT	SB RIGHT	SB ONRAMP	EB U-TURN	EB LEFT	EB THRU	EB ONRAMP	WB U-TURN	WB THRU	WB ONRAMP	WB RIGHT	TOTAL
SURVEY DATA																			
7:00 AM	to	7:15 AM		56	65	82	2	46	176	11		48	102	63	0	112	67	12	842
7:15 AM	to	7:30 AM		132	154	169	5	79	352	30		99	191	137	0	225	128	52	1753
7:30 AM	to	7:45 AM		233	255	248	10	126	525	40		172	331	201	0	359	196	78	2774
7:45 AM	to	8:00 AM		353	351	352	15	191	702	48		250	583	225	0	516	262	119	3967
8:00 AM	to	8:15 AM		490	471	440	23	227	836	63		330	786	290	0	652	331	158	5097
8:15 AM	to	8:30 AM		626	575	526	30	288	970	66		421	942	323	0	841	383	195	6186
8:30 AM	to	8:45 AM		749	696	608	41	318	1136	89		482	1038	380	0	984	423	227	7171
8:45 AM	to	9:00 AM		853	801	693	47	354	1256	103		561	1179	423	0	1134	475	268	8147
TOTAL BY PERIOD																			
7:00 AM	to	7:15 AM	0	56	65	82	2	46	176	11	0	48	102	63	0	112	67	12	842
7:15 AM	to	7:30 AM	0	76	89	87	3	33	176	19	0	51	89	74	0	113	61	40	911
7:30 AM	to	7:45 AM	0	101	101	79	5	47	173	10	0	73	140	64	0	134	68	26	1021
7:45 AM	to	8:00 AM	0	120	96	104	5	65	177	8	0	78	252	24	0	157	66	41	1193
8:00 AM	to	8:15 AM	0	137	120	88	8	36	134	15	0	80	203	65	0	136	69	39	1130
8:15 AM	to	8:30 AM	0	136	104	86	7	61	134	3	0	91	156	33	0	189	52	37	1089
8:30 AM	to	8:45 AM	0	123	121	82	11	30	166	23	0	61	96	57	0	143	40	32	985
8:45 AM	to	9:00 AM	0	104	105	85	6	36	120	14	0	79	141	43	0	150	52	41	976
HOURLY TOTALS																			
7:00 AM	to	8:00 AM	0	353	351	352	15	191	702	48	0	250	583	225	0	516	262	119	3967
7:15 AM	to	8:15 AM	0	434	406	358	21	181	660	52	0	282	684	227	0	540	264	146	4255
7:30 AM	to	8:30 AM	0	494	421	357	25	209	618	36	0	322	751	186	0	616	255	143	4433
7:45 AM	to	8:45 AM	0	516	441	360	31	192	611	49	0	310	707	179	0	625	227	149	4397
8:00 AM	to	9:00 AM	0	500	450	341	32	163	554	55	0	311	596	198	0	618	213	149	4180

PEAK HOUR SUMMARY

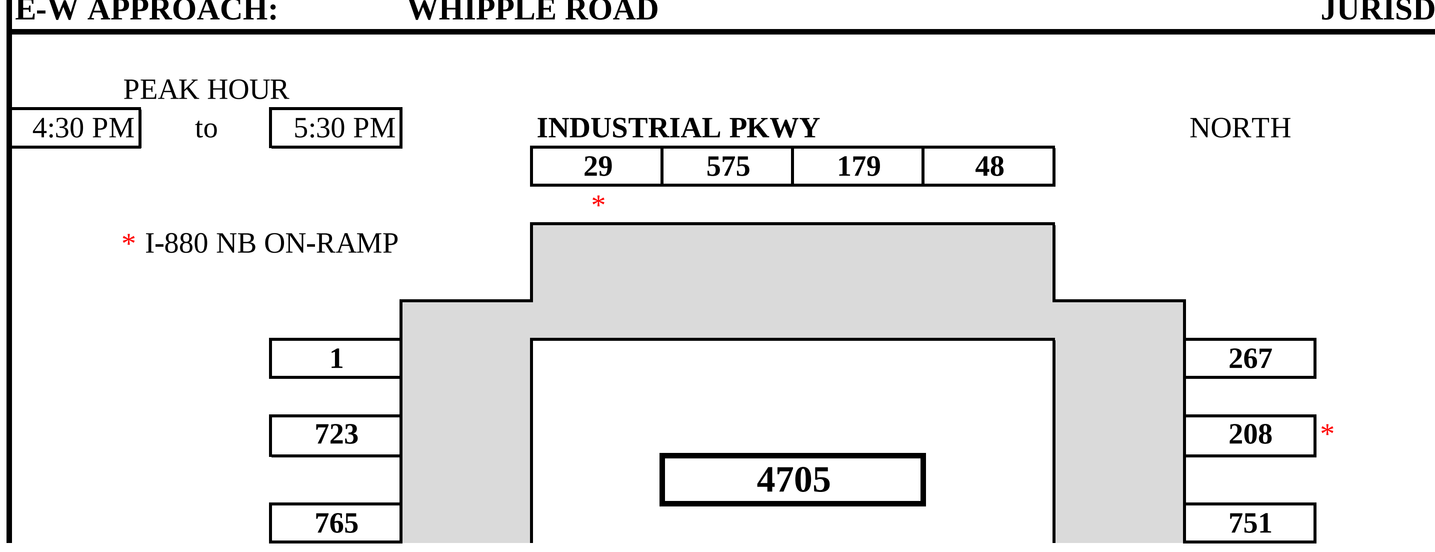
7:30 AM to 8:30 AM	NB U-TURN	NB LEFT	NB THRU	NB RIGHT	SB U-TURN	SB LEFT	SB RIGHT	SB ONRAMP	EB U-TURN	EB LEFT	EB THRU	EB ONRAMP	WB U-TURN	WB THRU	WB ONRAMP	WB RIGHT	TOTAL
VOLUME	0	494	421	357	25	209	618	36	0	322	751	186	0	616	255	143	4433
PHF BY MOVEMENT	0.00	0.90	0.88	0.86	0.78	0.80	0.87	0.60	0.00	0.88	0.75	0.72	0.00	0.81	0.92	0.87	OVERALL
PHF BY APPROACH	0.92				0.87				0.89				0.91				0.93
BICYCLE	0				0				0				0				0
PEDESTRIAN	2				0				4				2				8
	N-LEG				S-LEG				E-LEG				W-LEG				
PEDESTRIAN BY LEG:	6				0				2				0				8

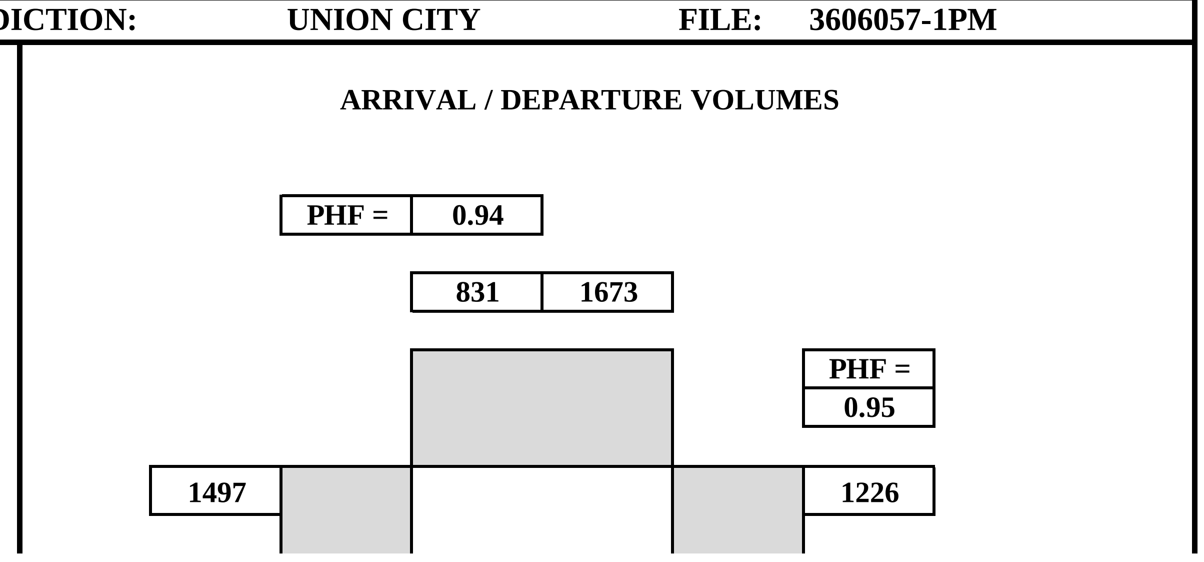
TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

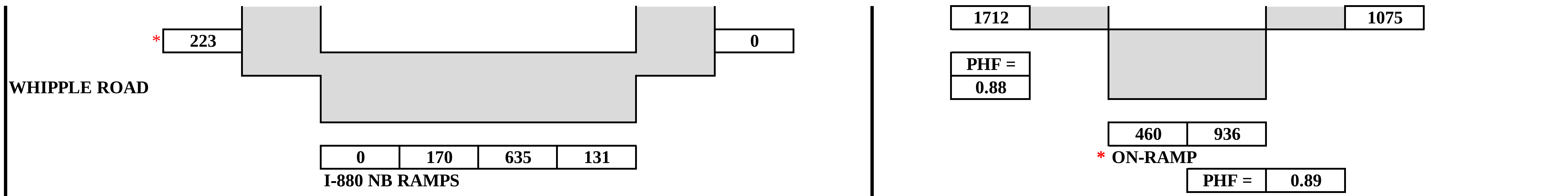
B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN UNION CITY		SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	I-880 NB RAMPS	- INDUSTRIAL PKWY	SURVEY TIME:	4:00 PM	TO	6:00 PM
E-W APPROACH:	WHIPPLE ROAD		JURISDICTION:	UNION CITY	FILE:	3606057-1PM







TIME		PERIOD	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
From		To	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	RIGHT	ONRAMP	U-TURN	LEFT	THRU	ONRAMP	U-TURN	THRU	ONRAMP	RIGHT	
S U R V E Y D A T A																			
4:00 PM	to	4:15 PM		40	164	54	6	50	118	7	0	179	167	58		164	45	65	**1117**
4:15 PM	to	4:30 PM		102	312	99	15	97	242	15	1	348	354	127		336	87	117	**2252**
4:30 PM	to	4:45 PM		154	484	139	28	139	365	23	1	532	528	206		530	132	182	**3443**
4:45 PM	to	5:00 PM		192	627	176	41	185	517	31	1	744	752	257		721	177	249	**4670**
5:00 PM	to	5:15 PM		234	774	201	54	230	657	37	1	898	925	303		918	237	313	**5782**
5:15 PM	to	5:30 PM		272	947	230	63	276	817	44	2	1071	1119	350		1087	295	384	**6957**
5:30 PM	to	5:45 PM		330	1114	261	75	318	969	46	3	1238	1278	405		1302	327	454	**8120**
5:45 PM	to	6:00 PM		352	1293	299	84	375	1121	51	4	1413	1456	458		1477	374	525	**9282**
T O T A L B Y P E R I O D																			
4:00 PM	to	4:15 PM	0	40	164	54	6	50	118	7	0	179	167	58	0	164	45	65	**1117**
4:15 PM	to	4:30 PM	0	62	148	45	9	47	124	8	1	169	187	69	0	172	42	52	**1135**
4:30 PM	to	4:45 PM	0	52	172	40	13	42	123	8	0	184	174	79	0	194	45	65	**1191**
4:45 PM	to	5:00 PM	0	38	143	37	13	46	152	8	0	212	224	51	0	191	45	67	**1227**
5:00 PM	to	5:15 PM	0	42	147	25	13	45	140	6	0	154	173	46	0	197	60	64	**1112**
5:15 PM	to	5:30 PM	0	38	173	29	9	46	160	7	1	173	194	47	0	169	58	71	**1175**
5:30 PM	to	5:45 PM	0	58	167	31	12	42	152	2	1	167	159	55	0	215	32	70	**1163**
5:45 PM	to	6:00 PM	0	22	179	38	9	57	152	5	1	175	178	53	0	175	47	71	**1162**
H O U R L Y T O T A L S																			
4:00 PM	to	5:00 PM	0	192	627	176	41	185	517	31	1	744	752	257	0	721	177	249	**4670**
4:15 PM	to	5:15 PM	0	194	610	147	48	180	539	30	1	719	758	245	0	754	192	248	**4665**
4:30 PM	to	5:30 PM	0	170	635	131	48	179	575	29	1	723	765	223	0	751	208	267	**4705**
4:45 PM	to	5:45 PM	0	176	630	122	47	179	604	23	2	706	750	199	0	772	195	272	**4677**
5:00 PM	to	6:00 PM	0	160	666	123	43	190	604	20	3	669	704	201	0	756	197	276	**4612**

P E A K H O U R S U M M A R Y

4:30 PM to 5:30 PM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	RIGHT	ONRAMP	U-TURN	LEFT	THRU	ONRAMP	U-TURN	THRU	ONRAMP	RIGHT	
VOLUME	0	170	635	131	48	179	575	29	1	723	765	223	0	751	208	267	**4705**
PHF BY MOVEMENT	0.00	0.82	0.92	0.82	0.92	0.97	0.90	0.91	0.25	0.85	0.85	0.71	0.00	0.95	0.87	0.94	OVERALL
PHF BY APPROACH	0.89				0.94				0.88				0.95				0.96
BICYCLE	0				0				0				0				**0**
PEDESTRIAN	1				3				5				4				**13**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	9				0				4				0				**13**

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

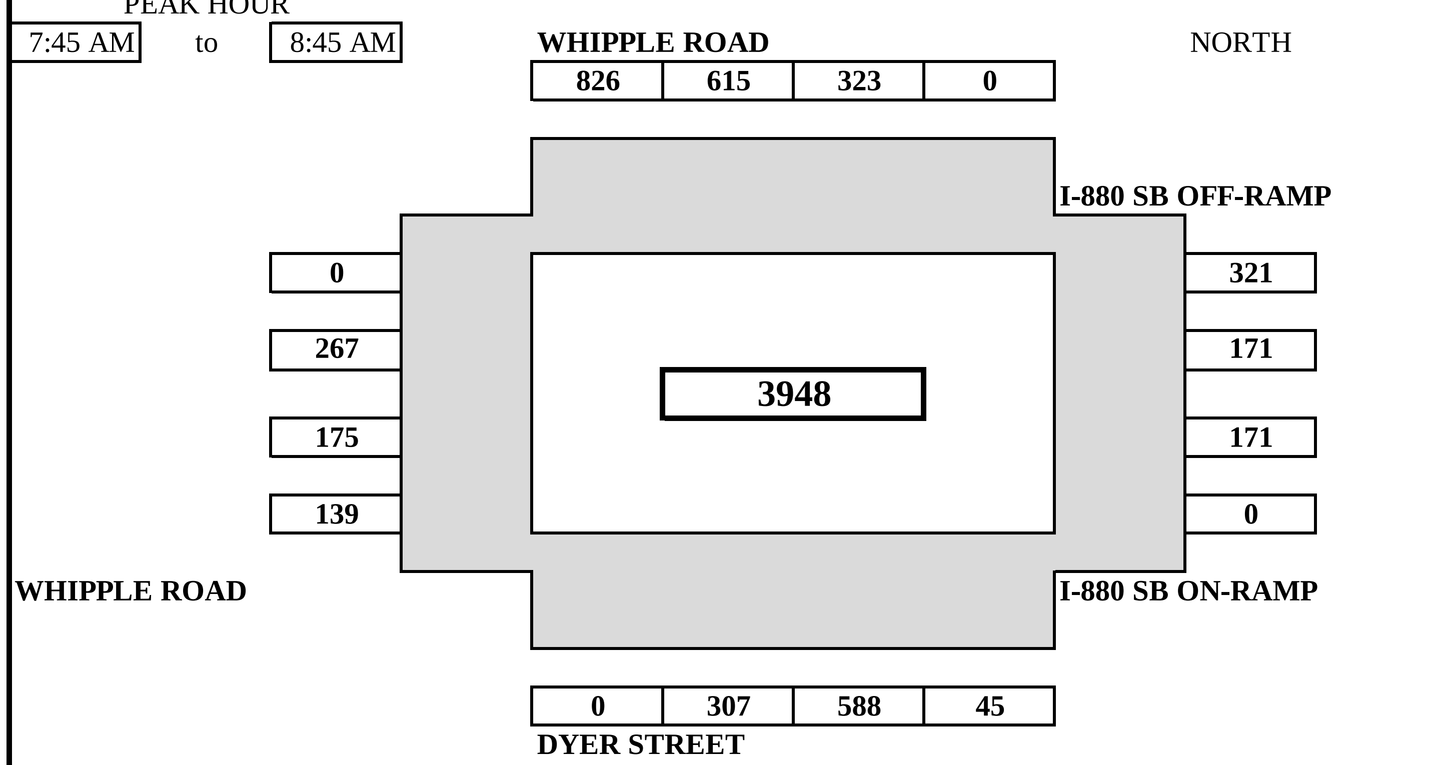
B.A.Y.M.E.T.R.I.C.S.

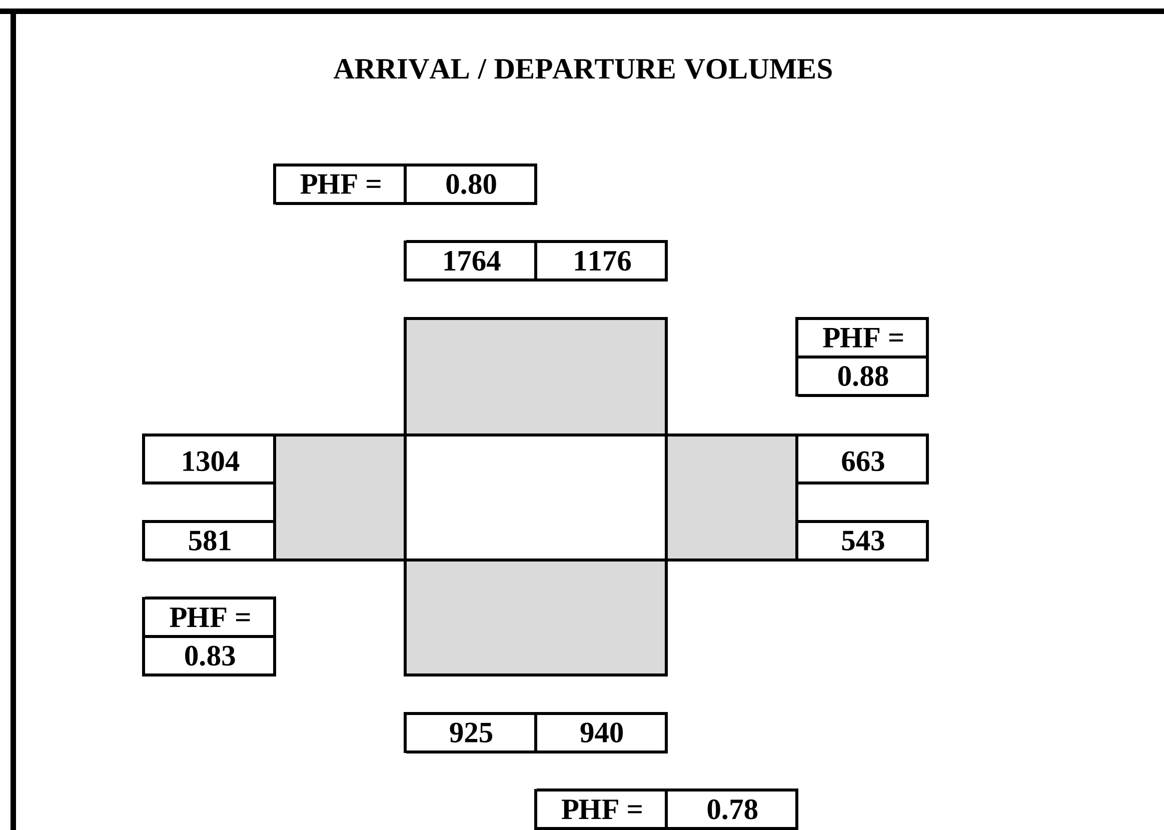
INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**		**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**WHIPPLE ROAD**	**- DYER STREET**	**SURVEY TIME:**	**7:00 AM**	**TO**	**9:00 AM**
E-W APPROACH:	**WHIPPLE ROAD**	**- I-88O SB RAMPS**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-2AM**

PEAK HOUR

7:45 AM to 8:45 AM





TIME PERIOD From		To	NB U-TURN	NB LEFT	NB THRU	NB RIGHT	SB U-TURN	SB LEFT	SB THRU	SB RIGHT	EB U-TURN	EB LEFT	EB THRU	EB RIGHT	WB U-TURN	WB LEFT	WB THRU	WB RIGHT	TOTAL
SURVEY DATA																			
7:00 AM	to	7:15 AM		30	103	11		88	107	112		52	40	16		30	18	58	**665**
7:15 AM	to	7:30 AM		58	192	32		212	242	257		117	96	40		80	45	122	**1493**
7:30 AM	to	7:45 AM		122	327	40		299	264	415		184	157	75		103	62	218	**2266**
7:45 AM	to	8:00 AM		193	466	49		408	503	620		267	214	110		143	103	326	**3402**
8:00 AM	to	8:15 AM		295	651	62		488	611	822		345	256	146		182	136	413	**4407**
8:15 AM	to	8:30 AM		369	803	72		548	766	1055		407	303	174		229	187	479	**5392**
8:30 AM	to	8:45 AM		429	915	85		622	879	1241		451	332	214		274	233	539	**6214**
8:45 AM	to	9:00 AM		485	1021	94		695	1004	1455		507	380	258		326	284	638	**7147**
TOTAL BY PERIOD																			
7:00 AM	to	7:15 AM	0	30	103	11	0	88	107	112	0	52	40	16	0	30	18	58	**665**
7:15 AM	to	7:30 AM	0	28	89	21	0	124	135	145	0	65	56	24	0	50	27	64	**828**
7:30 AM	to	7:45 AM	0	64	135	8	0	87	22	158	0	67	61	35	0	23	17	96	**773**
7:45 AM	to	8:00 AM	0	71	139	9	0	109	239	205	0	83	57	35	0	40	41	108	**1136**
8:00 AM	to	8:15 AM	0	102	185	13	0	80	108	202	0	78	42	36	0	39	33	87	**1005**
8:15 AM	to	8:30 AM	0	74	152	10	0	60	155	233	0	62	47	28	0	47	51	66	**985**
8:30 AM	to	8:45 AM	0	60	112	13	0	74	113	186	0	44	29	40	0	45	46	60	**822**
8:45 AM	to	9:00 AM	0	56	106	9	0	73	125	214	0	56	48	44	0	52	51	99	**933**
HOURLY TOTALS																			
7:00 AM	to	8:00 AM	0	193	466	49	0	408	503	620	0	267	214	110	0	143	103	326	**3402**
7:15 AM	to	8:15 AM	0	265	548	51	0	400	504	710	0	293	216	130	0	152	118	355	**3742**
7:30 AM	to	8:30 AM	0	311	611	40	0	336	524	798	0	290	207	134	0	149	142	357	**3899**
7:45 AM	to	8:45 AM	0	307	588	45	0	323	615	826	0	267	175	139	0	171	171	321	**3948**
8:00 AM	to	9:00 AM	0	292	555	45	0	287	501	835	0	240	166	148	0	183	181	312	**3745**

PEAK HOUR SUMMARY

7:45 AM to 8:45 AM	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	TOTAL
VOLUME	0	307	588	45	0	323	615	826	0	267	175	139	0	171	171	321	**3948**
PHF BY MOVEMENT	0.00	0.75	0.79	0.87	0.00	0.74	0.64	0.89	0.00	0.80	0.77	0.87	0.00	0.91	0.84	0.74	OVERALL
PHF BY APPROACH	0.78				0.80				0.83				0.88				0.87
BICYCLE	1				4				1				0				**6**
PEDESTRIAN	4				1				0				0				**5**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	0				0				0				5				**5**

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

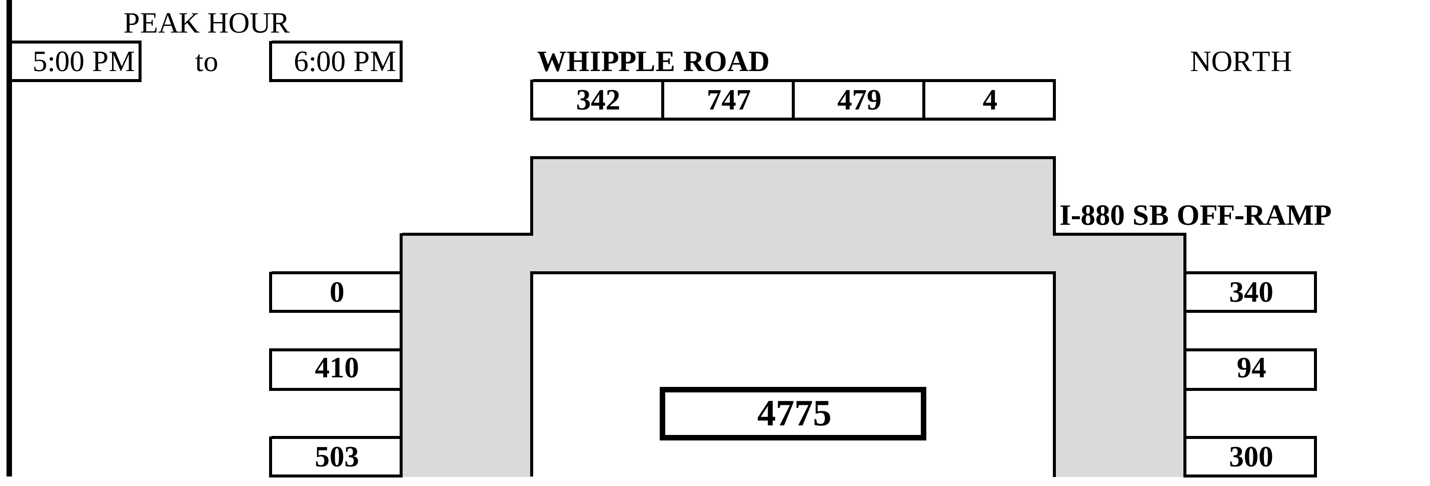
B.A.Y.M.E.T.R.I.C.S.

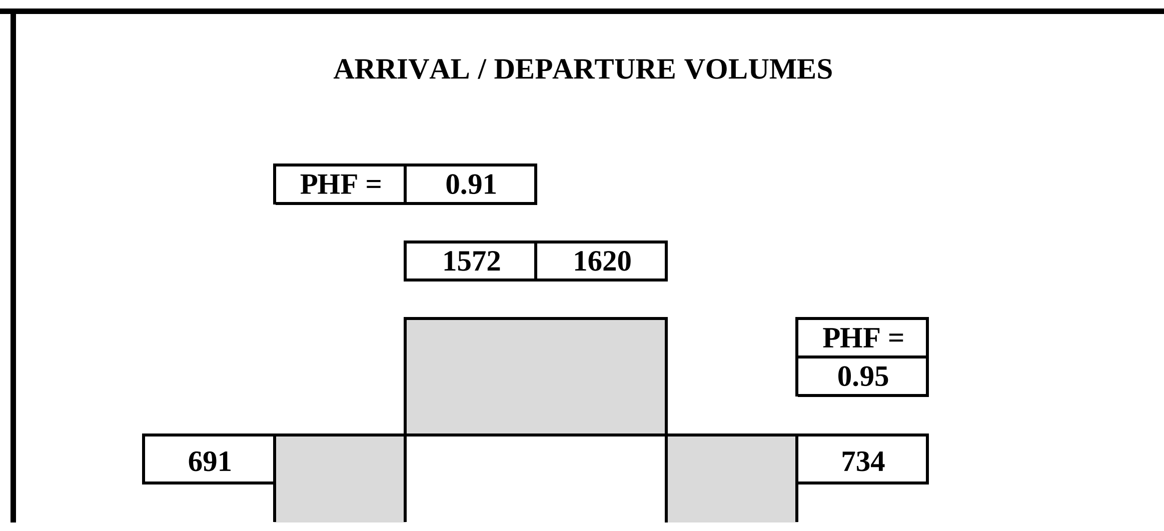
INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**		**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**WHIPPLE ROAD**	**- DYER STREET**	**SURVEY TIME:**	**4:00 PM**	**TO**	**6:00 PM**
E-W APPROACH:	**WHIPPLE ROAD**	**- I-88O SB RAMPS**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-2PM**

PEAK HOUR

5:00 PM to 6:00 PM





	289				0
WHIPPLE ROAD					I-880 SB ON-RAMP
		0	255	866	146
		DYER STREET			

1202			1128
PHF = 0.96			
	1336	1267	
	PHF =	0.92	

TIME		PERIOD	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
From		To	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	
SURVEY DATA																			
4:00 PM	to	4:15 PM	0	74	245	26	0	102	143	79		80	94	62		69	26	79	**1079**
4:15 PM	to	4:30 PM	1	135	481	57	0	205	298	200		176	185	127		133	62	176	**2236**
4:30 PM	to	4:45 PM	1	195	717	92	0	324	442	293		299	264	185		206	97	259	**3374**
4:45 PM	to	5:00 PM	3	265	951	118	2	432	640	376		438	373	273		279	120	335	**4605**
5:00 PM	to	5:15 PM	3	330	1174	150	2	557	810	456		537	509	347		349	142	436	**5802**
5:15 PM	to	5:30 PM	3	377	1381	192	3	681	970	539		646	641	419		421	166	526	**6965**
5:30 PM	to	5:45 PM	3	436	1593	228	4	801	1156	628		753	773	489		503	185	590	**8142**
5:45 PM	to	6:00 PM	3	520	1817	264	6	911	1387	718		848	876	562		579	214	675	**9380**
TOTAL BY PERIOD																			
4:00 PM	to	4:15 PM	0	74	245	26	0	102	143	79	0	80	94	62	0	69	26	79	**1079**
4:15 PM	to	4:30 PM	1	61	236	31	0	103	155	121	0	96	91	65	0	64	36	97	**1157**
4:30 PM	to	4:45 PM	0	60	236	35	0	119	144	93	0	123	79	58	0	73	35	83	**1138**
4:45 PM	to	5:00 PM	2	70	234	26	2	108	198	83	0	139	109	88	0	73	23	76	**1231**
5:00 PM	to	5:15 PM	0	65	223	32	0	125	170	80	0	99	136	74	0	70	22	101	**1197**
5:15 PM	to	5:30 PM	0	47	207	42	1	124	160	83	0	109	132	72	0	72	24	90	**1163**
5:30 PM	to	5:45 PM	0	59	212	36	1	120	186	89	0	107	132	70	0	82	19	64	**1177**
5:45 PM	to	6:00 PM	0	84	224	36	2	110	231	90	0	95	103	73	0	76	29	85	**1238**
HOURLY TOTALS																			
4:00 PM	to	5:00 PM	3	265	951	118	2	432	640	376	0	438	373	273	0	279	120	335	**4605**
4:15 PM	to	5:15 PM	3	256	929	124	2	455	667	377	0	457	415	285	0	280	116	357	**4723**
4:30 PM	to	5:30 PM	2	242	900	135	3	476	672	339	0	470	456	292	0	288	104	350	**4729**
4:45 PM	to	5:45 PM	2	241	876	136	4	477	714	335	0	454	509	304	0	297	88	331	**4768**
5:00 PM	to	6:00 PM	0	255	866	146	4	479	747	342	0	410	503	289	0	300	94	340	**4775**

PEAK HOUR SUMMARY

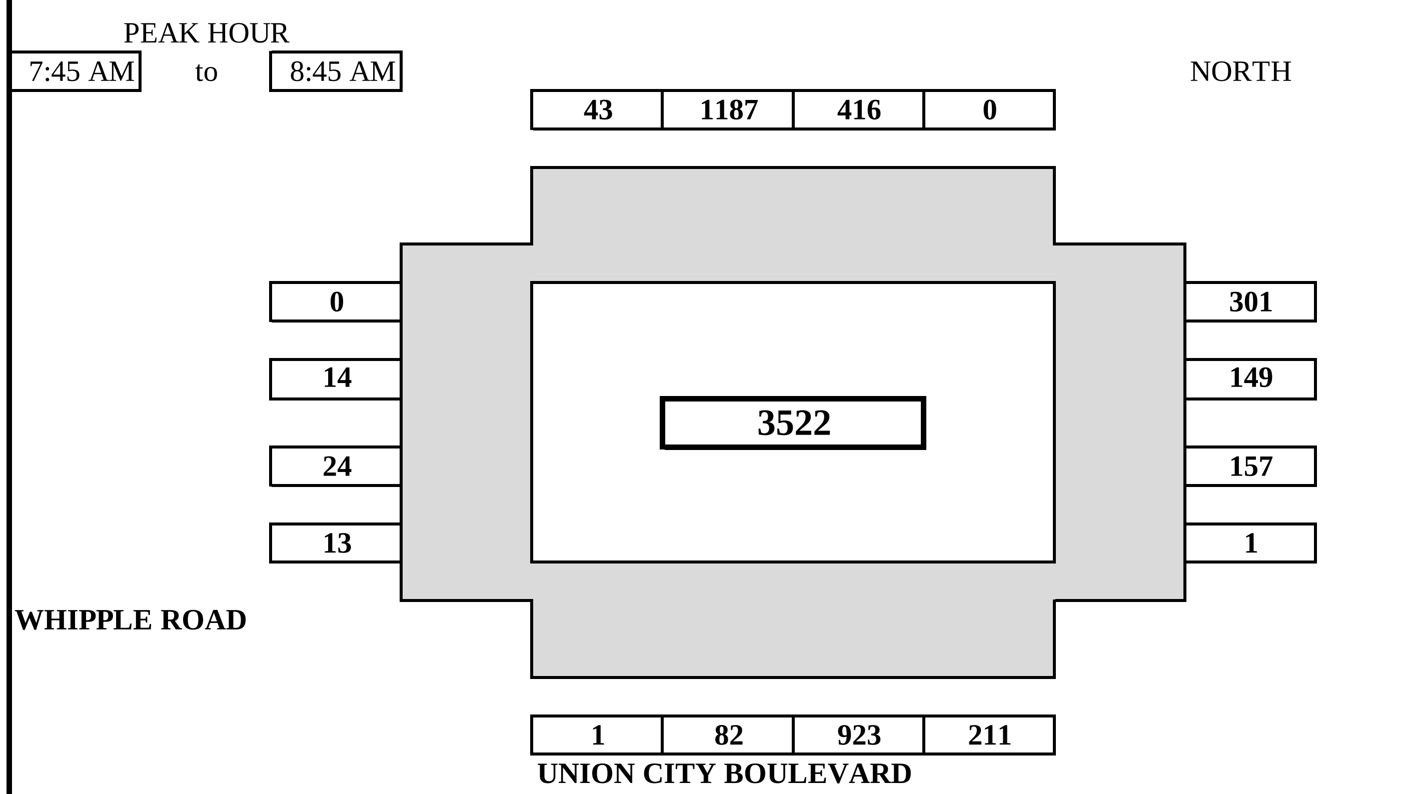
5:00 PM to 6:00 PM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	
VOLUME	0	255	866	146	4	479	747	342	0	410	503	289	0	300	94	340	**4775**
PHF BY MOVEMENT	0.00	0.76	0.97	0.87	0.50	0.96	0.81	0.95	0.00	0.94	0.92	0.98	0.00	0.91	0.81	0.84	OVERALL
PHF BY APPROACH	0.92				0.91				0.96				0.95				0.96
BICYCLE	0				8				4				2				**14**
PEDESTRIAN	3				7				0				0				**10**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	0				0				0				10				**10**

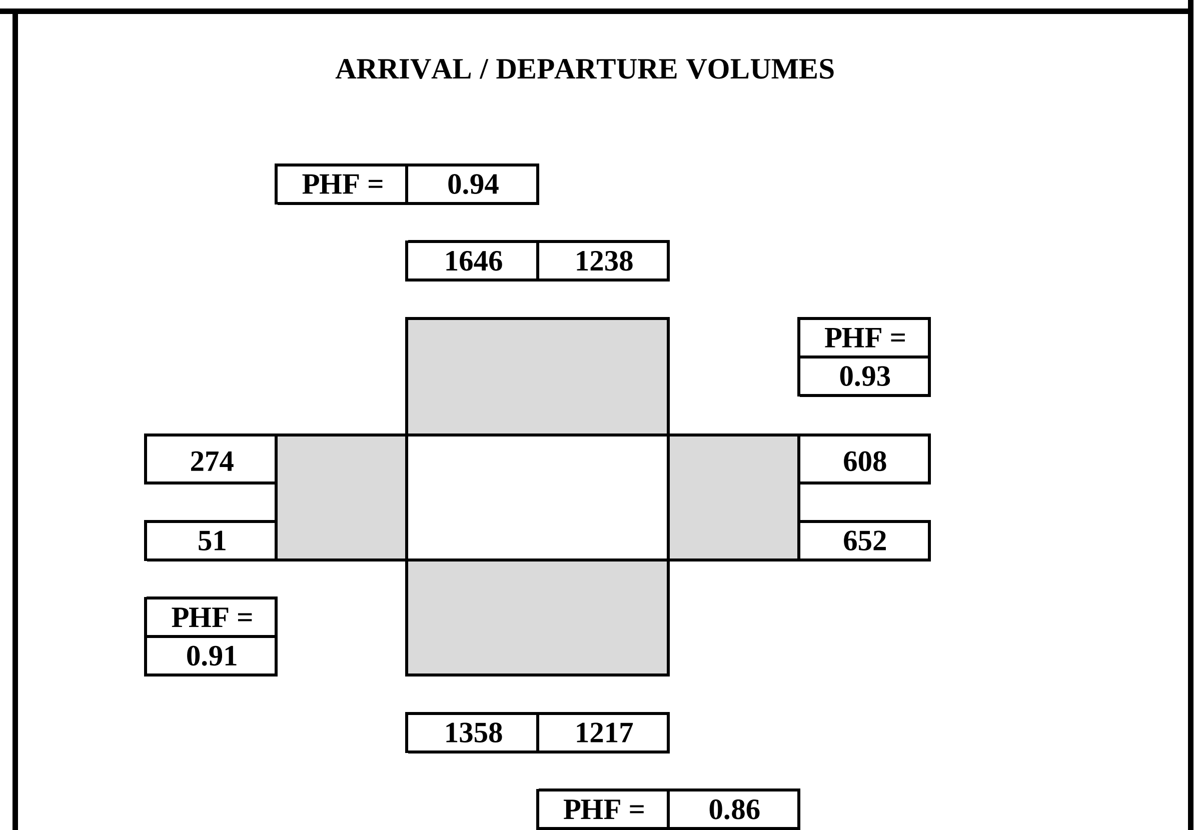
TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN UNION CITY	SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	UNION CITY BOULEVARD	SURVEY TIME:	7:00 AM	TO	9:00 AM
E-W APPROACH:	WHIPPLE ROAD	JURISDICTION:	UNION CITY	FILE:	3606057-3AM





TIME PERIOD From		To	NORTHBOUND U-TURN	LEFT	THRU	RIGHT	SOUTHBOUND U-TURN	LEFT	THRU	RIGHT	EASTBOUND U-TURN	LEFT	THRU	RIGHT	WESTBOUND U-TURN	LEFT	THRU	RIGHT	TOTAL
SURVEY DATA																			
7:00 AM	to	7:15 AM	0	8	143	30	0	68	276	6		1	1	1	0	22	13	57	626
7:15 AM	to	7:30 AM	1	10	306	63	0	173	595	9		2	6	4	0	54	20	120	1363
7:30 AM	to	7:45 AM	1	15	480	104	0	282	869	15		5	12	6	1	82	38	199	2109
7:45 AM	to	8:00 AM	1	31	729	165	0	423	1157	25		9	16	11	2	130	54	276	3029
8:00 AM	to	8:15 AM	1	51	991	238	0	512	1425	39		12	22	12	2	160	97	366	3928
8:15 AM	to	8:30 AM	1	80	1178	288	0	605	1728	49		16	27	17	2	207	144	427	4769
8:30 AM	to	8:45 AM	2	97	1403	315	0	698	2056	58		19	36	19	2	239	187	500	5631
8:45 AM	to	9:00 AM	2	116	1571	353	1	791	2337	74		27	51	22	2	265	274	554	6440
TOTAL BY PERIOD																			
7:00 AM	to	7:15 AM	0	8	143	30	0	68	276	6	0	1	1	1	0	22	13	57	626
7:15 AM	to	7:30 AM	1	2	163	33	0	105	319	3	0	1	5	3	0	32	7	63	737
7:30 AM	to	7:45 AM	0	5	174	41	0	109	274	6	0	3	6	2	1	28	18	79	746
7:45 AM	to	8:00 AM	0	16	249	61	0	141	288	10	0	4	4	5	1	48	16	77	920
8:00 AM	to	8:15 AM	0	20	262	73	0	89	268	14	0	3	6	1	0	30	43	90	899
8:15 AM	to	8:30 AM	0	29	187	50	0	93	303	10	0	4	5	5	0	47	47	61	841
8:30 AM	to	8:45 AM	1	17	225	27	0	93	328	9	0	3	9	2	0	32	43	73	862
8:45 AM	to	9:00 AM	0	19	168	38	1	93	281	16	0	8	15	3	0	26	87	54	809
HOURLY TOTALS																			
7:00 AM	to	8:00 AM	1	31	729	165	0	423	1157	25	0	9	16	11	2	130	54	276	3029
7:15 AM	to	8:15 AM	1	43	848	208	0	444	1149	33	0	11	21	11	2	138	84	309	3302
7:30 AM	to	8:30 AM	0	70	872	225	0	432	1133	40	0	14	21	13	2	153	124	307	3406
7:45 AM	to	8:45 AM	1	82	923	211	0	416	1187	43	0	14	24	13	1	157	149	301	3522
8:00 AM	to	9:00 AM	1	85	842	188	1	368	1180	49	0	18	35	11	0	135	220	278	3411

PEAK HOUR SUMMARY

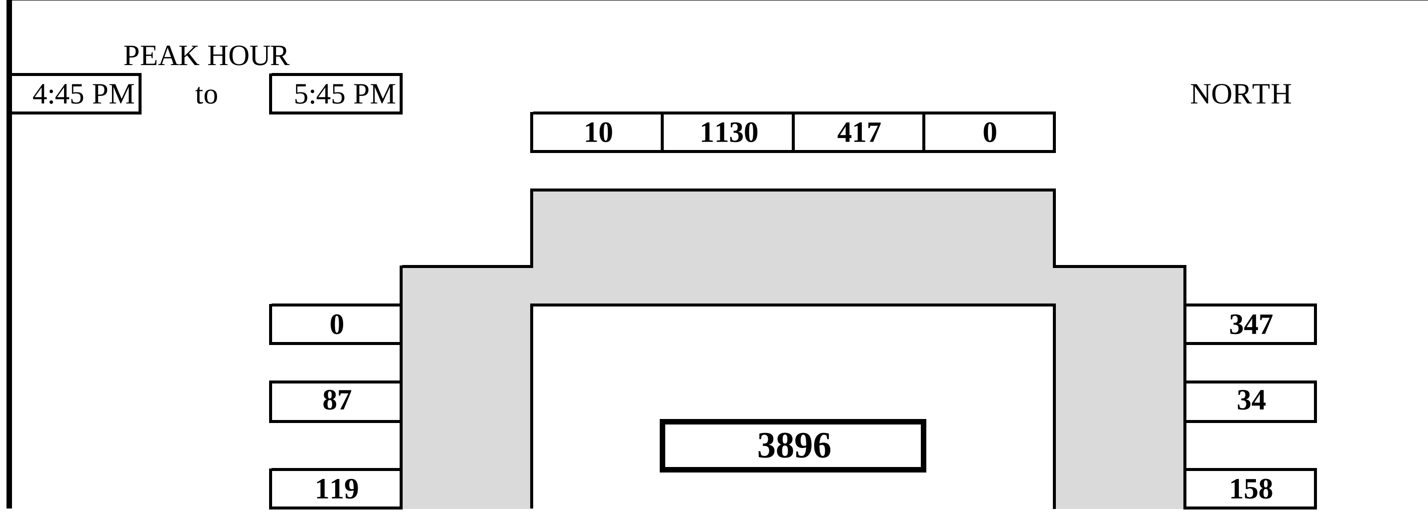
7:45 AM to 8:45 AM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	
VOLUME	1	82	923	211	0	416	1187	43	0	14	24	13	1	157	149	301	3522
PHF BY MOVEMENT	0.25	0.71	0.88	0.72	0.00	0.74	0.90	0.77	0.00	0.88	0.67	0.65	0.25	0.82	0.79	0.84	OVERALL
PHF BY APPROACH	0.86				0.94				0.91				0.93				0.96
BICYCLE	2				1				0				0				3
PEDESTRIAN	0				2				1				1				4
	N-LEG				S-LEG				E-LEG				W-LEG				
PEDESTRIAN BY LEG:	1				1				2				0				4

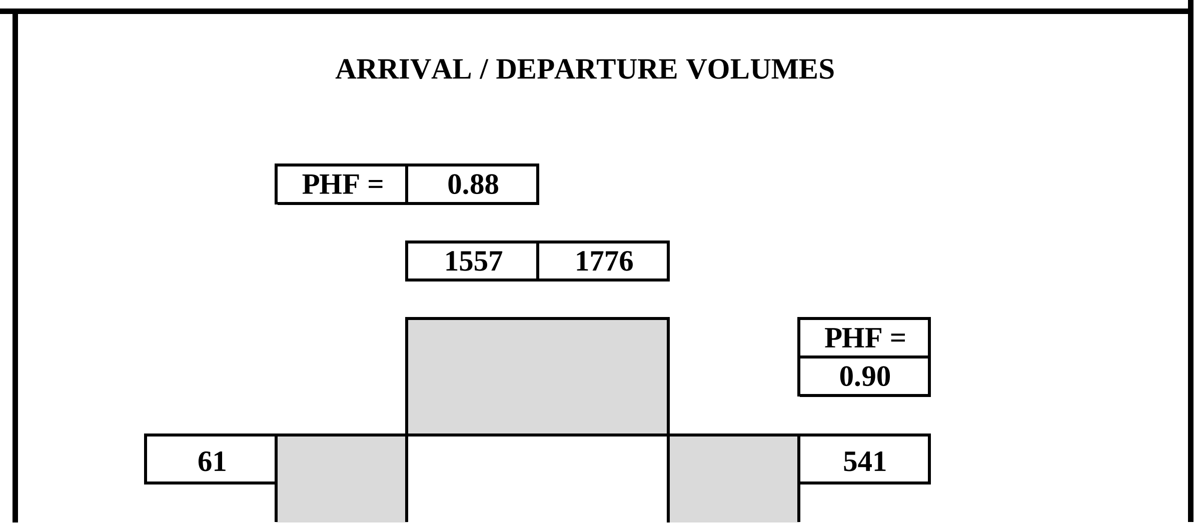
TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

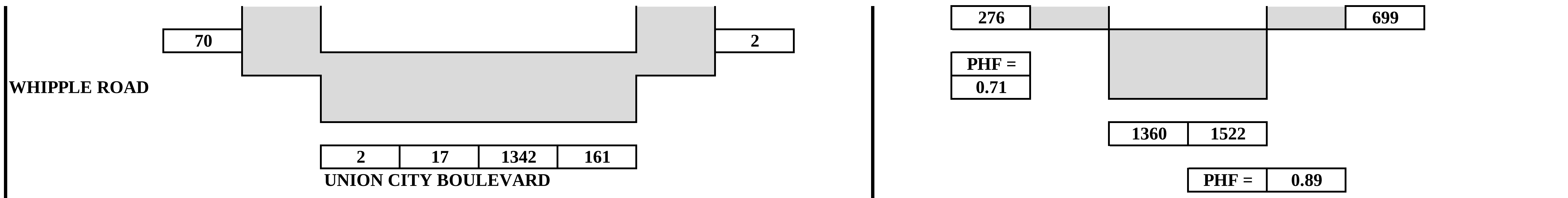
B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN UNION CITY	SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	UNION CITY BOULEVARD	SURVEY TIME:	4:00 PM	TO	6:00 PM
E-W APPROACH:	WHIPPLE ROAD	JURISDICTION:	UNION CITY	FILE:	3606057-3PM







TIME		PERIOD	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
From		To	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	
SURVEY DATA																			
4:00 PM	to	4:15 PM	0	9	367	56	0	121	241	4		12	20	7	1	28	17	70	**953**
4:15 PM	to	4:30 PM	0	15	688	101	0	225	462	7		37	48	19	2	64	42	142	**1852**
4:30 PM	to	4:45 PM	0	19	1045	159	0	308	686	8		58	78	34	2	91	57	211	**2756**
4:45 PM	to	5:00 PM	1	25	1423	202	0	415	938	11		75	100	41	2	135	68	306	**3742**
5:00 PM	to	5:15 PM	2	29	1722	248	0	508	1179	14		107	142	64	2	181	79	396	**4673**
5:15 PM	to	5:30 PM	2	31	2072	288	0	613	1489	16		123	169	86	3	212	86	486	**5676**
5:30 PM	to	5:45 PM	2	36	2387	320	0	725	1816	18		145	197	104	4	249	91	558	**6652**
5:45 PM	to	6:00 PM	3	41	2699	355	2	825	2111	23		153	214	106	4	277	101	664	**7578**
TOTAL BY PERIOD																			
4:00 PM	to	4:15 PM	0	9	367	56	0	121	241	4	0	12	20	7	1	28	17	70	**953**
4:15 PM	to	4:30 PM	0	6	321	45	0	104	221	3	0	25	28	12	1	36	25	72	**899**
4:30 PM	to	4:45 PM	0	4	357	58	0	83	224	1	0	21	30	15	0	27	15	69	**904**
4:45 PM	to	5:00 PM	1	6	378	43	0	107	252	3	0	17	22	7	0	44	11	95	**986**
5:00 PM	to	5:15 PM	1	4	299	46	0	93	241	3	0	32	42	23	0	46	11	90	**931**
5:15 PM	to	5:30 PM	0	2	350	40	0	105	310	2	0	16	27	22	1	31	7	90	**1003**
5:30 PM	to	5:45 PM	0	5	315	32	0	112	327	2	0	22	28	18	1	37	5	72	**976**
5:45 PM	to	6:00 PM	1	5	312	35	2	100	295	5	0	8	17	2	0	28	10	106	**926**
HOURLY TOTALS																			
4:00 PM	to	5:00 PM	1	25	1423	202	0	415	938	11	0	75	100	41	2	135	68	306	**3742**
4:15 PM	to	5:15 PM	2	20	1355	192	0	387	938	10	0	95	122	57	1	153	62	326	**3720**
4:30 PM	to	5:30 PM	2	16	1384	187	0	388	1027	9	0	86	121	67	1	148	44	344	**3824**
4:45 PM	to	5:45 PM	2	17	1342	161	0	417	1130	10	0	87	119	70	2	158	34	347	**3896**
5:00 PM	to	6:00 PM	2	16	1276	153	2	410	1173	12	0	78	114	65	2	142	33	358	**3836**

PEAK HOUR SUMMARY

4:45 PM to 5:45 PM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	
VOLUME	2	17	1342	161	0	417	1130	10	0	87	119	70	2	158	34	347	**3896**
PHF BY MOVEMENT	0.50	0.71	0.89	0.88	0.00	0.93	0.86	0.83	0.00	0.68	0.71	0.76	0.50	0.86	0.77	0.91	OVERALL
PHF BY APPROACH	0.89				0.88				0.71				0.90				0.97
BICYCLE	0				5				0				1				**6**
PEDESTRIAN	1				3				5				3				**12**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	4				4				1				3				**12**

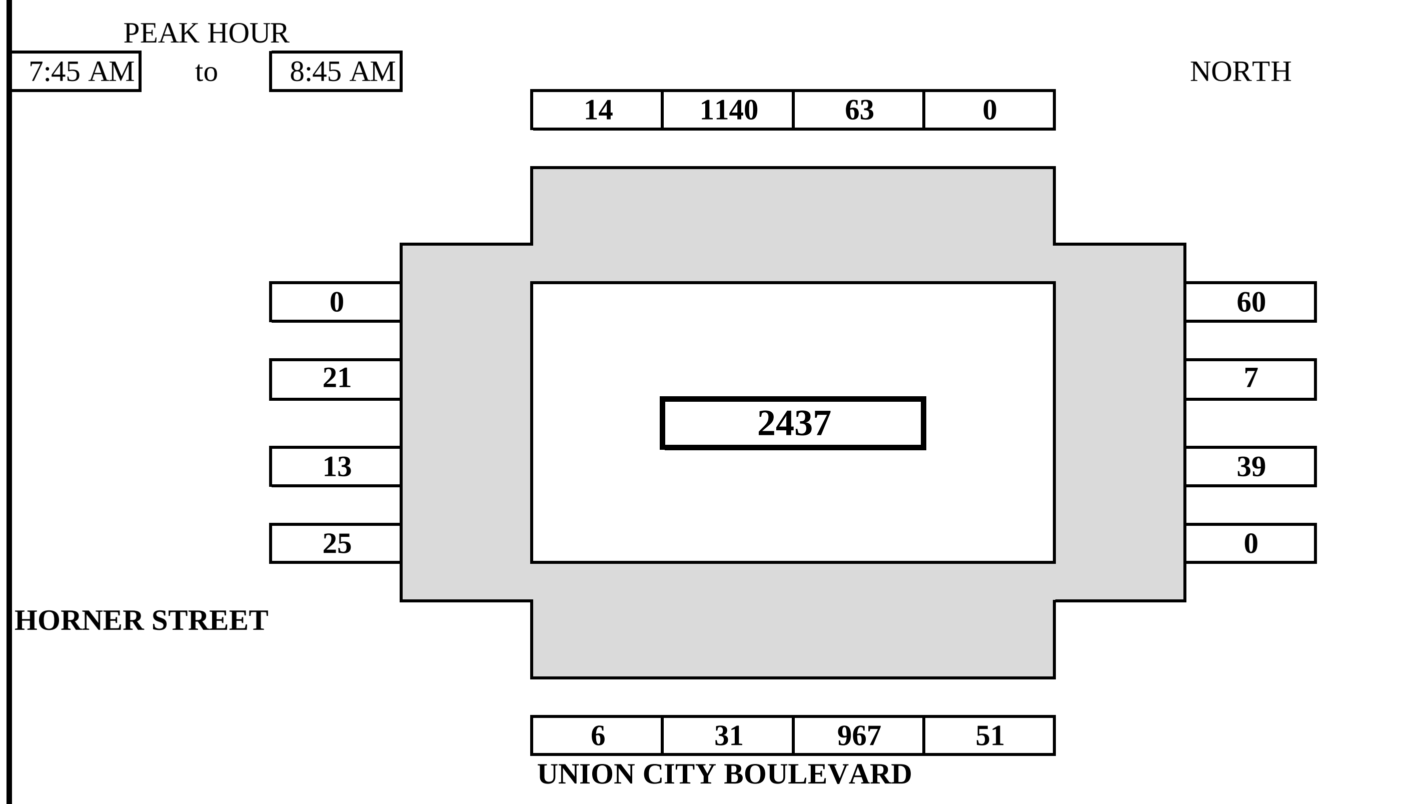
TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

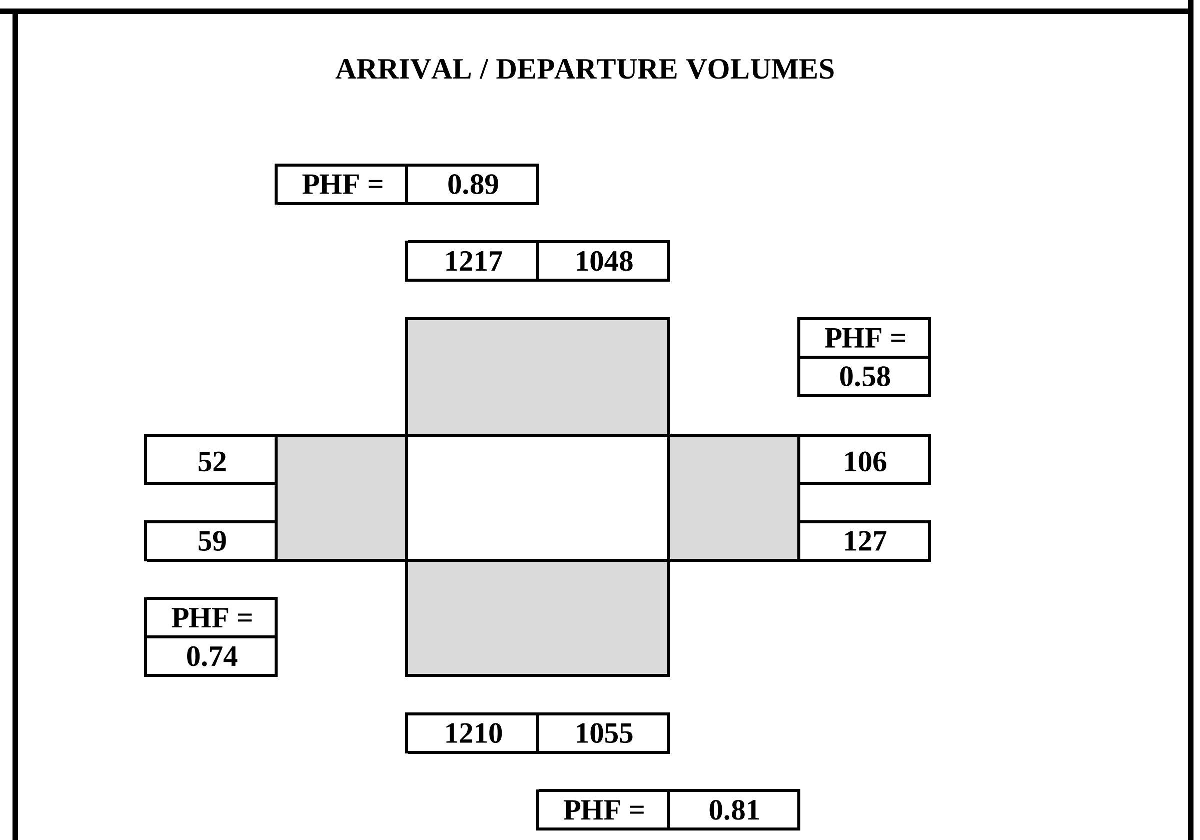
B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**	**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**UNION CITY BOULEVARD**	**SURVEY TIME:**	**7:00 AM**	**TO**	**9:00 AM**
E-W APPROACH:	**HORNER STREET**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-4AM**

PEAK HOUR 7:45 AM to 8:45 AM





TIME From		PERIOD To	NB U-TURN	NB LEFT	NB THRU	NB RIGHT	SB U-TURN	SB LEFT	SB THRU	SB RIGHT	EB U-TURN	EB LEFT	EB THRU	EB RIGHT	WB U-TURN	WB LEFT	WB THRU	WB RIGHT	TOTAL
SURVEY DATA																			
7:00 AM	to	7:15 AM	2	8	159	6		5	297	25		7	4	5		3	3	4	**528**
7:15 AM	to	7:30 AM	2	12	340	9		15	562	26		10	6	11		4	4	11	**1012**
7:30 AM	to	7:45 AM	4	16	534	37		31	835	31		15	9	28		13	4	23	**1580**
7:45 AM	to	8:00 AM	5	24	801	57		62	1088	36		22	14	36		20	5	39	**2209**
8:00 AM	to	8:15 AM	5	31	1098	77		77	1338	36		25	19	43		40	6	64	**2859**
8:15 AM	to	8:30 AM	6	37	1296	87		94	1656	43		30	21	48		46	6	78	**3448**
8:30 AM	to	8:45 AM	10	47	1501	88		94	1975	45		36	22	53		52	11	83	**4017**
8:45 AM	to	9:00 AM	12	53	1679	92		102	2265	50		41	24	53		53	14	89	**4527**
TOTAL BY PERIOD																			
7:00 AM	to	7:15 AM	2	8	159	6	0	5	297	25	0	7	4	5	0	3	3	4	**528**
7:15 AM	to	7:30 AM	0	4	181	3	0	10	265	1	0	3	2	6	0	1	1	7	**484**
7:30 AM	to	7:45 AM	2	4	194	28	0	16	273	5	0	5	3	17	0	9	0	12	**568**
7:45 AM	to	8:00 AM	1	8	267	20	0	31	253	5	0	7	5	8	0	7	1	16	**629**
8:00 AM	to	8:15 AM	0	7	297	20	0	15	250	0	0	3	5	7	0	20	1	25	**650**
8:15 AM	to	8:30 AM	1	6	198	10	0	17	318	7	0	5	2	5	0	6	0	14	**589**
8:30 AM	to	8:45 AM	4	10	205	1	0	0	319	2	0	6	1	5	0	6	5	5	**569**
8:45 AM	to	9:00 AM	2	6	178	4	0	8	290	5	0	5	2	0	0	1	3	6	**510**
HOURLY TOTALS																			
7:00 AM	to	8:00 AM	5	24	801	57	0	62	1088	36	0	22	14	36	0	20	5	39	**2209**
7:15 AM	to	8:15 AM	3	23	939	71	0	72	1041	11	0	18	15	38	0	37	3	60	**2331**
7:30 AM	to	8:30 AM	4	25	956	78	0	79	1094	17	0	20	15	37	0	42	2	67	**2436**
7:45 AM	to	8:45 AM	6	31	967	51	0	63	1140	14	0	21	13	25	0	39	7	60	**2437**
8:00 AM	to	9:00 AM	7	29	878	35	0	40	1177	14	0	19	10	17	0	33	9	50	**2318**

PEAK HOUR SUMMARY

7:45 AM to 8:45 AM	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	TOTAL
VOLUME	6	31	967	51	0	63	1140	14	0	21	13	25	0	39	7	60	**2437**
PHF BY MOVEMENT	0.38	0.78	0.81	0.64	0.00	0.51	0.89	0.50	0.00	0.75	0.65	0.78	0.00	0.49	0.35	0.60	OVERALL
PHF BY APPROACH	0.81				0.89				0.74				0.58				0.94
BICYCLE	3				1				2				1				**7**
PEDESTRIAN	7				6				26				14				**53**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	29				11				11				2				**53**

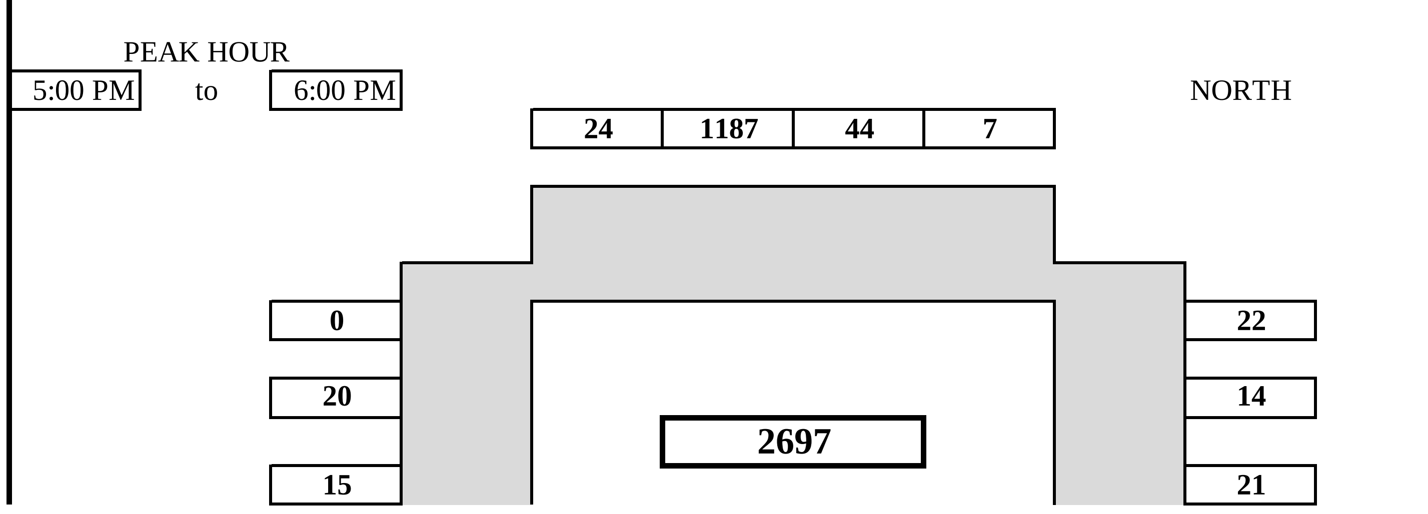
TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

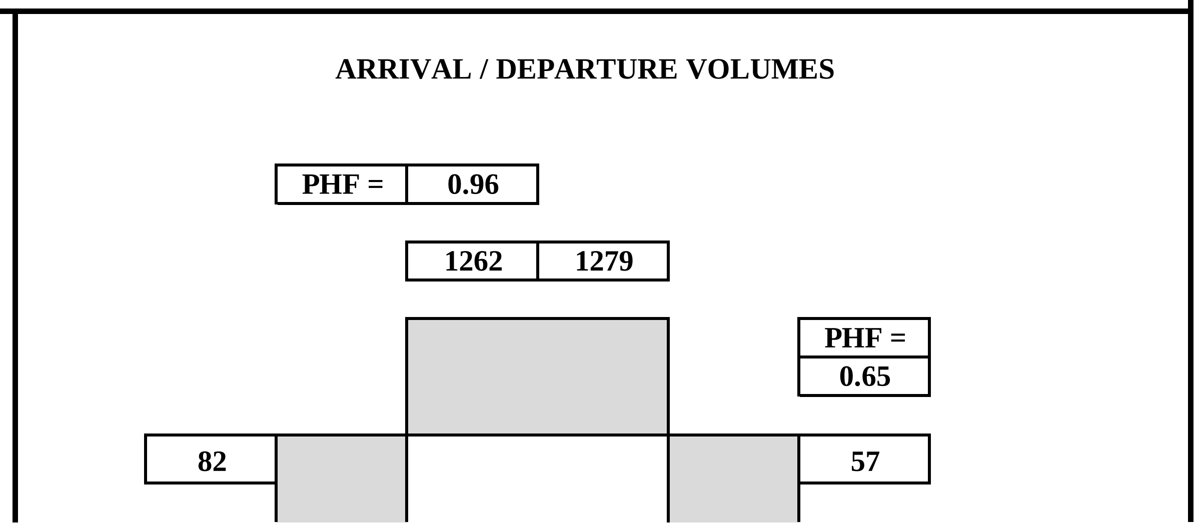
B.A.Y.M.E.T.R.I.C.S.

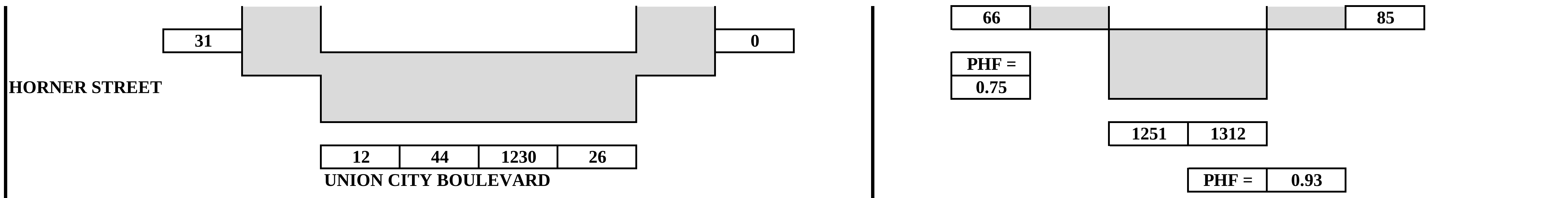
INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**	**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**UNION CITY BOULEVARD**	**SURVEY TIME:**	**4:00 PM**	**TO**	**6:00 PM**
E-W APPROACH:	**HORNER STREET**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-4PM**

PEAK HOUR 5:00 PM to 6:00 PM







TIME PERIOD From		To	NORTHBOUND U-TURN	LEFT	THRU	RIGHT	SOUTHBOUND U-TURN	LEFT	THRU	RIGHT	EASTBOUND U-TURN	LEFT	THRU	RIGHT	WESTBOUND U-TURN	LEFT	THRU	RIGHT	TOTAL
SURVEY DATA																			
4:00 PM	to	4:15 PM	1	8	328	9	1	15	228	12		2	3	0		9	3	8	**627**
4:15 PM	to	4:30 PM	3	17	693	16	2	24	449	22		3	4	4		11	4	15	**1267**
4:30 PM	to	4:45 PM	4	25	984	27	3	39	686	30		6	7	6		18	9	21	**1865**
4:45 PM	to	5:00 PM	9	33	1316	32	3	47	907	35		9	10	11		18	12	25	**2467**
5:00 PM	to	5:15 PM	10	44	1639	40	7	68	1184	39		9	11	16		20	12	27	**3126**
5:15 PM	to	5:30 PM	13	61	1960	47	7	70	1489	48		15	15	26		28	18	31	**3828**
5:30 PM	to	5:45 PM	17	72	2209	53	8	81	1795	57		21	17	36		33	20	37	**4456**
5:45 PM	to	6:00 PM	21	77	2546	58	10	91	2094	59		29	25	42		39	26	47	**5164**
TOTAL BY PERIOD																			
4:00 PM	to	4:15 PM	1	8	328	9	1	15	228	12	0	2	3	0	0	9	3	8	**627**
4:15 PM	to	4:30 PM	2	9	365	7	1	9	221	10	0	1	1	4	0	2	1	7	**640**
4:30 PM	to	4:45 PM	1	8	291	11	1	15	237	8	0	3	3	2	0	7	5	6	**598**
4:45 PM	to	5:00 PM	5	8	332	5	0	8	221	5	0	3	3	5	0	0	3	4	**602**
5:00 PM	to	5:15 PM	1	11	323	8	4	21	277	4	0	0	1	5	0	2	0	2	**659**
5:15 PM	to	5:30 PM	3	17	321	7	0	2	305	9	0	6	4	10	0	8	6	4	**702**
5:30 PM	to	5:45 PM	4	11	249	6	1	11	306	9	0	6	2	10	0	5	2	6	**628**
5:45 PM	to	6:00 PM	4	5	337	5	2	10	299	2	0	8	8	6	0	6	6	10	**708**
HOURLY TOTALS																			
4:00 PM	to	5:00 PM	9	33	1316	32	3	47	907	35	0	9	10	11	0	18	12	25	**2467**
4:15 PM	to	5:15 PM	9	36	1311	31	6	53	956	27	0	7	8	16	0	11	9	19	**2499**
4:30 PM	to	5:30 PM	10	44	1267	31	5	46	1040	26	0	12	11	22	0	17	14	16	**2561**
4:45 PM	to	5:45 PM	13	47	1225	26	5	42	1109	27	0	15	10	30	0	15	11	16	**2591**
5:00 PM	to	6:00 PM	12	44	1230	26	7	44	1187	24	0	20	15	31	0	21	14	22	**2697**

PEAK HOUR SUMMARY

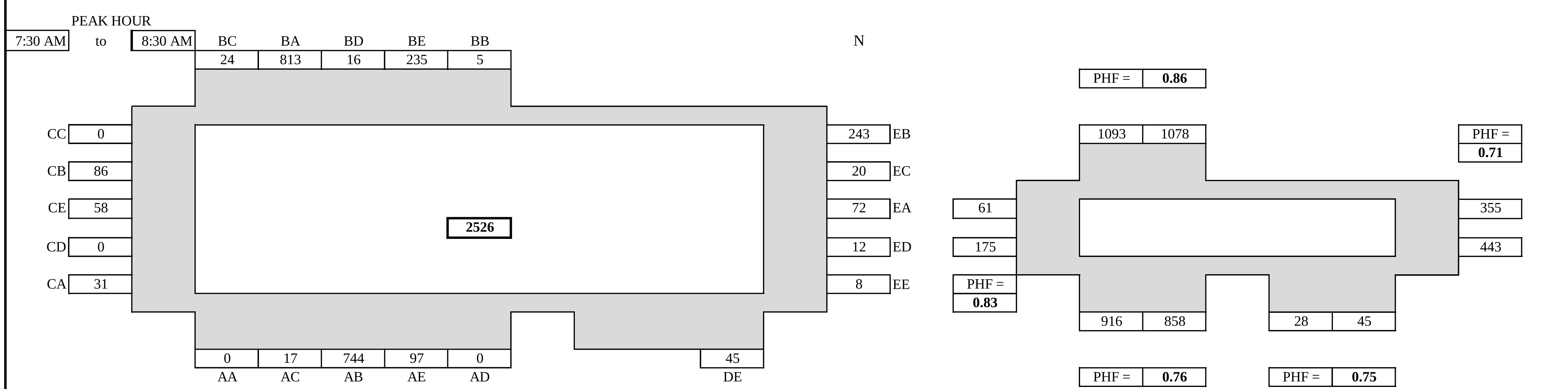
5:00 PM to 6:00 PM	NORTHBOUND NBU	NBL	NBT	NBR	SOUTHBOUND SBU	SBL	SBT	SBR	EASTBOUND EBU	EBL	EBT	EBR	WESTBOUND WBU	WBL	WBT	WBR	TOTAL
VOLUME	12	44	1230	26	7	44	1187	24	0	20	15	31	0	21	14	22	**2697**
PHF BY MOVEMENT	0.75	0.65	0.91	0.81	0.44	0.52	0.97	0.67	0.00	0.63	0.47	0.78	0.00	0.66	0.58	0.55	OVERALL
PHF BY APPROACH	0.93				0.96				0.75				0.65				0.95
BICYCLE	1				5				0				2				**8**
PEDESTRIAN	20				8				8				6				**42**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	7				7				22				6				**42**

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN OAKLAND	SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	UNION CITY BOULEVARD	SURVEY TIME:	7:00 AM TO		9:00 AM
E-W APPROACH:	ALVERADO BOULEVARD	JURISDICTION:	OAKLAND	FILE:	3606057-5AM



TIME PERIOD FROM		TO	A (UNION CITY BL) NB AA	AC	AB	AE	AD	B (UNION CITY BL) SB BB	BE	BD	BA	BC	D DE	C (ALVARADO BL) EB CC	CB	CE	CD	CA	E (ALVERADO BL) WB EE	ED	EA	EC	EB	TOTAL
SURVEY DATA																								
7:00 AM	to	7:15 AM	0	0	121	2	0	2	37	2	205	3	8		18	19	1	3	0	0	8	1	20	*450*
7:15 AM	to	7:30 AM	0	1	224	10	0	4	89	5	439	10	23		41	34	1	12	1	1	11	7	68	*981*
7:30 AM	to	7:45 AM	0	1	396	17	0	5	148	5	690	16	35		70	47	1	23	3	3	20	8	116	*1604*
7:45 AM	to	8:00 AM	0	7	592	53	0	7	201	10	827	18	50		90	63	1	34	5	6	34	16	180	*2194*
8:00 AM	to	8:15 AM	0	14	822	97	0	8	270	16	1009	28	61		108	74	1	36	7	11	65	22	261	*2910*
8:15 AM	to	8:30 AM	0	18	968	107	0	9	324	21	1252	34	68		127	92	1	43	9	13	83	27	311	*3507*
8:30 AM	to	8:45 AM	0	19	1110	115	0	12	381	22	1522	37	75		138	99	1	48	9	13	92	30	369	*4092*
8:45 AM	to	9:00 AM	1	20	1244	122	0	13	440	24	1751	42	83		153	115	1	53	12	14	95	33	422	*4638*
TOTAL BY PERIOD																								
7:00 AM	to	7:15 AM	0	0	121	2	0	2	37	2	205	3	8	0	18	19	1	3	0	0	8	1	20	*450*
7:15 AM	to	7:30 AM	0	1	103	8	0	2	52	3	234	7	15	0	23	15	0	9	1	1	3	6	48	*531*
7:30 AM	to	7:45 AM	0	0	172	7	0	1	59	0	251	6	12	0	29	13	0	11	2	2	9	1	48	*623*
7:45 AM	to	8:00 AM	0	6	196	36	0	2	53	5	137	2	15	0	20	16	0	11	2	3	14	8	64	*590*
8:00 AM	to	8:15 AM	0	7	230	44	0	1	69	6	182	10	11	0	18	11	0	2	2	5	31	6	81	*716*
8:15 AM	to	8:30 AM	0	4	146	10	0	1	54	5	243	6	7	0	19	18	0	7	2	2	18	5	50	*597*
8:30 AM	to	8:45 AM	0	1	142	8	0	3	57	1	270	3	7	0	11	7	0	5	0	0	9	3	58	*585*
8:45 AM	to	9:00 AM	1	1	134	7	0	1	59	2	229	5	8	0	15	16	0	5	3	1	3	3	53	*546*
HOURLY TOTALS																								
7:00 AM	to	8:00 AM	0	7	592	53	0	7	201	10	827	18	50	0	90	63	1	34	5	6	34	16	180	*2194*
7:15 AM	to	8:15 AM	0	14	701	95	0	6	233	14	804	25	53	0	90	55	0	33	7	11	57	21	241	*2460*
7:30 AM	to	8:30 AM	0	17	744	97	0	5	235	16	813	24	45	0	86	58	0	31	8	12	72	20	243	*2526*
7:45 AM	to	8:45 AM	0	18	714	98	0	7	233	17	832	21	40	0	68	52	0	25	6	10	72	22	253	*2488*
8:00 AM	to	9:00 AM	1	13	652	69	0	6	239	14	924	24	33	0	63	52	0	19	7	8	61	17	242	*2444*

PEAK HOUR SUMMARY

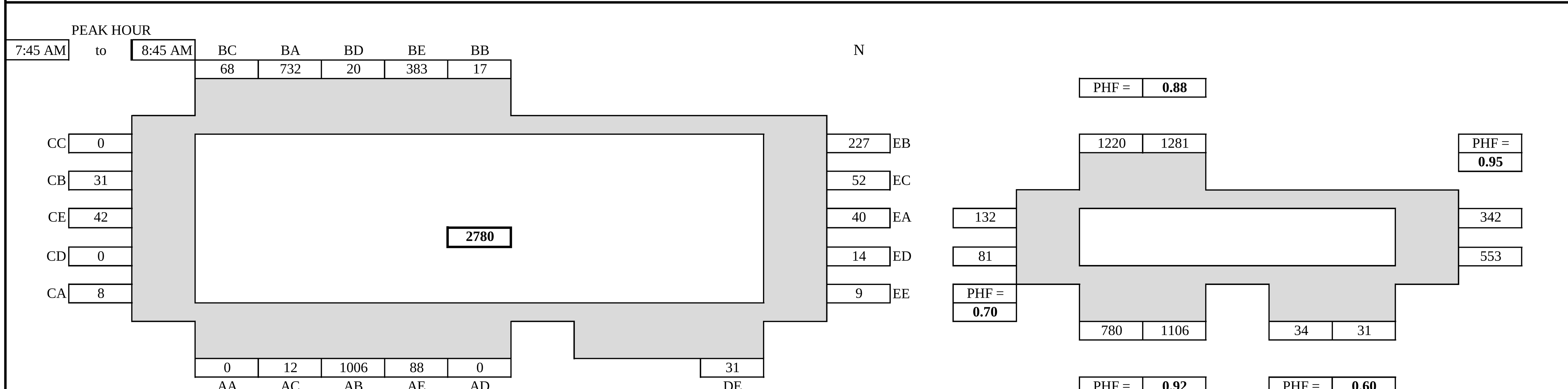
7:30 AM to 8:30 AM	A (UNION CITY BL) NB AA	AC	AB	AE	AD	B (UNION CITY BL) SB BC	BA	BD	BE	BB	D DE	C (ALVARADO BL) EB CC	CB	CE	CD	CA	E (ALVERADO BL) WB EB	EC	EA	ED	EE	TOTAL
VOLUME	0	17	744	97	0	5	235	16	813	24	45	0	86	58	0	31	8	12	72	20	243	2526
PHF BY MOVEMENT	0.00	0.61	0.81	0.55	0.00	0.63	0.85	0.67	0.81	0.60	0.75	0.00	0.74	0.81	0.00	0.70	1.00	0.60	0.58	0.63	0.75	OVERALL
PHF BY APPROACH	0.76					0.86					0.75	0.83					0.71					0.88
PEDESTRIANS	4					1						16					3					24
BICYCLE	2					0					1	0					0					3

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	TRAFFIC COUNTS IN OAKLAND	SURVEY DATE:	6/7/2016	DAY:	TUESDAY
N-S APPROACH:	UNION CITY BOULEVARD	SURVEY TIME:	7:00 AM TO		9:00 AM
E-W APPROACH:	ALVERADO BOULEVARD	JURISDICTION:	OAKLAND	FILE:	3606057-5AM



TIME PERIOD FROM		TO	A (UNION CITY BL) NB AA	AC	AB	AE	AD	B (UNION CITY BL) SB BB	BE	BD	BA	BC	D DE	C (ALVARADO BL) EB CC	CB	CE	CD	CA	E (ALVERADO BL) WB EE	ED	EA	EC	EB	TOTAL
SURVEY DATA																								
7:00 AM	to	7:15 AM		1	289	13	1	6	81	4	128	8	4		8	3	0	1	2	2	7	7	33	*598*
7:15 AM	to	7:30 AM		3	562	33	2	7	166	5	262	18	16		16	11	0	2	5	4	8	19	87	*1226*
7:30 AM	to	7:45 AM		6	820	47	2	8	219	6	404	27	24		24	21	0	5	5	6	23	33	153	*1833*
7:45 AM	to	8:00 AM		10	1087	78	2	15	321	10	564	46	32		30	33	0	10	7	9	36	45	209	*2544*
8:00 AM	to	8:15 AM		14	1334	101	2	18	411	14	731	62	38		38	43	0	11	9	12	45	53	277	*3213*
8:15 AM	to	8:30 AM		15	1576	114	2	19	511	21	917	71	42		42	49	0	11	11	16	58	66	335	*3876*
8:30 AM	to	8:45 AM		18	1826	135	2	25	602	26	1136	95	55		55	63	0	13	14	20	63	85	380	*4613*
8:45 AM	to	9:00 AM		21	2062	146	4	31	706	29	1301	113	64		65	65	0	13	16	24	67	96	435	*5258*
TOTAL BY PERIOD																								
7:00 AM	to	7:15 AM	0	1	289	13	1	6	81	4	128	8	4	0	8	3	0	1	2	2	7	7	33	*598*
7:15 AM	to	7:30 AM	0	2	273	20	1	1	85	1	134	10	12	0	8	8	0	1	3	2	1	12	54	*628*
7:30 AM	to	7:45 AM	0	3	258	14	0	1	53	1	142	9	8	0	8	10	0	3	0	2	15	14	66	*607*
7:45 AM	to	8:00 AM	0	4	267	31	0	7	102	4	160	19	8	0	6	12	0	5	2	3	13	12	56	*711*

8:00 AM	to	8:15 AM	0	4	247	23	0	3	90	4	167	16	6	0	8	10	0	1	2	3	9	8	68	***669***
8:15 AM	to	8:30 AM	0	1	242	13	0	1	100	7	186	9	4	0	4	6	0	0	2	4	13	13	58	***663***
8:30 AM	to	8:45 AM	0	3	250	21	0	6	91	5	219	24	13	0	13	14	0	2	3	4	5	19	45	***737***
8:45 AM	to	9:00 AM	0	3	236	11	2	6	104	3	165	18	9	0	10	2	0	0	2	4	4	11	55	***645***
H O U R L Y T O T A L S																								
7:00 AM	to	8:00 AM	0	10	1087	78	2	15	321	10	564	46	32	0	30	33	0	10	7	9	36	45	209	***2544***
7:15 AM	to	8:15 AM	0	13	1045	88	1	12	330	10	603	54	34	0	30	40	0	10	7	10	38	46	244	***2615***
7:30 AM	to	8:30 AM	0	12	1014	81	0	12	345	16	655	53	26	0	26	38	0	9	6	12	50	47	248	***2650***
7:45 AM	to	8:45 AM	0	12	1006	88	0	17	383	20	732	68	31	0	31	42	0	8	9	14	40	52	227	***2780***
8:00 AM	to	9:00 AM	0	11	975	68	2	16	385	19	737	67	32	0	35	32	0	3	9	15	31	51	226	***2714***
P E A K H O U R S U M M A R Y																								
7:45 AM	to	8:45 AM	A (UNION CITY BL) NB					B (UNION CITY BL) SB					D	C (ALVARADO BL) EB					E (ALVERADO BL) WB					TOTAL
			AA	AC	AB	AE	AD	BC	BA	BD	BE	BB	DE	CC	CB	CE	CD	CA	EB	EC	EA	ED	EE	
VOLUME			0	12	1006	88	0	17	383	20	732	68	31	0	31	42	0	8	9	14	40	52	227	2780
PHF BY MOVEMENT			0.00	0.75	0.94	0.71	0.00	0.61	0.94	0.71	0.84	0.71	0.60	0.00	0.60	0.75	0.00	0.40	0.75	0.88	0.77	0.68	0.83	OVERALL
PHF BY APPROACH			0.92					0.88					0.60	0.70					0.95					0.94
PEDESTRIANS			2					0						7					1					10
BICYCLE			1					7					0	2					1					11

TEL: (510) 232 - 1271 **FAX: (510) 232 - 1272**

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**	**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**UNION CITY BOULEVARD**	**SURVEY TIME:**	**7:00 AM**	**TO**	**9:00 AM**
E-W APPROACH:	**DYER STREET**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-6AM**

PEAK HOUR
7:30 AM to 8:30 AM

NORTH

3 | 936 | 6 | 2

0
22
24
16

1951

5
12
178
0

DYER STREET

0 | 9 | 595 | 143
UNION CITY BOULEVARD

ARRIVAL / DEPARTURE VOLUMES

PHF = 0.79
947 | 624
PHF = 0.68
24 | 195
62 | 173
PHF = 0.78
1130 | 747
PHF = 0.74

TIME		PERIOD	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
From		To	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	
SURVEY DATA																			
7:00 AM	to	7:15 AM		0	57	14	0	1	265	1		2	4	8		74	2	1	**429**
7:15 AM	to	7:30 AM		1	127	34	0	1	489	4		6	9	17		135	5	1	**829**
7:30 AM	to	7:45 AM		1	246	70	1	5	782	4		10	19	23		186	8	3	**1358**
7:45 AM	to	8:00 AM		5	414	118	1	6	935	4		15	25	30		205	10	3	**1771**
8:00 AM	to	8:15 AM		9	620	159	2	6	1148	6		22	29	33		247	14	3	**2298**
8:15 AM	to	8:30 AM		10	722	177	2	7	1425	7		28	33	33		313	17	6	**2780**
8:30 AM	to	8:45 AM		13	829	199	2	10	1711	9		30	36	40		372	17	7	**3275**
8:45 AM	to	9:00 AM		13	908	212	3	10	1949	11		32	38	43		406	19	7	**3651**
TOTAL BY PERIOD																			
7:00 AM	to	7:15 AM	0	0	57	14	0	1	265	1	0	2	4	8	0	74	2	1	**429**
7:15 AM	to	7:30 AM	0	1	70	20	0	0	224	3	0	4	5	9	0	61	3	0	**400**
7:30 AM	to	7:45 AM	0	0	119	36	1	4	293	0	0	4	10	6	0	51	3	2	**529**
7:45 AM	to	8:00 AM	0	4	168	48	0	1	153	0	0	5	6	7	0	19	2	0	**413**
8:00 AM	to	8:15 AM	0	4	206	41	1	0	213	2	0	7	4	3	0	42	4	0	**527**
8:15 AM	to	8:30 AM	0	1	102	18	0	1	277	1	0	6	4	0	0	66	3	3	**482**
8:30 AM	to	8:45 AM	0	3	107	22	0	3	286	2	0	2	3	7	0	59	0	1	**495**
8:45 AM	to	9:00 AM	0	0	79	13	1	0	238	2	0	2	2	3	0	34	2	0	**376**
HOURLY TOTALS																			
7:00 AM	to	8:00 AM	0	5	414	118	1	6	935	4	0	15	25	30	0	205	10	3	**1771**
7:15 AM	to	8:15 AM	0	9	563	145	2	5	883	5	0	20	25	25	0	173	12	2	**1869**
7:30 AM	to	8:30 AM	0	9	595	143	2	6	936	3	0	22	24	16	0	178	12	5	**1951**
7:45 AM	to	8:45 AM	0	12	583	129	1	5	929	5	0	20	17	17	0	186	9	4	**1917**
8:00 AM	to	9:00 AM	0	8	494	94	2	4	1014	7	0	17	13	13	0	201	9	4	**1880**

PEAK HOUR SUMMARY

7:30 AM to 8:30 AM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	
VOLUME	0	9	595	143	2	6	936	3	0	22	24	16	0	178	12	5	**1951**
PHF BY MOVEMENT	0.00	0.56	0.72	0.74	0.50	0.38	0.80	0.38	0.00	0.79	0.60	0.57	0.00	0.67	0.75	0.42	OVERALL
PHF BY APPROACH	0.74				0.79				0.78				0.68				0.92
BICYCLE	2				0				0				1				**3**
PEDESTRIAN	3				4				2				2				**11**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	4				0				0				7				**11**

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

B.A.Y.M.E.T.R.I.C.S.

INTERSECTION TURNING MOVEMENT SUMMARY

PROJECT:	**TRAFFIC COUNTS IN UNION CITY**	**SURVEY DATE:**	**6/7/2016**	**DAY:**	**TUESDAY**
N-S APPROACH:	**UNION CITY BOULEVARD**	**SURVEY TIME:**	**4:00 PM**	**TO**	**6:00 PM**
E-W APPROACH:	**DYER STREET**	**JURISDICTION:**	**UNION CITY**	**FILE:**	**3606057-6PM**

PEAK HOUR
5:00 PM to 6:00 PM

NORTH

9 | 619 | 13 | 0

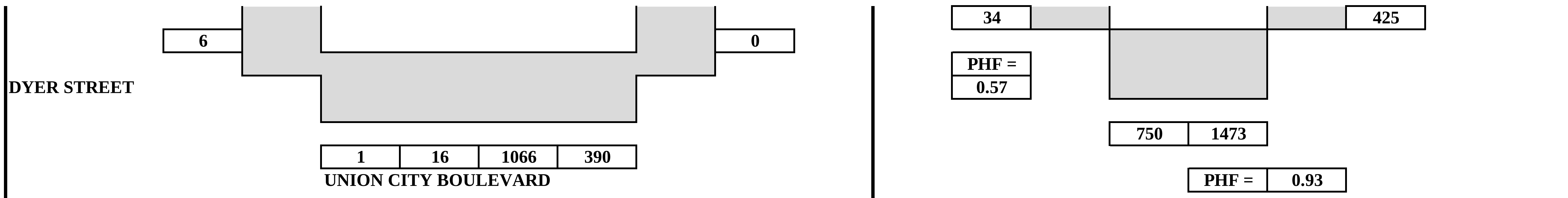
0
6
22

2294

2
20
124

ARRIVAL / DEPARTURE VOLUMES

PHF = 0.93
641 | 1074
PHF = 0.91
45 | 146



TIME		PERIOD	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
From		To	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	U-TURN	LEFT	THRU	RIGHT	
SURVEY DATA																			
4:00 PM	to	4:15 PM	0	6	332	104		2	103	3		0	3	2		25	2	0	**582**
4:15 PM	to	4:30 PM	0	9	640	215		4	210	6		4	5	5		50	8	3	**1159**
4:30 PM	to	4:45 PM	1	10	918	333		6	338	8		5	8	8		84	8	4	**1731**
4:45 PM	to	5:00 PM	1	11	1179	447		7	446	12		7	14	8		110	13	5	**2260**
5:00 PM	to	5:15 PM	2	15	1434	537		8	592	16		11	22	11		141	20	5	**2814**
5:15 PM	to	5:30 PM	2	22	1698	652		13	744	19		11	28	12		166	25	5	**3397**
5:30 PM	to	5:45 PM	2	24	1994	749		18	909	21		12	30	12		198	31	5	**4005**
5:45 PM	to	6:00 PM	2	27	2245	837		20	1065	21		13	36	14		234	33	7	**4554**
TOTAL BY PERIOD																			
4:00 PM	to	4:15 PM	0	6	332	104	0	2	103	3	0	0	3	2	0	25	2	0	**582**
4:15 PM	to	4:30 PM	0	3	308	111	0	2	107	3	0	4	2	3	0	25	6	3	**577**
4:30 PM	to	4:45 PM	1	1	278	118	0	2	128	2	0	1	3	3	0	34	0	1	**572**
4:45 PM	to	5:00 PM	0	1	261	114	0	1	108	4	0	2	6	0	0	26	5	1	**529**
5:00 PM	to	5:15 PM	1	4	255	90	0	1	146	4	0	4	8	3	0	31	7	0	**554**
5:15 PM	to	5:30 PM	0	7	264	115	0	5	152	3	0	0	6	1	0	25	5	0	**583**
5:30 PM	to	5:45 PM	0	2	296	97	0	5	165	2	0	1	2	0	0	32	6	0	**608**
5:45 PM	to	6:00 PM	0	3	251	88	0	2	156	0	0	1	6	2	0	36	2	2	**549**
HOURLY TOTALS																			
4:00 PM	to	5:00 PM	1	11	1179	447	0	7	446	12	0	7	14	8	0	110	13	5	**2260**
4:15 PM	to	5:15 PM	2	9	1102	433	0	6	489	13	0	11	19	9	0	116	18	5	**2232**
4:30 PM	to	5:30 PM	2	13	1058	437	0	9	534	13	0	7	23	7	0	116	17	2	**2238**
4:45 PM	to	5:45 PM	1	14	1076	416	0	12	571	13	0	7	22	4	0	114	23	1	**2274**
5:00 PM	to	6:00 PM	1	16	1066	390	0	13	619	9	0	6	22	6	0	124	20	2	**2294**

PEAK HOUR SUMMARY

5:00 PM to 6:00 PM	NORTHBOUND				SOUTHBOUND				EASTBOUND				WESTBOUND				TOTAL
	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	
VOLUME	1	16	1066	390	0	13	619	9	0	6	22	6	0	124	20	2	**2294**
PHF BY MOVEMENT	0.25	0.57	0.90	0.85	0.00	0.65	0.94	0.56	0.00	0.38	0.69	0.50	0.00	0.86	0.71	0.25	OVERALL
PHF BY APPROACH	0.93				0.93				0.57				0.91				0.94
BICYCLE	1				0				3				0				**4**
PEDESTRIAN	2				4				2				3				**11**
	N-LEG				**S-LEG**				**E-LEG**				**W-LEG**				
PEDESTRIAN BY LEG:	5				0				2				4				**11**

TEL: (510) 232 - 1271 FAX: (510) 232 - 1272

APPENDIX B
LEVEL OF SERVICE CALCULATION SHEETS
for
BASE CASE SCENARIO

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	186	616	255	143	494	421	357	25	209	618
Future Volume (vph)	322	751	186	616	255	143	494	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1442	3223	1442	1414	1612	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1442	3223	1442	1414	1612	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	209	677	280	157	537	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	209	677	280	40	537	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	12%	12%	12%	12%	12%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1442	827	370	362	505	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.33	0.26			c0.16	c0.28
v/s Ratio Perm			0.14			0.03						
v/c Ratio	0.93	0.64	0.14	0.82	0.76	0.11	1.06	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.15	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	23.3	1.8	0.2	8.9	13.5	0.6	57.9	6.3			87.8	11.9
Delay (s)	61.9	34.1	0.2	50.8	54.6	34.7	99.1	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		36.2		49.5				65.8				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	55.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	267	175	139	171	171	321	307	588	45	323	615	826
Future Volume (vph)	267	175	139	171	171	321	307	588	45	323	615	826
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1579	3258	1583	1681	1731	1410	3433	3539	1583	3127	3539	1533
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1579	3258	1583	1681	1731	1410	3433	3539	1583	3127	3539	1533
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	322	211	167	194	194	365	394	754	58	404	769	1032
RTOR Reduction (vph)	0	0	143	0	0	257	0	0	36	0	0	284
Lane Group Flow (vph)	174	359	24	175	213	108	394	754	22	404	769	749
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	2%	2%	4%	12%	2%	2%	2%	12%	2%	4%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	17.4	17.4	17.4	17.8	17.8	17.8	16.8	46.0	46.0	18.5	47.7	47.7
Effective Green, g (s)	17.4	17.4	17.4	17.8	17.8	17.8	16.8	46.0	46.0	18.5	47.7	47.7
Actuated g/C Ratio	0.14	0.14	0.14	0.15	0.15	0.15	0.14	0.38	0.38	0.15	0.40	0.40
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	228	472	229	249	256	209	480	1356	606	482	1406	609
v/s Ratio Prot	c0.11	0.11		0.10	c0.12		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.49
v/c Ratio	0.76	0.76	0.11	0.70	0.83	0.52	0.82	0.56	0.04	0.84	0.55	1.23
Uniform Delay, d1	49.3	49.3	44.5	48.6	49.6	47.1	50.1	29.0	23.1	49.3	27.8	36.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.97	0.99
Incremental Delay, d2	12.7	6.4	0.1	7.1	19.3	0.9	10.3	1.6	0.1	7.1	0.9	111.7
Delay (s)	62.0	55.7	44.6	55.7	68.9	48.0	60.4	30.6	23.3	57.0	28.0	147.6
Level of Service	E	E	D	E	E	D	E	C	C	E	C	F
Approach Delay (s)		54.6			55.7			40.0			89.3	
Approach LOS		D			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	66.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	82.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	157	149	301	1	82	923	211	416
Future Volume (vph)	14	24	13	1	157	149	301	1	82	923	211	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3368	1863	1533		1770	3471	1530	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3368	1863	1533		1770	3471	1530	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	169	160	324	1	95	1073	245	443
RTOR Reduction (vph)	0	13	0	0	0	0	270	0	0	0	78	0
Lane Group Flow (vph)	15	27	0	0	170	160	54	0	96	1073	167	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	4%	2%	4%	0%	2%	4%	4%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	10.5			11.6	19.4	19.4		12.4	53.9	53.9	20.7
Effective Green, g (s)	2.7	10.5			11.6	19.4	19.4		12.4	53.9	53.9	20.7
Actuated g/C Ratio	0.02	0.09			0.10	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	41	302			335	310	255		188	1605	707	598
v/s Ratio Prot	0.01	0.01			c0.05	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.11	
v/c Ratio	0.37	0.09			0.51	0.52	0.21		0.51	0.67	0.24	0.74
Uniform Delay, d1	56.1	48.6			49.7	44.3	41.9		49.2	24.4	18.9	45.4
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.0	0.0			0.4	0.6	0.2		1.0	1.2	0.2	4.3
Delay (s)	58.1	48.7			50.2	44.9	42.1		50.2	25.5	19.1	49.7
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		51.2				44.9				26.1		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	30.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	116.5	Sum of lost time (s)	19.8
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.2	
Effective Green, g (s)	62.2	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1843	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.4	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	21.7	
Level of Service	C	
Approach Delay (s)	28.8	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	21	13	25	39	7	60	6	31	967	51	63	1140
Future Volume (vph)	21	13	25	39	7	60	6	31	967	51	63	1140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.94			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.98			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1694			1641			1775	3439		1770	3465
Flt Permitted		0.74			0.85			0.95	1.00		0.95	1.00
Satd. Flow (perm)		1271			1418			1775	3439		1770	3465
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	28	18	34	67	12	103	7	38	1194	63	71	1281
RTOR Reduction (vph)	0	29	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	51	0	0	130	0	0	45	1255	0	71	1296
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.3			13.3			4.5	69.8		6.8	72.1
Effective Green, g (s)		13.3			13.3			4.5	69.8		6.8	72.1
Actuated g/C Ratio		0.13			0.13			0.04	0.66		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		160			179			76	2286		114	2379
v/s Ratio Prot								0.03	0.36		c0.04	c0.37
v/s Ratio Perm		0.04			c0.09							
v/c Ratio		0.32			0.73			0.59	0.55		0.62	0.54
Uniform Delay, d1		41.7			44.1			49.3	9.3		47.9	8.2
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		0.4			11.8			8.0	1.0		7.4	0.9
Delay (s)		42.2			55.9			57.3	10.2		55.2	9.1
Level of Service		D			E			E	B		E	A
Approach Delay (s)		42.2			55.9				11.9			11.5
Approach LOS		D			E				B			B

Intersection Summary			
HCM 2000 Control Delay	15.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	14
Future Volume (vph)	14
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	16
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	2%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	744	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	744	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3471	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3471	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	979	128	6
RTOR Reduction (vph)	0	130	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	81	0	0	0	129	28	45	22	979	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Effective Green, g (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.42	0.42	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		296				229	244	199	46	1463	644	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.28		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.56	0.11	0.23	0.48	0.67	0.20	
Uniform Delay, d1		38.6				36.9	34.7	35.2	43.5	21.1	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.3	0.2	
Delay (s)		39.1				38.8	34.8	35.4	46.3	22.4	16.7	
Level of Service		D				D	C	D	D	C	B	
Approach Delay (s)		39.1					36.3			22.2		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	20.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	813	24	45
Future Volume (vph)	235	16	813	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3456		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3456		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	945	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	972	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.5	12.5	48.3		11.9
Effective Green, g (s)	12.5	12.5	48.3		11.9
Actuated g/C Ratio	0.14	0.14	0.53		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	218	228	1842		208
v/s Ratio Prot	c0.09	0.09	0.28		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.53		0.04
Uniform Delay, d1	37.1	37.0	13.7		34.4
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	5.1	0.4		0.0
Delay (s)	43.6	42.2	14.1		34.4
Level of Service	D	D	B		C
Approach Delay (s)			20.8		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	22	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	22	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.96		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1764		1681	1696	1555	1766	3471	1550		1770	3469
Flt Permitted		0.85		0.83	0.77	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1527		1469	1367	1555	1766	3471	1550		1770	3469
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	28	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	12	0	0	0	6	0	0	62	0	0	0
Lane Group Flow (vph)	0	68	0	139	141	1	12	804	131	0	11	1189
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.6		11.6	11.6	11.6	0.8	36.1	36.1		0.8	36.1
Effective Green, g (s)		11.6		11.6	11.6	11.6	0.8	36.1	36.1		0.8	36.1
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.56	0.56		0.01	0.56
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		276		266	247	281	22	1957	874		22	1956
v/s Ratio Prot							c0.01	0.23			0.01	c0.34
v/s Ratio Perm		0.04		0.09	c0.10	0.00			0.08			
v/c Ratio		0.25		0.52	0.57	0.00	0.55	0.41	0.15		0.50	0.61
Uniform Delay, d1		22.4		23.7	23.9	21.5	31.4	7.9	6.6		31.4	9.3
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.2		0.9	2.0	0.0	14.0	0.2	0.1		6.4	0.6
Delay (s)		22.6		24.6	25.9	21.5	45.4	8.1	6.7		37.8	9.9
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		22.6			25.1			8.3				10.1
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	64.0	Sum of lost time (s)	15.5
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	3
Future Volume (vph)	3
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	4
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	2%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	223	751	208	267	170	635	131	48	179	575
Future Volume (vph)	724	765	223	751	208	267	170	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1442	3223	1442	1408	1612	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1442	3223	1442	1408	1612	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	253	791	219	281	191	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	253	791	219	169	191	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	12%	12%	12%	12%	12%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1442	837	374	366	455	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.12	c0.27			c0.15	0.24
v/s Ratio Perm			0.18			0.12						
v/c Ratio	1.33	0.55	0.18	0.95	0.59	0.46	0.42	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.0	45.9			56.1	33.8
Progression Factor	0.72	1.05	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.5	0.9	0.2	20.3	6.6	4.2	0.2	20.3			80.1	1.1
Delay (s)	194.2	25.4	0.2	67.5	48.6	44.6	38.2	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		93.5		59.3				61.1				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	73.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	410	503	289	300	94	340	255	866	146	4	479	747
Future Volume (vph)	410	503	289	300	94	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1579	3294	1583	1681	1708	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1579	3294	1583	1681	1708	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	427	524	301	316	99	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	194	0	0	226	0	0	95	0	0	0
Lane Group Flow (vph)	307	644	107	205	210	132	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	4%	4%	2%	2%	4%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.1	29.1	29.1	19.3	19.3	19.3	14.5	36.7	36.7		24.6	46.8
Effective Green, g (s)	30.4	30.4	30.4	20.2	20.2	20.2	15.2	38.1	38.1		25.3	48.2
Actuated g/C Ratio	0.23	0.23	0.23	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.37
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	369	770	370	261	265	221	401	1037	463		608	1312
v/s Ratio Prot	0.19	c0.20		0.12	c0.12		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.09			0.04			
v/c Ratio	0.83	0.84	0.29	0.79	0.79	0.60	0.69	0.91	0.14		0.87	0.63
Uniform Delay, d1	47.4	47.4	40.9	52.8	52.9	51.1	55.1	44.3	33.9		50.8	33.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.96	0.83
Incremental Delay, d2	14.1	7.5	0.2	13.3	14.0	2.9	4.1	13.0	0.6		9.1	1.6
Delay (s)	61.5	55.0	41.1	66.1	66.9	54.0	59.3	57.2	34.5		57.8	29.3
Level of Service	E	D	D	E	E	D	E	E	C		E	C
Approach Delay (s)		53.2			60.7			55.0				40.8
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	50.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	342
Future Volume (vph)	342
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1511
Flt Permitted	1.00
Satd. Flow (perm)	1511
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	376
RTOR Reduction (vph)	237
Lane Group Flow (vph)	139
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	4%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	46.8
Effective Green, g (s)	48.2
Actuated g/C Ratio	0.37
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	560
v/s Ratio Prot	
v/s Ratio Perm	0.09
v/c Ratio	0.25
Uniform Delay, d1	28.4
Progression Factor	1.46
Incremental Delay, d2	0.7
Delay (s)	42.1
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	158	34	347	2	17	1342	161	417
Future Volume (vph)	87	119	70	2	158	34	347	2	17	1342	161	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3368	1863	1527		1773	3471	1532	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3368	1863	1527		1773	3471	1532	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	176	38	386	2	19	1508	181	474
RTOR Reduction (vph)	0	75	0	0	0	0	254	0	0	0	55	0
Lane Group Flow (vph)	123	192	0	0	178	38	132	0	21	1508	126	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	4%	2%	4%	0%	2%	4%	4%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	18.0			12.4	16.4	16.4		6.0	55.6	55.6	28.2
Effective Green, g (s)	14.6	19.3			13.7	17.7	17.7		6.6	56.9	56.9	28.8
Actuated g/C Ratio	0.11	0.14			0.10	0.13	0.13		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	478			344	246	201		87	1473	650	723
v/s Ratio Prot	c0.07	0.06			0.05	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.08	
v/c Ratio	0.64	0.40			0.52	0.15	0.66		0.24	1.02	0.19	0.66
Uniform Delay, d1	57.2	52.1			57.0	51.5	55.3		61.3	38.5	24.2	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			1.3	0.1	5.7		0.5	29.7	0.7	1.6
Delay (s)	64.3	52.3			58.3	51.6	61.0		61.8	68.2	24.8	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.1				59.6				63.5		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	48.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.8	
Effective Green, g (s)	79.1	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2045	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.63	
Uniform Delay, d1	18.0	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.5	
Level of Service	B	
Approach Delay (s)	27.6	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	20	15	31	21	14	22	12	44	1230	26	7	44
Future Volume (vph)	20	15	31	21	14	22	12	44	1230	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.94			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1700			1713			1777	3456			1774
Flt Permitted		0.79			0.75			0.95	1.00			0.11
Satd. Flow (perm)		1369			1305			1777	3456			197
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	27	20	41	32	22	34	13	47	1323	28	7	46
RTOR Reduction (vph)	0	32	0	0	23	0	0	0	2	0	0	0
Lane Group Flow (vph)	0	56	0	0	65	0	0	60	1349	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	0%	2%	4%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		8.0			8.0			6.6	54.8			37.1
Effective Green, g (s)		8.9			8.9			7.5	56.1			38.0
Actuated g/C Ratio		0.08			0.08			0.07	0.49			0.33
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		105			100			115	1685			65
v/s Ratio Prot								0.03	c0.39			
v/s Ratio Perm		0.04			c0.05							c0.27
v/c Ratio		0.53			0.65			0.52	0.80			0.82
Uniform Delay, d1		51.0			51.5			52.0	24.8			35.3
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		2.6			10.4			2.0	4.1			50.2
Delay (s)		53.6			61.9			54.0	28.9			85.5
Level of Service		D			E			D	C			F
Approach Delay (s)		53.6			61.9				29.9			
Approach LOS		D			E				C			

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	24
Future Volume (vph)	1187	24
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3460	
Flt Permitted	1.00	
Satd. Flow (perm)	3460	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1236	25
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1260	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	85.3	
Effective Green, g (s)	86.6	
Actuated g/C Ratio	0.75	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2605	
v/s Ratio Prot	0.36	
v/s Ratio Perm		
v/c Ratio	0.48	
Uniform Delay, d1	5.5	
Progression Factor	1.00	
Incremental Delay, d2	0.6	
Delay (s)	6.2	
Level of Service	A	
Approach Delay (s)	9.4	
Approach LOS	A	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1006	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1006	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3471	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3471	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1093	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	214	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	25	13	1093	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	40.6	40.6	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	41.9	41.9	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.46	0.46	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		268				180	191	156	39	1607	709	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.31		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.33	0.68	0.14	
Uniform Delay, d1		38.5				37.9	37.5	37.0	43.6	19.0	13.9	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	1.8	1.3	0.1	
Delay (s)		38.6				38.3	37.8	37.2	45.4	20.4	14.0	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.6					37.5			20.1		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	732	68	31
Future Volume (vph)	383	20	732	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3426		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3426		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	832	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	906	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	54.8		8.4
Effective Green, g (s)	16.2	16.2	56.1		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	283	295	2123		165
v/s Ratio Prot	c0.16	0.13	0.26		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.43		0.03
Uniform Delay, d1	36.3	35.3	8.9		36.5
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	27.9	9.4	0.2		0.0
Delay (s)	64.2	44.7	9.1		36.6
Level of Service	E	D	A		D
Approach Delay (s)			24.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	6	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	6	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00
Flt Protected		0.99		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1794		1681	1706	1557		1772	3471	1548	1770	3463
Flt Permitted		0.93		0.94	0.78	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1680		1665	1378	1557		1772	3471	1548	1770	3463
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	11	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	8	0	0	0	2	0	0	0	83	0	0
Lane Group Flow (vph)	0	53	0	72	86	0	0	18	1146	336	14	676
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		6.9		6.9	6.9	6.9		0.8	33.8	33.8	0.7	33.7
Effective Green, g (s)		7.8		7.8	7.8	7.8		1.7	35.5	35.5	2.4	35.4
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		230		228	188	213		52	2165	965	74	2154
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		0.03		0.04	c0.06	0.00				0.22		
v/c Ratio		0.23		0.32	0.46	0.00		0.35	0.53	0.35	0.19	0.31
Uniform Delay, d1		21.9		22.1	22.6	21.2		27.1	6.0	5.1	26.3	5.0
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.2		0.3	0.6	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		22.1		22.4	23.2	21.2		28.5	6.3	5.4	26.8	5.2
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		22.1			22.9				6.3			5.6
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	56.9	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	9
Future Volume (vph)	9
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	10
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	2%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	189	616	255	143	497	421	357	25	209	618
Future Volume (vph)	322	751	189	616	255	143	497	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1417	3223	1442	1414	1597	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1417	3223	1442	1414	1597	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	212	677	280	157	540	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	212	677	280	40	540	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	14%	12%	12%	12%	13%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1417	827	370	362	500	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.34	0.26			c0.16	c0.28
v/s Ratio Perm			0.15			0.03						
v/c Ratio	0.93	0.64	0.15	0.82	0.76	0.11	1.08	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.14	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	23.1	1.8	0.2	8.9	13.5	0.6	63.5	6.3			87.8	11.9
Delay (s)	61.7	33.8	0.2	50.8	54.6	34.7	104.7	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		35.9		49.5				68.1				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	55.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	270	178	139	171	174	321	307	588	45	323	615	829
Future Volume (vph)	270	178	139	171	174	321	307	588	45	323	615	829
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1564	3209	1583	1681	1701	1411	3433	3539	1583	3127	3539	1533
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1564	3209	1583	1681	1701	1411	3433	3539	1583	3127	3539	1533
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	325	214	167	194	198	365	394	754	58	404	769	1036
RTOR Reduction (vph)	0	0	142	0	0	255	0	0	36	0	0	286
Lane Group Flow (vph)	175	364	25	175	217	110	394	754	22	404	769	750
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	5%	6%	2%	2%	6%	12%	2%	2%	2%	12%	2%	4%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	17.7	17.7	17.7	18.2	18.2	18.2	16.8	45.3	45.3	18.5	47.0	47.0
Effective Green, g (s)	17.7	17.7	17.7	18.2	18.2	18.2	16.8	45.3	45.3	18.5	47.0	47.0
Actuated g/C Ratio	0.15	0.15	0.15	0.15	0.15	0.15	0.14	0.38	0.38	0.15	0.39	0.39
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	230	473	233	254	257	214	480	1335	597	482	1386	600
v/s Ratio Prot	0.11	c0.11		0.10	c0.13		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.49
v/c Ratio	0.76	0.77	0.11	0.69	0.84	0.51	0.82	0.56	0.04	0.84	0.55	1.25
Uniform Delay, d1	49.1	49.2	44.3	48.2	49.5	46.8	50.1	29.6	23.6	49.3	28.4	36.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.98	0.99
Incremental Delay, d2	12.5	6.7	0.1	6.1	20.8	0.9	10.3	1.7	0.1	7.1	0.9	120.7
Delay (s)	61.6	55.9	44.4	54.3	70.4	47.7	60.4	31.3	23.7	56.7	28.6	157.0
Level of Service	E	E	D	D	E	D	E	C	C	E	C	F
Approach Delay (s)		54.6			55.7			40.4			94.0	
Approach LOS		D			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	69.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	162	149	301	1	82	923	216	416
Future Volume (vph)	14	24	13	1	162	149	301	1	82	923	216	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3274	1863	1533		1770	3471	1501	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3274	1863	1533		1770	3471	1501	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	174	160	324	1	95	1073	251	443
RTOR Reduction (vph)	0	13	0	0	0	0	270	0	0	0	80	0
Lane Group Flow (vph)	15	27	0	0	175	160	54	0	96	1073	171	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	7%	2%	4%	0%	2%	4%	6%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	10.4			11.9	19.6	19.6		12.4	54.0	54.0	20.7
Effective Green, g (s)	2.7	10.4			11.9	19.6	19.6		12.4	54.0	54.0	20.7
Actuated g/C Ratio	0.02	0.09			0.10	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	40	298			333	312	257		187	1604	693	596
v/s Ratio Prot	0.01	0.01			c0.05	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.11	
v/c Ratio	0.38	0.09			0.53	0.51	0.21		0.51	0.67	0.25	0.74
Uniform Delay, d1	56.2	48.9			49.8	44.3	41.9		49.3	24.4	19.1	45.5
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.0			0.7	0.6	0.2		1.0	1.2	0.3	4.4
Delay (s)	58.4	48.9			50.5	44.8	42.1		50.3	25.6	19.3	49.9
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		51.5				45.0				26.2		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	31.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	116.8	Sum of lost time (s)	19.8
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.3	
Effective Green, g (s)	62.3	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1841	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.5	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	21.9	
Level of Service	C	
Approach Delay (s)	29.0	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	23	13	25	39	7	60	6	31	970	51	63	1143
Future Volume (vph)	23	13	25	39	7	60	6	31	970	51	63	1143
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.94			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.98			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1630			1641			1775	3440		1770	3456
Flt Permitted		0.71			0.84			0.95	1.00		0.95	1.00
Satd. Flow (perm)		1183			1411			1775	3440		1770	3456
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	31	18	34	67	12	103	7	38	1198	63	71	1284
RTOR Reduction (vph)	0	27	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	56	0	0	130	0	0	45	1259	0	71	1301
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	13%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.2			13.2			4.5	69.9		6.8	72.2
Effective Green, g (s)		13.2			13.2			4.5	69.9		6.8	72.2
Actuated g/C Ratio		0.13			0.13			0.04	0.67		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		148			177			76	2290		114	2376
v/s Ratio Prot								0.03	0.37		c0.04	c0.38
v/s Ratio Perm		0.05			c0.09							
v/c Ratio		0.38			0.74			0.59	0.55		0.62	0.55
Uniform Delay, d1		42.1			44.2			49.3	9.3		47.9	8.2
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		0.6			12.8			8.0	1.0		7.4	0.9
Delay (s)		42.7			57.1			57.3	10.2		55.2	9.1
Level of Service		D			E			E	B		E	A
Approach Delay (s)		42.7			57.1				11.8			11.5
Approach LOS		D			E				B			B

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	16
Future Volume (vph)	16
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	18
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	19%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	747	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	747	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3471	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3471	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	983	128	6
RTOR Reduction (vph)	0	130	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	81	0	0	0	129	28	45	22	983	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				11.9	11.9	11.9	2.4	38.3	38.3	
Effective Green, g (s)		8.0				11.9	11.9	11.9	2.4	38.3	38.3	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.42	0.42	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		296				229	244	199	46	1465	645	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.28		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.56	0.11	0.23	0.48	0.67	0.20	
Uniform Delay, d1		38.6				37.0	34.8	35.3	43.5	21.1	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.3	0.2	
Delay (s)		39.1				38.9	34.8	35.5	46.4	22.5	16.7	
Level of Service		D				D	C	D	D	C	B	
Approach Delay (s)		39.1					36.3			22.3		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.7	Sum of lost time (s)	20.0
Intersection Capacity Utilization	71.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	816	24	45
Future Volume (vph)	235	16	816	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3456		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3456		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	949	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	976	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.5	12.5	48.4		11.9
Effective Green, g (s)	12.5	12.5	48.4		11.9
Actuated g/C Ratio	0.14	0.14	0.53		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	218	227	1844		208
v/s Ratio Prot	c0.09	0.09	0.28		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.53		0.04
Uniform Delay, d1	37.2	37.1	13.7		34.4
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	5.5	0.4		0.0
Delay (s)	43.6	42.6	14.1		34.4
Level of Service	D	D	B		C
Approach Delay (s)			20.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	25	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	25	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.97		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1676		1681	1696	1555	1766	3471	1550		1770	3453
Flt Permitted		0.83		0.81	0.78	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1425		1439	1376	1555	1766	3471	1550		1770	3453
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	32	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	11	0	0	0	6	0	0	62	0	0	0
Lane Group Flow (vph)	0	73	0	139	141	1	12	804	131	0	11	1193
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	16%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.6		11.6	11.6	11.6	0.8	36.9	36.9		0.8	36.9
Effective Green, g (s)		11.6		11.6	11.6	11.6	0.8	36.9	36.9		0.8	36.9
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.57	0.57		0.01	0.57
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		255		257	246	278	21	1976	882		21	1966
v/s Ratio Prot							c0.01	0.23			0.01	c0.35
v/s Ratio Perm		0.05		0.10	c0.10	0.00			0.08			
v/c Ratio		0.28		0.54	0.57	0.00	0.57	0.41	0.15		0.52	0.61
Uniform Delay, d1		23.0		24.2	24.3	21.9	31.8	7.8	6.6		31.8	9.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.2		1.2	2.0	0.0	21.2	0.2	0.1		10.4	0.6
Delay (s)		23.2		25.4	26.3	21.9	53.0	8.0	6.7		42.2	9.8
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		23.2			25.8			8.3				10.1
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	64.8	Sum of lost time (s)	15.5
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	6
Future Volume (vph)	6
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	8
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	67%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	226	751	208	267	173	635	131	48	179	575
Future Volume (vph)	724	765	226	751	208	267	173	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1429	3223	1442	1408	1583	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1429	3223	1442	1408	1583	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	257	791	219	281	194	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	257	791	219	169	194	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	13%	12%	12%	12%	14%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1429	837	374	366	446	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.12	c0.27			c0.15	0.24
v/s Ratio Perm			0.18			0.12						
v/c Ratio	1.33	0.55	0.18	0.95	0.59	0.46	0.43	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.2	45.9			56.1	33.8
Progression Factor	0.72	1.04	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.4	0.9	0.2	20.3	6.6	4.2	0.2	20.3			80.1	1.1
Delay (s)	194.2	25.2	0.2	67.5	48.6	44.6	38.4	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		93.3		59.3				61.0				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	73.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	413	506	289	300	97	340	255	866	146	4	479	747
Future Volume (vph)	413	506	289	300	97	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1564	3263	1583	1681	1685	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1564	3263	1583	1681	1685	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	430	527	301	316	102	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	193	0	0	225	0	0	95	0	0	0
Lane Group Flow (vph)	310	647	108	205	213	133	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	5%	5%	2%	2%	7%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.3	29.3	29.3	19.5	19.5	19.5	14.5	36.6	36.6		24.3	46.4
Effective Green, g (s)	30.6	30.6	30.6	20.4	20.4	20.4	15.2	38.0	38.0		25.0	47.8
Actuated g/C Ratio	0.24	0.24	0.24	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.37
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	368	768	372	263	264	223	401	1034	462		601	1301
v/s Ratio Prot	0.20	c0.20		0.12	c0.13		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.09			0.04			
v/c Ratio	0.84	0.84	0.29	0.78	0.81	0.60	0.69	0.91	0.14		0.88	0.63
Uniform Delay, d1	47.4	47.4	40.8	52.6	52.9	51.0	55.1	44.4	33.9		51.1	33.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.95	0.83
Incremental Delay, d2	15.3	8.0	0.2	12.5	15.5	2.8	4.1	13.3	0.6		10.1	1.6
Delay (s)	62.7	55.4	40.9	65.1	68.4	53.8	59.3	57.6	34.6		58.8	29.6
Level of Service	E	E	D	E	E	D	E	E	C		E	C
Approach Delay (s)		53.7			60.8			55.3				41.5
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	51.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1497
Flt Permitted	1.00
Satd. Flow (perm)	1497
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	379
RTOR Reduction (vph)	240
Lane Group Flow (vph)	139
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	5%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	46.4
Effective Green, g (s)	47.8
Actuated g/C Ratio	0.37
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	550
v/s Ratio Prot	
v/s Ratio Perm	0.09
v/c Ratio	0.25
Uniform Delay, d1	28.7
Progression Factor	1.47
Incremental Delay, d2	0.8
Delay (s)	42.9
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	163	34	347	2	17	1342	166	417
Future Volume (vph)	87	119	70	2	163	34	347	2	17	1342	166	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3275	1863	1527		1773	3471	1489	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3275	1863	1527		1773	3471	1489	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	181	38	386	2	19	1508	187	474
RTOR Reduction (vph)	0	76	0	0	0	0	254	0	0	0	56	0
Lane Group Flow (vph)	123	191	0	0	183	38	132	0	21	1508	131	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	7%	2%	4%	0%	2%	4%	7%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	17.6			12.8	16.4	16.4		6.0	55.6	55.6	28.2
Effective Green, g (s)	14.6	18.9			14.1	17.7	17.7		6.6	56.9	56.9	28.8
Actuated g/C Ratio	0.11	0.14			0.11	0.13	0.13		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	468			344	246	201		87	1473	632	723
v/s Ratio Prot	c0.07	0.06			0.06	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.09	
v/c Ratio	0.64	0.41			0.53	0.15	0.66		0.24	1.02	0.21	0.66
Uniform Delay, d1	57.2	52.5			56.8	51.5	55.3		61.3	38.5	24.3	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			1.6	0.1	5.7		0.5	29.7	0.7	1.6
Delay (s)	64.3	52.7			58.4	51.6	61.0		61.8	68.2	25.1	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.3				59.6				63.4		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	48.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.8	
Effective Green, g (s)	79.1	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2045	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.63	
Uniform Delay, d1	18.0	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.5	
Level of Service	B	
Approach Delay (s)	27.6	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	22	15	31	21	14	22	12	44	1233	26	7	44
Future Volume (vph)	22	15	31	21	14	22	12	44	1233	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.94			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1639			1713			1777	3456			1774
Flt Permitted		0.79			0.75			0.95	1.00			0.11
Satd. Flow (perm)		1308			1301			1777	3456			197
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	29	20	41	32	22	34	13	47	1326	28	7	46
RTOR Reduction (vph)	0	31	0	0	23	0	0	0	2	0	0	0
Lane Group Flow (vph)	0	59	0	0	65	0	0	60	1352	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	14%	2%	2%	2%	2%	2%	0%	2%	4%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		8.0			8.0			6.6	54.8			37.1
Effective Green, g (s)		8.9			8.9			7.5	56.1			38.0
Actuated g/C Ratio		0.08			0.08			0.07	0.49			0.33
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		101			100			115	1685			65
v/s Ratio Prot								0.03	c0.39			
v/s Ratio Perm		0.04			c0.05							c0.27
v/c Ratio		0.58			0.65			0.52	0.80			0.82
Uniform Delay, d1		51.2			51.5			52.0	24.8			35.3
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		5.4			10.4			2.0	4.2			50.2
Delay (s)		56.6			61.9			54.0	28.9			85.5
Level of Service		E			E			D	C			F
Approach Delay (s)		56.6			61.9				30.0			
Approach LOS		E			E				C			

Intersection Summary			
HCM 2000 Control Delay	22.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↑>	
Traffic Volume (vph)	1190	26
Future Volume (vph)	1190	26
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1240	27
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1266	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	4%	12%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	85.3	
Effective Green, g (s)	86.6	
Actuated g/C Ratio	0.75	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2599	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.49	
Uniform Delay, d1	5.5	
Progression Factor	1.00	
Incremental Delay, d2	0.7	
Delay (s)	6.2	
Level of Service	A	
Approach Delay (s)	9.4	
Approach LOS	A	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1009	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1009	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3471	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3471	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1097	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	214	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	25	13	1097	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	40.7	40.7	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	42.0	42.0	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.46	0.46	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		267				179	191	156	39	1609	710	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.32		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.33	0.68	0.14	
Uniform Delay, d1		38.6				37.9	37.6	37.1	43.6	19.1	13.9	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	1.8	1.3	0.1	
Delay (s)		38.6				38.4	37.9	37.2	45.5	20.4	14.0	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.6					37.6			20.1		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	735	68	31
Future Volume (vph)	383	20	735	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3426		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3426		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	835	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	909	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	54.9		8.4
Effective Green, g (s)	16.2	16.2	56.2		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	283	295	2125		165
v/s Ratio Prot	c0.16	0.13	0.27		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.43		0.03
Uniform Delay, d1	36.4	35.3	8.9		36.6
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	27.9	9.4	0.2		0.0
Delay (s)	64.2	44.7	9.1		36.6
Level of Service	E	D	A		D
Approach Delay (s)			24.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	9	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	9	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00
Flt Protected		0.99		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1629		1681	1706	1557		1772	3471	1548	1770	3441
Flt Permitted		0.90		0.91	0.82	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1485		1611	1449	1557		1772	3471	1548	1770	3441
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	16	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	8	0	0	0	2	0	0	0	83	0	1
Lane Group Flow (vph)	0	58	0	72	86	0	0	18	1146	336	14	678
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	44%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		6.9		6.9	6.9	6.9		0.8	33.8	33.8	0.7	33.7
Effective Green, g (s)		7.8		7.8	7.8	7.8		1.7	35.5	35.5	2.4	35.4
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		203		220	198	213		52	2165	965	74	2140
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		0.04		0.04	c0.06	0.00				0.22		
v/c Ratio		0.29		0.33	0.43	0.00		0.35	0.53	0.35	0.19	0.32
Uniform Delay, d1		22.1		22.2	22.5	21.2		27.1	6.0	5.1	26.3	5.1
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.3		0.3	0.6	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		22.3		22.5	23.1	21.2		28.5	6.3	5.4	26.8	5.2
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		22.3			22.8				6.3			5.6
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	56.9	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	12
Future Volume (vph)	12
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	13
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	33%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	189	616	255	143	497	421	357	25	209	618
Future Volume (vph)	322	751	189	616	255	143	497	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1417	3223	1442	1414	1597	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1417	3223	1442	1414	1597	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	212	677	280	157	540	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	212	677	280	40	540	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	14%	12%	12%	12%	13%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1417	827	370	362	500	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.34	0.26			c0.16	c0.28
v/s Ratio Perm			0.15			0.03						
v/c Ratio	0.93	0.64	0.15	0.82	0.76	0.11	1.08	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.14	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	23.1	1.8	0.2	8.9	13.5	0.6	63.5	6.3			87.8	11.9
Delay (s)	61.7	33.8	0.2	50.8	54.6	34.7	104.7	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		35.9		49.5				68.1				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	55.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	270	178	139	171	174	321	307	588	45	323	615	829
Future Volume (vph)	270	178	139	171	174	321	307	588	45	323	615	829
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1564	3209	1583	1681	1701	1411	3433	3539	1583	3127	3539	1533
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1564	3209	1583	1681	1701	1411	3433	3539	1583	3127	3539	1533
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	325	214	167	194	198	365	394	754	58	404	769	1036
RTOR Reduction (vph)	0	0	142	0	0	255	0	0	36	0	0	286
Lane Group Flow (vph)	175	364	25	175	217	110	394	754	22	404	769	750
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	5%	6%	2%	2%	6%	12%	2%	2%	2%	12%	2%	4%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	17.7	17.7	17.7	18.2	18.2	18.2	16.8	45.3	45.3	18.5	47.0	47.0
Effective Green, g (s)	17.7	17.7	17.7	18.2	18.2	18.2	16.8	45.3	45.3	18.5	47.0	47.0
Actuated g/C Ratio	0.15	0.15	0.15	0.15	0.15	0.15	0.14	0.38	0.38	0.15	0.39	0.39
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	230	473	233	254	257	214	480	1335	597	482	1386	600
v/s Ratio Prot	0.11	c0.11		0.10	c0.13		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.49
v/c Ratio	0.76	0.77	0.11	0.69	0.84	0.51	0.82	0.56	0.04	0.84	0.55	1.25
Uniform Delay, d1	49.1	49.2	44.3	48.2	49.5	46.8	50.1	29.6	23.6	49.3	28.4	36.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.98	0.99
Incremental Delay, d2	12.5	6.7	0.1	6.1	20.8	0.9	10.3	1.7	0.1	7.1	0.9	120.7
Delay (s)	61.6	55.9	44.4	54.3	70.4	47.7	60.4	31.3	23.7	56.7	28.6	157.0
Level of Service	E	E	D	D	E	D	E	C	C	E	C	F
Approach Delay (s)		54.6			55.7			40.4			94.0	
Approach LOS		D			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	69.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	162	149	301	1	82	923	216	416
Future Volume (vph)	14	24	13	1	162	149	301	1	82	923	216	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3274	1863	1533		1770	3471	1501	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3274	1863	1533		1770	3471	1501	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	174	160	324	1	95	1073	251	443
RTOR Reduction (vph)	0	13	0	0	0	0	270	0	0	0	80	0
Lane Group Flow (vph)	15	27	0	0	175	160	54	0	96	1073	171	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	7%	2%	4%	0%	2%	4%	6%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	10.4			11.9	19.6	19.6		12.4	54.0	54.0	20.7
Effective Green, g (s)	2.7	10.4			11.9	19.6	19.6		12.4	54.0	54.0	20.7
Actuated g/C Ratio	0.02	0.09			0.10	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	40	298			333	312	257		187	1604	693	596
v/s Ratio Prot	0.01	0.01			c0.05	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.11	
v/c Ratio	0.38	0.09			0.53	0.51	0.21		0.51	0.67	0.25	0.74
Uniform Delay, d1	56.2	48.9			49.8	44.3	41.9		49.3	24.4	19.1	45.5
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.0			0.7	0.6	0.2		1.0	1.2	0.3	4.4
Delay (s)	58.4	48.9			50.5	44.8	42.1		50.3	25.6	19.3	49.9
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		51.5				45.0				26.2		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	31.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	116.8	Sum of lost time (s)	19.8
Intersection Capacity Utilization	67.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.3	
Effective Green, g (s)	62.3	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1841	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.5	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	21.9	
Level of Service	C	
Approach Delay (s)	29.0	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	25	13	25	39	7	60	6	31	968	51	63	1141
Future Volume (vph)	25	13	25	39	7	60	6	31	968	51	63	1141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.95			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.98			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1586			1641			1775	3440		1770	3450
Flt Permitted		0.69			0.84			0.95	1.00		0.95	1.00
Satd. Flow (perm)		1119			1404			1775	3440		1770	3450
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	34	18	34	67	12	103	7	38	1195	63	71	1282
RTOR Reduction (vph)	0	25	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	61	0	0	130	0	0	45	1256	0	71	1301
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	20%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.2			13.2			4.5	69.9		6.8	72.2
Effective Green, g (s)		13.2			13.2			4.5	69.9		6.8	72.2
Actuated g/C Ratio		0.13			0.13			0.04	0.67		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		140			176			76	2290		114	2372
v/s Ratio Prot								0.03	0.37		c0.04	c0.38
v/s Ratio Perm		0.05			c0.09							
v/c Ratio		0.43			0.74			0.59	0.55		0.62	0.55
Uniform Delay, d1		42.4			44.3			49.3	9.2		47.9	8.2
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		0.8			13.6			8.0	0.9		7.4	0.9
Delay (s)		43.2			57.9			57.3	10.2		55.2	9.1
Level of Service		D			E			E	B		E	A
Approach Delay (s)		43.2			57.9				11.8			11.5
Approach LOS		D			E				B			B

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	18
Future Volume (vph)	18
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	20
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	28%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	745	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	745	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3471	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3471	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	980	128	6
RTOR Reduction (vph)	0	130	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	81	0	0	0	129	28	45	22	980	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Effective Green, g (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.42	0.42	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		296				229	244	199	46	1463	644	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.28		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.56	0.11	0.23	0.48	0.67	0.20	
Uniform Delay, d1		38.6				36.9	34.7	35.2	43.5	21.1	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.3	0.2	
Delay (s)		39.1				38.8	34.8	35.4	46.3	22.4	16.7	
Level of Service		D				D	C	D	D	C	B	
Approach Delay (s)		39.1					36.3			22.2		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	20.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	814	24	45
Future Volume (vph)	235	16	814	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3456		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3456		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	947	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	974	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.5	12.5	48.3		11.9
Effective Green, g (s)	12.5	12.5	48.3		11.9
Actuated g/C Ratio	0.14	0.14	0.53		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	218	228	1842		208
v/s Ratio Prot	c0.09	0.09	0.28		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.53		0.04
Uniform Delay, d1	37.1	37.0	13.8		34.4
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	5.1	0.4		0.0
Delay (s)	43.6	42.2	14.1		34.4
Level of Service	D	D	B		C
Approach Delay (s)			20.8		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	23	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	23	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.96		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1721		1681	1696	1555	1766	3471	1550		1770	3462
Flt Permitted		0.85		0.83	0.78	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1483		1461	1372	1555	1766	3471	1550		1770	3462
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	29	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	12	0	0	0	6	0	0	62	0	0	0
Lane Group Flow (vph)	0	69	0	139	141	1	12	804	131	0	11	1190
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	9%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.6		11.6	11.6	11.6	0.8	36.3	36.3		0.8	36.3
Effective Green, g (s)		11.6		11.6	11.6	11.6	0.8	36.3	36.3		0.8	36.3
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.57	0.57		0.01	0.57
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		267		263	247	280	22	1962	876		22	1957
v/s Ratio Prot							c0.01	0.23			0.01	c0.34
v/s Ratio Perm		0.05		0.10	c0.10	0.00			0.08			
v/c Ratio		0.26		0.53	0.57	0.00	0.55	0.41	0.15		0.50	0.61
Uniform Delay, d1		22.6		23.8	24.0	21.6	31.5	7.9	6.6		31.5	9.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.2		0.9	2.0	0.0	14.0	0.2	0.1		6.4	0.6
Delay (s)		22.8		24.7	26.0	21.6	45.5	8.1	6.7		37.9	9.9
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		22.8			25.3			8.3				10.1
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	64.2	Sum of lost time (s)	15.5
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	4
Future Volume (vph)	4
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	5
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	50%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: I-880 NB Off-Ramp/Industrial Pkwy & Whipple Rd

Project Alternative D PM

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	226	751	208	267	173	635	131	48	179	575
Future Volume (vph)	724	765	226	751	208	267	173	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1429	3223	1442	1408	1583	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1429	3223	1442	1408	1583	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	257	791	219	281	194	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	257	791	219	169	194	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	13%	12%	12%	12%	14%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1429	837	374	366	446	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.12	c0.27			c0.15	0.24
v/s Ratio Perm			0.18			0.12						
v/c Ratio	1.33	0.55	0.18	0.95	0.59	0.46	0.43	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.2	45.9			56.1	33.8
Progression Factor	0.72	1.04	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.4	0.9	0.2	20.3	6.6	4.2	0.2	20.3			80.1	1.1
Delay (s)	194.2	25.2	0.2	67.5	48.6	44.6	38.4	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		93.3		59.3				61.0				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	73.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	413	506	289	300	97	340	255	866	146	4	479	747
Future Volume (vph)	413	506	289	300	97	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1564	3263	1583	1681	1685	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.97	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1564	3263	1583	1681	1685	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	430	527	301	316	102	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	193	0	0	225	0	0	95	0	0	0
Lane Group Flow (vph)	310	647	108	205	213	133	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	5%	5%	2%	2%	7%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.3	29.3	29.3	19.5	19.5	19.5	14.5	36.6	36.6		24.3	46.4
Effective Green, g (s)	30.6	30.6	30.6	20.4	20.4	20.4	15.2	38.0	38.0		25.0	47.8
Actuated g/C Ratio	0.24	0.24	0.24	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.37
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	368	768	372	263	264	223	401	1034	462		601	1301
v/s Ratio Prot	0.20	c0.20		0.12	c0.13		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.09			0.04			
v/c Ratio	0.84	0.84	0.29	0.78	0.81	0.60	0.69	0.91	0.14		0.88	0.63
Uniform Delay, d1	47.4	47.4	40.8	52.6	52.9	51.0	55.1	44.4	33.9		51.1	33.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.95	0.83
Incremental Delay, d2	15.3	8.0	0.2	12.5	15.5	2.8	4.1	13.3	0.6		10.1	1.6
Delay (s)	62.7	55.4	40.9	65.1	68.4	53.8	59.3	57.6	34.6		58.8	29.6
Level of Service	E	E	D	E	E	D	E	E	C		E	C
Approach Delay (s)		53.7			60.8			55.3				41.5
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	51.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	345
Future Volume (vph)	345
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1497
Flt Permitted	1.00
Satd. Flow (perm)	1497
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	379
RTOR Reduction (vph)	240
Lane Group Flow (vph)	139
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	5%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	46.4
Effective Green, g (s)	47.8
Actuated g/C Ratio	0.37
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	550
v/s Ratio Prot	
v/s Ratio Perm	0.09
v/c Ratio	0.25
Uniform Delay, d1	28.7
Progression Factor	1.47
Incremental Delay, d2	0.8
Delay (s)	42.9
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	163	34	347	2	17	1342	166	417
Future Volume (vph)	87	119	70	2	163	34	347	2	17	1342	166	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3275	1863	1527		1773	3471	1489	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3275	1863	1527		1773	3471	1489	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	181	38	386	2	19	1508	187	474
RTOR Reduction (vph)	0	76	0	0	0	0	254	0	0	0	56	0
Lane Group Flow (vph)	123	191	0	0	183	38	132	0	21	1508	131	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	7%	2%	4%	0%	2%	4%	7%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	17.6			12.8	16.4	16.4		6.0	55.6	55.6	28.2
Effective Green, g (s)	14.6	18.9			14.1	17.7	17.7		6.6	56.9	56.9	28.8
Actuated g/C Ratio	0.11	0.14			0.11	0.13	0.13		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	468			344	246	201		87	1473	632	723
v/s Ratio Prot	c0.07	0.06			0.06	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.09	
v/c Ratio	0.64	0.41			0.53	0.15	0.66		0.24	1.02	0.21	0.66
Uniform Delay, d1	57.2	52.5			56.8	51.5	55.3		61.3	38.5	24.3	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			1.6	0.1	5.7		0.5	29.7	0.7	1.6
Delay (s)	64.3	52.7			58.4	51.6	61.0		61.8	68.2	25.1	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.3				59.6				63.4		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	48.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.8	
Effective Green, g (s)	79.1	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2045	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.63	
Uniform Delay, d1	18.0	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.5	
Level of Service	B	
Approach Delay (s)	27.6	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	24	15	31	21	14	22	12	44	1231	26	7	44
Future Volume (vph)	24	15	31	21	14	22	12	44	1231	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.94			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1600			1713			1777	3456			1774
Flt Permitted		0.78			0.76			0.95	1.00			0.11
Satd. Flow (perm)		1278			1319			1777	3456			208
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	32	20	41	32	22	34	13	47	1324	28	7	46
RTOR Reduction (vph)	0	29	0	0	23	0	0	0	2	0	0	0
Lane Group Flow (vph)	0	64	0	0	65	0	0	60	1350	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	21%	2%	2%	2%	2%	2%	0%	2%	4%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		9.0			9.0			6.6	55.8			35.1
Effective Green, g (s)		9.9			9.9			7.5	57.1			36.0
Actuated g/C Ratio		0.09			0.09			0.07	0.50			0.31
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		110			113			115	1715			65
v/s Ratio Prot								0.03	c0.39			
v/s Ratio Perm		c0.05			0.05							c0.26
v/c Ratio		0.58			0.58			0.52	0.79			0.82
Uniform Delay, d1		50.5			50.5			52.0	23.9			36.4
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		4.5			4.4			2.0	3.7			50.2
Delay (s)		55.1			54.9			54.0	27.7			86.6
Level of Service		E			D			D	C			F
Approach Delay (s)		55.1			54.9				28.8			
Approach LOS		E			D				C			

Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1188	28
Future Volume (vph)	1188	28
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3446	
Flt Permitted	1.00	
Satd. Flow (perm)	3446	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1238	29
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1266	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	4%	18%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	84.3	
Effective Green, g (s)	85.6	
Actuated g/C Ratio	0.74	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2565	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.49	
Uniform Delay, d1	5.9	
Progression Factor	1.00	
Incremental Delay, d2	0.7	
Delay (s)	6.6	
Level of Service	A	
Approach Delay (s)	9.8	
Approach LOS	A	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1007	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1007	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3471	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3471	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1095	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	214	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	25	13	1095	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	40.7	40.7	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	42.0	42.0	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.46	0.46	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		267				179	191	156	39	1609	710	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.32		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.33	0.68	0.14	
Uniform Delay, d1		38.6				37.9	37.6	37.1	43.6	19.0	13.9	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	1.8	1.3	0.1	
Delay (s)		38.6				38.4	37.9	37.2	45.5	20.3	14.0	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.6					37.6			20.1		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	733	68	31
Future Volume (vph)	383	20	733	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3426		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3426		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	833	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	907	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	54.9		8.4
Effective Green, g (s)	16.2	16.2	56.2		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	283	295	2125		165
v/s Ratio Prot	c0.16	0.13	0.26		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.43		0.03
Uniform Delay, d1	36.4	35.3	8.9		36.6
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	27.9	9.4	0.2		0.0
Delay (s)	64.2	44.7	9.1		36.6
Level of Service	E	D	A		D
Approach Delay (s)			24.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	7	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	7	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00
Flt Protected		0.99		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1706		1681	1706	1557		1772	3471	1548	1770	3453
Flt Permitted		0.92		0.93	0.79	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1589		1654	1398	1557		1772	3471	1548	1770	3453
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	12	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	8	0	0	0	2	0	0	0	83	0	0
Lane Group Flow (vph)	0	54	0	72	86	0	0	18	1146	336	14	677
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	29%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		6.9		6.9	6.9	6.9		0.8	33.8	33.8	0.7	33.7
Effective Green, g (s)		7.8		7.8	7.8	7.8		1.7	35.5	35.5	2.4	35.4
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		217		226	191	213		52	2165	965	74	2148
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		0.03		0.04	c0.06	0.00				0.22		
v/c Ratio		0.25		0.32	0.45	0.00		0.35	0.53	0.35	0.19	0.32
Uniform Delay, d1		21.9		22.2	22.6	21.2		27.1	6.0	5.1	26.3	5.1
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.2		0.3	0.6	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		22.2		22.4	23.2	21.2		28.5	6.3	5.4	26.8	5.2
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		22.2			22.8				6.3			5.6
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	56.9	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	10
Future Volume (vph)	10
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	11
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	20%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

APPENDIX C
LEVEL OF SERVICE CALCULATION SHEETS
for
WORST CASE SCENARIO

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Future Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	220	677	280	157	548	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	220	677	280	40	548	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	17%	12%	12%	12%	14%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1380	827	370	362	496	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.35	0.26			c0.16	c0.28
v/s Ratio Perm			0.16			0.03						
v/c Ratio	0.93	0.64	0.16	0.82	0.76	0.11	1.10	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.11	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	22.8	1.8	0.2	8.9	13.5	0.6	72.2	6.3			87.8	11.9
Delay (s)	61.3	33.1	0.2	50.8	54.6	34.7	113.4	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		35.2		49.5				71.7				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	56.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Future Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	334	223	167	194	206	365	394	754	58	404	769	1045
RTOR Reduction (vph)	0	0	142	0	0	253	0	0	37	0	0	287
Lane Group Flow (vph)	184	373	25	175	225	112	394	754	21	404	769	758
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	8%	9%	2%	2%	9%	12%	2%	2%	2%	12%	2%	5%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Effective Green, g (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Actuated g/C Ratio	0.15	0.15	0.15	0.16	0.16	0.16	0.14	0.37	0.37	0.15	0.38	0.38
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	230	473	240	263	259	221	480	1303	583	482	1353	581
v/s Ratio Prot	c0.12	0.12		0.10	c0.14		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.50
v/c Ratio	0.80	0.79	0.11	0.67	0.87	0.51	0.82	0.58	0.04	0.84	0.57	1.30
Uniform Delay, d1	49.1	49.0	43.9	47.6	49.4	46.4	50.1	30.4	24.3	49.3	29.2	37.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00
Incremental Delay, d2	16.9	7.9	0.1	4.9	24.4	0.7	10.3	1.9	0.1	7.0	1.0	144.2
Delay (s)	66.0	56.9	44.0	52.5	73.8	47.0	60.4	32.3	24.4	56.2	29.6	181.0
Level of Service	E	E	D	D	E	D	E	C	C	E	C	F
Approach Delay (s)		56.2			56.1			41.1			105.8	
Approach LOS		E			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	74.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Future Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	190	160	324	1	95	1073	269	443
RTOR Reduction (vph)	0	13	0	0	0	0	269	0	0	0	86	0
Lane Group Flow (vph)	15	27	0	0	191	160	55	0	96	1073	183	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	13%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Effective Green, g (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Actuated g/C Ratio	0.02	0.08			0.11	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	40	279			334	317	260		186	1604	650	593
v/s Ratio Prot	0.01	0.01			c0.06	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.13	
v/c Ratio	0.38	0.10			0.57	0.50	0.21		0.52	0.67	0.28	0.75
Uniform Delay, d1	56.6	49.8			49.7	44.3	42.0		49.7	24.6	19.5	45.9
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.1			1.5	0.5	0.1		1.0	1.2	0.3	4.5
Delay (s)	58.7	49.8			51.1	44.7	42.1		50.7	25.8	19.9	50.4
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		52.2				45.3				26.3		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	117.5	Sum of lost time (s)	19.8
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.6	
Effective Green, g (s)	62.6	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1839	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.7	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	22.1	
Level of Service	C	
Approach Delay (s)	29.2	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	31	13	25	39	7	60	6	31	978	51	63	1151
Future Volume (vph)	31	13	25	39	7	60	6	31	978	51	63	1151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.95			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.98			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1486			1641			1775	3409		1770	3399
Flt Permitted		0.64			0.83			0.95	1.00		0.95	1.00
Satd. Flow (perm)		975			1389			1775	3409		1770	3399
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	42	18	34	67	12	103	7	38	1207	63	71	1293
RTOR Reduction (vph)	0	23	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	71	0	0	130	0	0	45	1268	0	71	1319
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	35%	2%	2%	2%	2%	2%	0%	2%	5%	2%	2%	5%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.2			13.2			4.5	69.9		6.8	72.2
Effective Green, g (s)		13.2			13.2			4.5	69.9		6.8	72.2
Actuated g/C Ratio		0.13			0.13			0.04	0.67		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		122			174			76	2269		114	2337
v/s Ratio Prot								0.03	0.37		c0.04	c0.39
v/s Ratio Perm		0.07			c0.09							
v/c Ratio		0.58			0.75			0.59	0.56		0.62	0.56
Uniform Delay, d1		43.3			44.3			49.3	9.3		47.9	8.4
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		4.5			14.3			8.0	1.0		7.4	1.0
Delay (s)		47.8			58.6			57.3	10.3		55.2	9.4
Level of Service		D			E			E	B		E	A
Approach Delay (s)		47.8			58.6				11.9			11.7
Approach LOS		D			E				B			B

Intersection Summary			
HCM 2000 Control Delay	15.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	24
Future Volume (vph)	24
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	27
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	46%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	755	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	755	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3438	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3438	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	993	128	6
RTOR Reduction (vph)	0	130	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	81	0	0	0	129	28	45	22	993	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	5%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				12.0	12.0	12.0	2.4	38.7	38.7	
Effective Green, g (s)		8.0				12.0	12.0	12.0	2.4	38.7	38.7	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.42	0.42	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		294				229	244	199	46	1457	648	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.29		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.56	0.11	0.23	0.48	0.68	0.20	
Uniform Delay, d1		38.9				37.2	35.0	35.5	43.8	21.3	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.4	0.2	
Delay (s)		39.4				39.1	35.0	35.7	46.7	22.8	16.7	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		39.4					36.5			22.5		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	91.3	Sum of lost time (s)	20.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	824	24	45
Future Volume (vph)	235	16	824	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3424		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3424		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	958	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	985	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	5%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.6	12.6	48.9		12.0
Effective Green, g (s)	12.6	12.6	48.9		12.0
Actuated g/C Ratio	0.14	0.14	0.54		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	218	228	1833		208
v/s Ratio Prot	c0.09	0.09	0.29		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.54		0.04
Uniform Delay, d1	37.4	37.3	13.8		34.6
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	5.1	0.4		0.0
Delay (s)	43.9	42.4	14.2		34.6
Level of Service	D	D	B		C
Approach Delay (s)			20.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	33	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	33	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.97		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1535		1681	1696	1555	1766	3471	1550		1770	3421
Flt Permitted		0.80		0.78	0.76	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1256		1377	1347	1555	1766	3471	1550		1770	3421
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	42	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	10	0	0	0	6	0	0	61	0	0	0
Lane Group Flow (vph)	0	84	0	139	141	1	12	804	132	0	11	1203
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	36%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.8		11.8	11.8	11.8	0.8	38.0	38.0		0.8	38.0
Effective Green, g (s)		11.8		11.8	11.8	11.8	0.8	38.0	38.0		0.8	38.0
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.57	0.57		0.01	0.57
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		224		245	240	277	21	1995	891		21	1966
v/s Ratio Prot							c0.01	0.23			0.01	c0.35
v/s Ratio Perm		0.07		0.10	c0.10	0.00			0.09			
v/c Ratio		0.38		0.57	0.59	0.00	0.57	0.40	0.15		0.52	0.61
Uniform Delay, d1		23.9		24.8	24.9	22.3	32.5	7.8	6.5		32.5	9.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.4		1.8	2.4	0.0	21.2	0.2	0.1		10.4	0.7
Delay (s)		24.3		26.6	27.3	22.3	53.7	8.0	6.6		42.9	9.9
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		24.3			26.8			8.2				10.2
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	66.1	Sum of lost time (s)	15.5
Intersection Capacity Utilization	45.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	14
Future Volume (vph)	14
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	18
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	86%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Future Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	265	791	219	281	202	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	265	791	219	169	202	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	16%	12%	12%	12%	17%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1392	837	374	366	435	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.13	c0.27			c0.15	0.24
v/s Ratio Perm			0.19			0.12						
v/c Ratio	1.33	0.55	0.19	0.95	0.59	0.46	0.46	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.5	45.9			56.1	33.8
Progression Factor	0.72	1.03	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.3	0.9	0.2	20.3	6.6	4.2	0.3	20.3			80.1	1.1
Delay (s)	194.0	24.8	0.2	67.5	48.6	44.6	38.8	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		92.6		59.3				60.9				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	72.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Future Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	438	534	301	316	109	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	189	0	0	222	0	0	95	0	0	0
Lane Group Flow (vph)	315	657	112	209	216	136	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	6%	6%	2%	2%	13%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.7	29.7	29.7	20.0	20.0	20.0	14.5	36.0	36.0		24.0	45.5
Effective Green, g (s)	31.0	31.0	31.0	20.9	20.9	20.9	15.2	37.4	37.4		24.7	46.9
Actuated g/C Ratio	0.24	0.24	0.24	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.36
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	369	770	377	270	263	228	401	1018	455		594	1276
v/s Ratio Prot	0.20	c0.20		0.12	c0.13		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.10			0.04			
v/c Ratio	0.85	0.85	0.30	0.77	0.82	0.59	0.69	0.92	0.14		0.89	0.64
Uniform Delay, d1	47.3	47.3	40.6	52.3	52.7	50.6	55.1	44.9	34.4		51.4	34.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.95	0.83
Incremental Delay, d2	16.6	8.8	0.2	11.9	17.5	2.8	4.1	15.0	0.6		11.2	1.7
Delay (s)	63.9	56.1	40.7	64.2	70.2	53.4	59.3	59.9	35.0		59.7	30.5
Level of Service	E	E	D	E	E	D	E	E	D		E	C
Approach Delay (s)		54.4			60.9			56.9				42.5
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	52.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	352
Future Volume (vph)	352
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1469
Flt Permitted	1.00
Satd. Flow (perm)	1469
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	387
RTOR Reduction (vph)	247
Lane Group Flow (vph)	140
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	7%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	45.5
Effective Green, g (s)	46.9
Actuated g/C Ratio	0.36
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	529
v/s Ratio Prot	
v/s Ratio Perm	0.10
v/c Ratio	0.26
Uniform Delay, d1	29.4
Progression Factor	1.49
Incremental Delay, d2	0.8
Delay (s)	44.6
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Future Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	198	38	386	2	19	1508	203	474
RTOR Reduction (vph)	0	76	0	0	0	0	253	0	0	0	62	0
Lane Group Flow (vph)	123	191	0	0	200	38	133	0	21	1508	141	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	15%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	16.9			13.9	16.8	16.8		6.0	55.2	55.2	28.2
Effective Green, g (s)	14.6	18.2			15.2	18.1	18.1		6.6	56.5	56.5	28.8
Actuated g/C Ratio	0.11	0.14			0.11	0.14	0.14		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	451			345	251	206		87	1463	584	723
v/s Ratio Prot	c0.07	0.06			0.07	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.10	
v/c Ratio	0.64	0.42			0.58	0.15	0.64		0.24	1.03	0.24	0.66
Uniform Delay, d1	57.2	53.1			56.4	51.2	54.9		61.3	38.8	25.0	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			2.4	0.1	5.1		0.5	31.8	1.0	1.6
Delay (s)	64.3	53.3			58.7	51.3	60.0		61.8	70.5	25.9	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.8				59.0				65.2		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	49.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.4	
Effective Green, g (s)	78.7	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2035	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.64	
Uniform Delay, d1	18.2	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.7	
Level of Service	B	
Approach Delay (s)	27.8	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	30	15	31	21	14	22	12	44	1241	26	7	44
Future Volume (vph)	30	15	31	21	14	22	12	44	1241	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.95			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1504			1714			1777	3423			1774
Flt Permitted		0.77			0.78			0.95	1.00			0.12
Satd. Flow (perm)		1186			1360			1777	3423			220
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	40	20	41	32	22	34	13	47	1334	28	7	46
RTOR Reduction (vph)	0	25	0	0	23	0	0	0	1	0	0	0
Lane Group Flow (vph)	0	76	0	0	65	0	0	60	1361	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	37%	2%	2%	2%	2%	2%	0%	2%	5%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		10.4			10.4			6.6	56.4			33.1
Effective Green, g (s)		11.3			11.3			7.5	57.7			34.0
Actuated g/C Ratio		0.10			0.10			0.07	0.50			0.30
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		116			133			115	1717			65
v/s Ratio Prot								0.03	c0.40			
v/s Ratio Perm		c0.06			0.05							c0.24
v/c Ratio		0.65			0.49			0.52	0.79			0.82
Uniform Delay, d1		50.0			49.1			52.0	23.7			37.6
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		9.6			1.0			2.0	3.8			50.2
Delay (s)		59.6			50.2			54.0	27.5			87.8
Level of Service		E			D			D	C			F
Approach Delay (s)		59.6			50.2				28.7			
Approach LOS		E			D				C			

Intersection Summary			
HCM 2000 Control Delay	22.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	58.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↑	
Traffic Volume (vph)	1198	34
Future Volume (vph)	1198	34
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3397	
Flt Permitted	1.00	
Satd. Flow (perm)	3397	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1248	35
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1282	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	5%	32%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	82.9	
Effective Green, g (s)	84.2	
Actuated g/C Ratio	0.73	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2487	
v/s Ratio Prot	0.38	
v/s Ratio Perm		
v/c Ratio	0.52	
Uniform Delay, d1	6.6	
Progression Factor	1.00	
Incremental Delay, d2	0.8	
Delay (s)	7.4	
Level of Service	A	
Approach Delay (s)	10.6	
Approach LOS	B	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1017	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1017	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3438	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3438	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1105	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	215	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	24	13	1105	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	5%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	41.2	41.2	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	42.5	42.5	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.47	0.47	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		266				178	190	155	38	1603	714	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.32		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.34	0.69	0.13	
Uniform Delay, d1		38.8				38.2	37.8	37.3	43.9	19.1	13.8	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	2.0	1.4	0.1	
Delay (s)		38.9				38.6	38.2	37.5	45.9	20.5	13.9	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.9					37.8			20.2		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	91.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	743	68	31
Future Volume (vph)	383	20	743	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3367		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3367		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	844	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	918	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	6%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	55.4		8.4
Effective Green, g (s)	16.2	16.2	56.7		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	281	293	2095		164
v/s Ratio Prot	c0.16	0.13	0.27		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.44		0.03
Uniform Delay, d1	36.7	35.6	8.9		36.8
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	29.4	10.0	0.2		0.0
Delay (s)	66.1	45.6	9.1		36.9
Level of Service	E	D	A		D
Approach Delay (s)			25.3		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	17	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	17	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1426		1681	1706	1557		1772	3471	1548	1770	3393
Flt Permitted		0.84		0.84	0.83	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1220		1485	1461	1557		1772	3471	1548	1770	3393
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	30	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	6	0	0	0	2	0	0	0	84	0	1
Lane Group Flow (vph)	0	74	0	72	86	0	0	18	1146	335	14	687
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	71%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		7.0		7.0	7.0	7.0		0.8	33.8	33.8	0.7	33.7
Effective Green, g (s)		7.9		7.9	7.9	7.9		1.7	35.5	35.5	2.4	35.4
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		169		205	202	215		52	2161	964	74	2107
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		c0.06		0.05	0.06	0.00				0.22		
v/c Ratio		0.44		0.35	0.43	0.00		0.35	0.53	0.35	0.19	0.33
Uniform Delay, d1		22.5		22.2	22.5	21.2		27.1	6.1	5.2	26.4	5.1
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.7		0.4	0.5	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		23.2		22.6	23.0	21.2		28.6	6.4	5.5	26.8	5.3
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		23.2			22.8				6.4			5.7
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	57.0	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	20
Future Volume (vph)	20
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	22
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	60%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Future Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	220	677	280	157	548	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	220	677	280	40	548	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	17%	12%	12%	12%	14%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1380	827	370	362	496	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.35	0.26			c0.16	c0.28
v/s Ratio Perm			0.16			0.03						
v/c Ratio	0.93	0.64	0.16	0.82	0.76	0.11	1.10	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.11	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	22.8	1.8	0.2	8.9	13.5	0.6	72.2	6.3			87.8	11.9
Delay (s)	61.3	33.1	0.2	50.8	54.6	34.7	113.4	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		35.2		49.5				71.7				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	56.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Future Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	334	223	167	194	206	365	394	754	58	404	769	1045
RTOR Reduction (vph)	0	0	142	0	0	253	0	0	37	0	0	287
Lane Group Flow (vph)	184	373	25	175	225	112	394	754	21	404	769	758
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	8%	9%	2%	2%	9%	12%	2%	2%	2%	12%	2%	5%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Effective Green, g (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Actuated g/C Ratio	0.15	0.15	0.15	0.16	0.16	0.16	0.14	0.37	0.37	0.15	0.38	0.38
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	230	473	240	263	259	221	480	1303	583	482	1353	581
v/s Ratio Prot	c0.12	0.12		0.10	c0.14		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.50
v/c Ratio	0.80	0.79	0.11	0.67	0.87	0.51	0.82	0.58	0.04	0.84	0.57	1.30
Uniform Delay, d1	49.1	49.0	43.9	47.6	49.4	46.4	50.1	30.4	24.3	49.3	29.2	37.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00
Incremental Delay, d2	16.9	7.9	0.1	4.9	24.4	0.7	10.3	1.9	0.1	7.0	1.0	144.2
Delay (s)	66.0	56.9	44.0	52.5	73.8	47.0	60.4	32.3	24.4	56.2	29.6	181.0
Level of Service	E	E	D	D	E	D	E	C	C	E	C	F
Approach Delay (s)		56.2			56.1			41.1			105.8	
Approach LOS		E			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	74.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Future Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	190	160	324	1	95	1073	269	443
RTOR Reduction (vph)	0	13	0	0	0	0	269	0	0	0	86	0
Lane Group Flow (vph)	15	27	0	0	191	160	55	0	96	1073	183	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	13%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Effective Green, g (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Actuated g/C Ratio	0.02	0.08			0.11	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	40	279			334	317	260		186	1604	650	593
v/s Ratio Prot	0.01	0.01			c0.06	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.13	
v/c Ratio	0.38	0.10			0.57	0.50	0.21		0.52	0.67	0.28	0.75
Uniform Delay, d1	56.6	49.8			49.7	44.3	42.0		49.7	24.6	19.5	45.9
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.1			1.5	0.5	0.1		1.0	1.2	0.3	4.5
Delay (s)	58.7	49.8			51.1	44.7	42.1		50.7	25.8	19.9	50.4
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		52.2				45.3				26.3		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	117.5	Sum of lost time (s)	19.8
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.6	
Effective Green, g (s)	62.6	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1839	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.7	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	22.1	
Level of Service	C	
Approach Delay (s)	29.2	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	27	13	25	39	7	60	6	31	981	51	63	1154
Future Volume (vph)	27	13	25	39	7	60	6	31	981	51	63	1154
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.95			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.98			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1549			1641			1775	3409		1770	3412
Flt Permitted		0.68			0.84			0.95	1.00		0.95	1.00
Satd. Flow (perm)		1072			1400			1775	3409		1770	3412
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	36	18	34	67	12	103	7	38	1211	63	71	1297
RTOR Reduction (vph)	0	24	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	64	0	0	130	0	0	45	1272	0	71	1318
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	26%	2%	2%	2%	2%	2%	0%	2%	5%	2%	2%	5%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.2			13.2			4.5	69.9		6.8	72.2
Effective Green, g (s)		13.2			13.2			4.5	69.9		6.8	72.2
Actuated g/C Ratio		0.13			0.13			0.04	0.67		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		134			176			76	2269		114	2346
v/s Ratio Prot								0.03	0.37		c0.04	c0.39
v/s Ratio Perm		0.06			c0.09							
v/c Ratio		0.47			0.74			0.59	0.56		0.62	0.56
Uniform Delay, d1		42.7			44.3			49.3	9.4		47.9	8.3
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		1.0			13.6			8.0	1.0		7.4	1.0
Delay (s)		43.6			57.9			57.3	10.4		55.2	9.3
Level of Service		D			E			E	B		E	A
Approach Delay (s)		43.6			57.9				12.0			11.7
Approach LOS		D			E				B			B

Intersection Summary			
HCM 2000 Control Delay	15.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	20
Future Volume (vph)	20
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	22
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	35%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	758	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	758	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3406	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3406	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	997	128	6
RTOR Reduction (vph)	0	131	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	80	0	0	0	129	28	45	22	997	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	6%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				12.0	12.0	12.0	2.4	39.1	39.1	
Effective Green, g (s)		8.0				12.0	12.0	12.0	2.4	39.1	39.1	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.43	0.43	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		293				228	243	198	46	1452	651	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.29		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.57	0.12	0.23	0.48	0.69	0.20	
Uniform Delay, d1		39.1				37.4	35.2	35.7	44.0	21.3	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.5	0.2	
Delay (s)		39.6				39.3	35.2	35.9	46.9	22.8	16.7	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		39.6					36.7			22.6		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	91.7	Sum of lost time (s)	20.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	827	24	45
Future Volume (vph)	235	16	827	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3392		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3392		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	962	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	989	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	6%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.6	12.6	49.3		12.0
Effective Green, g (s)	12.6	12.6	49.3		12.0
Actuated g/C Ratio	0.14	0.14	0.54		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	217	227	1823		207
v/s Ratio Prot	c0.09	0.09	0.29		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.54		0.04
Uniform Delay, d1	37.6	37.5	13.8		34.8
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.9	5.5	0.4		0.0
Delay (s)	44.5	43.0	14.3		34.8
Level of Service	D	D	B		C
Approach Delay (s)			21.1		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	36	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	36	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.97		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1490		1681	1696	1555	1766	3471	1550		1770	3410
Flt Permitted		0.79		0.77	0.75	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1201		1356	1333	1555	1766	3471	1550		1770	3410
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	46	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	9	0	0	0	6	0	0	60	0	0	1
Lane Group Flow (vph)	0	89	0	139	141	1	12	804	133	0	11	1206
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	42%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.8		11.8	11.8	11.8	0.8	38.4	38.4		0.8	38.4
Effective Green, g (s)		11.8		11.8	11.8	11.8	0.8	38.4	38.4		0.8	38.4
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.58	0.58		0.01	0.58
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		213		240	236	275	21	2004	895		21	1969
v/s Ratio Prot							c0.01	0.23			0.01	c0.35
v/s Ratio Perm		0.07		0.10	c0.11	0.00			0.09			
v/c Ratio		0.42		0.58	0.60	0.00	0.57	0.40	0.15		0.52	0.61
Uniform Delay, d1		24.3		25.1	25.2	22.5	32.7	7.7	6.5		32.7	9.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.5		2.1	2.7	0.0	21.2	0.2	0.1		10.4	0.7
Delay (s)		24.8		27.2	27.9	22.5	53.9	7.9	6.6		43.1	9.8
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		24.8			27.4			8.2				10.1
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	66.5	Sum of lost time (s)	15.5
Intersection Capacity Utilization	46.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	17
Future Volume (vph)	17
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	22
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	88%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Future Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	265	791	219	281	202	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	265	791	219	169	202	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	16%	12%	12%	12%	17%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1392	837	374	366	435	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.13	c0.27			c0.15	0.24
v/s Ratio Perm			0.19			0.12						
v/c Ratio	1.33	0.55	0.19	0.95	0.59	0.46	0.46	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.5	45.9			56.1	33.8
Progression Factor	0.72	1.03	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.3	0.9	0.2	20.3	6.6	4.2	0.3	20.3			80.1	1.1
Delay (s)	194.0	24.8	0.2	67.5	48.6	44.6	38.8	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		92.6		59.3				60.9				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	72.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Future Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	438	534	301	316	109	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	189	0	0	222	0	0	95	0	0	0
Lane Group Flow (vph)	315	657	112	209	216	136	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	6%	6%	2%	2%	13%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.7	29.7	29.7	20.0	20.0	20.0	14.5	36.0	36.0		24.0	45.5
Effective Green, g (s)	31.0	31.0	31.0	20.9	20.9	20.9	15.2	37.4	37.4		24.7	46.9
Actuated g/C Ratio	0.24	0.24	0.24	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.36
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	369	770	377	270	263	228	401	1018	455		594	1276
v/s Ratio Prot	0.20	c0.20		0.12	c0.13		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.10			0.04			
v/c Ratio	0.85	0.85	0.30	0.77	0.82	0.59	0.69	0.92	0.14		0.89	0.64
Uniform Delay, d1	47.3	47.3	40.6	52.3	52.7	50.6	55.1	44.9	34.4		51.4	34.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.95	0.83
Incremental Delay, d2	16.6	8.8	0.2	11.9	17.5	2.8	4.1	15.0	0.6		11.2	1.7
Delay (s)	63.9	56.1	40.7	64.2	70.2	53.4	59.3	59.9	35.0		59.7	30.5
Level of Service	E	E	D	E	E	D	E	E	D		E	C
Approach Delay (s)		54.4			60.9			56.9				42.5
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	52.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	352
Future Volume (vph)	352
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1469
Flt Permitted	1.00
Satd. Flow (perm)	1469
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	387
RTOR Reduction (vph)	247
Lane Group Flow (vph)	140
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	7%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	45.5
Effective Green, g (s)	46.9
Actuated g/C Ratio	0.36
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	529
v/s Ratio Prot	
v/s Ratio Perm	0.10
v/c Ratio	0.26
Uniform Delay, d1	29.4
Progression Factor	1.49
Incremental Delay, d2	0.8
Delay (s)	44.6
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Future Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	198	38	386	2	19	1508	203	474
RTOR Reduction (vph)	0	76	0	0	0	0	253	0	0	0	62	0
Lane Group Flow (vph)	123	191	0	0	200	38	133	0	21	1508	141	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	15%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	16.9			13.9	16.8	16.8		6.0	55.2	55.2	28.2
Effective Green, g (s)	14.6	18.2			15.2	18.1	18.1		6.6	56.5	56.5	28.8
Actuated g/C Ratio	0.11	0.14			0.11	0.14	0.14		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	451			345	251	206		87	1463	584	723
v/s Ratio Prot	c0.07	0.06			0.07	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.10	
v/c Ratio	0.64	0.42			0.58	0.15	0.64		0.24	1.03	0.24	0.66
Uniform Delay, d1	57.2	53.1			56.4	51.2	54.9		61.3	38.8	25.0	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			2.4	0.1	5.1		0.5	31.8	1.0	1.6
Delay (s)	64.3	53.3			58.7	51.3	60.0		61.8	70.5	25.9	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.8				59.0				65.2		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	49.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.4	
Effective Green, g (s)	78.7	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2035	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.64	
Uniform Delay, d1	18.2	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.7	
Level of Service	B	
Approach Delay (s)	27.8	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	26	15	31	21	14	22	12	44	1244	26	7	44
Future Volume (vph)	26	15	31	21	14	22	12	44	1244	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.94			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1565			1713			1777	3423			1774
Flt Permitted		0.78			0.76			0.95	1.00			0.11
Satd. Flow (perm)		1243			1325			1777	3423			215
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	35	20	41	32	22	34	13	47	1338	28	7	46
RTOR Reduction (vph)	0	27	0	0	23	0	0	0	1	0	0	0
Lane Group Flow (vph)	0	69	0	0	65	0	0	60	1365	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	27%	2%	2%	2%	2%	2%	0%	2%	5%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		9.5			9.5			6.6	56.5			33.9
Effective Green, g (s)		10.4			10.4			7.5	57.8			34.8
Actuated g/C Ratio		0.09			0.09			0.07	0.50			0.30
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		112			119			115	1720			65
v/s Ratio Prot								0.03	c0.40			
v/s Ratio Perm		c0.06			0.05							c0.25
v/c Ratio		0.61			0.55			0.52	0.79			0.82
Uniform Delay, d1		50.4			50.1			52.0	23.7			37.1
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		6.8			2.8			2.0	3.9			50.2
Delay (s)		57.2			52.8			54.0	27.5			87.3
Level of Service		E			D			D	C			F
Approach Delay (s)		57.2			52.8				28.6			
Approach LOS		E			D				C			

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	58.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1201	30
Future Volume (vph)	1201	30
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3408	
Flt Permitted	1.00	
Satd. Flow (perm)	3408	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1251	31
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1281	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	5%	23%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	83.8	
Effective Green, g (s)	85.1	
Actuated g/C Ratio	0.74	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2521	
v/s Ratio Prot	0.38	
v/s Ratio Perm		
v/c Ratio	0.51	
Uniform Delay, d1	6.2	
Progression Factor	1.00	
Incremental Delay, d2	0.7	
Delay (s)	7.0	
Level of Service	A	
Approach Delay (s)	10.2	
Approach LOS	B	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1020	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1020	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3438	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3438	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1109	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	215	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	24	13	1109	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	5%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	41.3	41.3	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	42.6	42.6	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.47	0.47	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		266				178	189	155	38	1605	715	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.32		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.34	0.69	0.13	
Uniform Delay, d1		38.9				38.2	37.9	37.4	44.0	19.1	13.8	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	2.0	1.4	0.1	
Delay (s)		38.9				38.7	38.2	37.5	45.9	20.5	13.9	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.9					37.9			20.3		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	91.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	746	68	31
Future Volume (vph)	383	20	746	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3367		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3367		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	848	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	922	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	6%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	55.5		8.4
Effective Green, g (s)	16.2	16.2	56.8		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	281	293	2096		164
v/s Ratio Prot	c0.16	0.13	0.27		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.44		0.03
Uniform Delay, d1	36.7	35.7	8.9		36.9
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	29.4	10.0	0.2		0.0
Delay (s)	66.1	45.7	9.1		36.9
Level of Service	E	D	A		D
Approach Delay (s)			25.3		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	20	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	20	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	0.99
Flt Protected		0.98		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1380		1681	1706	1557		1772	3471	1548	1770	3378
Flt Permitted		0.83		0.82	0.82	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1162		1446	1444	1557		1772	3471	1548	1770	3378
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	35	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	5	0	0	0	2	0	0	0	84	0	1
Lane Group Flow (vph)	0	80	0	72	86	0	0	18	1146	335	14	690
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	75%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		7.1		7.1	7.1	7.1		0.8	33.9	33.9	0.7	33.8
Effective Green, g (s)		8.0		8.0	8.0	8.0		1.7	35.6	35.6	2.4	35.5
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		162		202	201	217		52	2160	963	74	2096
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		c0.07		0.05	0.06	0.00				0.22		
v/c Ratio		0.49		0.36	0.43	0.00		0.35	0.53	0.35	0.19	0.33
Uniform Delay, d1		22.7		22.3	22.5	21.2		27.2	6.1	5.2	26.5	5.2
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.9		0.4	0.5	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		23.6		22.7	23.0	21.2		28.7	6.4	5.5	26.9	5.3
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		23.6			22.8				6.4			5.7
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	57.2	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	23
Future Volume (vph)	23
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	25
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	65%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Future Volume (vph)	322	751	196	616	255	143	504	421	357	25	209	618
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.7	5.4	4.0	5.4	5.4	5.4	5.1	5.1			4.4	4.4
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.93			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1380	3223	1442	1414	1583	2982			1630	2538
Peak-hour factor, PHF	0.89	0.89	0.89	0.91	0.91	0.91	0.92	0.92	0.92	0.87	0.87	0.87
Adj. Flow (vph)	362	844	220	677	280	157	548	458	388	29	240	710
RTOR Reduction (vph)	0	0	0	0	0	117	0	64	0	0	0	47
Lane Group Flow (vph)	362	844	220	677	280	40	548	782	0	0	269	704
Confl. Peds. (#/hr)	6					6			2		2	
Heavy Vehicles (%)	12%	12%	17%	12%	12%	12%	14%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Effective Green, g (s)	15.0	49.5	120.0	30.8	30.8	30.8	37.6	37.6			18.0	37.4
Actuated g/C Ratio	0.12	0.41	1.00	0.26	0.26	0.26	0.31	0.31			0.15	0.31
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	390	1329	1380	827	370	362	496	934			244	791
v/s Ratio Prot	0.12	0.26		c0.21	0.19		c0.35	0.26			c0.16	c0.28
v/s Ratio Perm			0.16			0.03						
v/c Ratio	0.93	0.64	0.16	0.82	0.76	0.11	1.10	0.84			1.10	0.89
Uniform Delay, d1	52.0	28.1	0.0	42.0	41.1	34.1	41.2	38.4			51.0	39.3
Progression Factor	0.74	1.11	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	22.8	1.8	0.2	8.9	13.5	0.6	72.2	6.3			87.8	11.9
Delay (s)	61.3	33.1	0.2	50.8	54.6	34.7	113.4	44.7			138.8	51.3
Level of Service	E	C	A	D	D	C	F	D			F	D
Approach Delay (s)		35.2		49.5				71.7				
Approach LOS		D		D				E				

Intersection Summary			
HCM 2000 Control Delay	56.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.6
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	36
Future Volume (vph)	36
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.87
Adj. Flow (vph)	41
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Future Volume (vph)	277	185	139	171	181	321	307	588	45	323	615	836
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1521	3121	1583	1681	1658	1411	3433	3539	1583	3127	3539	1519
Peak-hour factor, PHF	0.83	0.83	0.83	0.88	0.88	0.88	0.78	0.78	0.78	0.80	0.80	0.80
Adj. Flow (vph)	334	223	167	194	206	365	394	754	58	404	769	1045
RTOR Reduction (vph)	0	0	142	0	0	253	0	0	37	0	0	287
Lane Group Flow (vph)	184	373	25	175	225	112	394	754	21	404	769	758
Confl. Peds. (#/hr)	5					5						
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	8%	9%	2%	2%	9%	12%	2%	2%	2%	12%	2%	5%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	7		8	8		5	2		1	6	
Permitted Phases			7			8			2			6
Actuated Green, G (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Effective Green, g (s)	18.2	18.2	18.2	18.8	18.8	18.8	16.8	44.2	44.2	18.5	45.9	45.9
Actuated g/C Ratio	0.15	0.15	0.15	0.16	0.16	0.16	0.14	0.37	0.37	0.15	0.38	0.38
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4	4.7	5.4	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0
Lane Grp Cap (vph)	230	473	240	263	259	221	480	1303	583	482	1353	581
v/s Ratio Prot	c0.12	0.12		0.10	c0.14		0.11	0.21		c0.13	0.22	
v/s Ratio Perm			0.02			0.08			0.01			c0.50
v/c Ratio	0.80	0.79	0.11	0.67	0.87	0.51	0.82	0.58	0.04	0.84	0.57	1.30
Uniform Delay, d1	49.1	49.0	43.9	47.6	49.4	46.4	50.1	30.4	24.3	49.3	29.2	37.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00
Incremental Delay, d2	16.9	7.9	0.1	4.9	24.4	0.7	10.3	1.9	0.1	7.0	1.0	144.2
Delay (s)	66.0	56.9	44.0	52.5	73.8	47.0	60.4	32.3	24.4	56.2	29.6	181.0
Level of Service	E	E	D	D	E	D	E	C	C	E	C	F
Approach Delay (s)		56.2			56.1			41.1			105.8	
Approach LOS		E			E			D			F	

Intersection Summary			
HCM 2000 Control Delay	74.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	20.3
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Future Volume (vph)	14	24	13	1	177	149	301	1	82	923	231	416
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	1.00			1.00	1.00	0.99		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.95			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3353			3047	1863	1533		1770	3471	1408	3367
Peak-hour factor, PHF	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.86	0.86	0.86	0.86	0.94
Adj. Flow (vph)	15	26	14	1	190	160	324	1	95	1073	269	443
RTOR Reduction (vph)	0	13	0	0	0	0	269	0	0	0	86	0
Lane Group Flow (vph)	15	27	0	0	191	160	55	0	96	1073	183	443
Confl. Peds. (#/hr)	1						1		1		2	2
Confl. Bikes (#/hr)											1	
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	13%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Effective Green, g (s)	2.7	9.8			12.9	20.0	20.0		12.4	54.3	54.3	20.7
Actuated g/C Ratio	0.02	0.08			0.11	0.17	0.17		0.11	0.46	0.46	0.18
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	2.0	2.0			2.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	40	279			334	317	260		186	1604	650	593
v/s Ratio Prot	0.01	0.01			c0.06	c0.09			0.05	0.31		c0.13
v/s Ratio Perm							0.04				0.13	
v/c Ratio	0.38	0.10			0.57	0.50	0.21		0.52	0.67	0.28	0.75
Uniform Delay, d1	56.6	49.8			49.7	44.3	42.0		49.7	24.6	19.5	45.9
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.1			1.5	0.5	0.1		1.0	1.2	0.3	4.5
Delay (s)	58.7	49.8			51.1	44.7	42.1		50.7	25.8	19.9	50.4
Level of Service	E	D			D	D	D		D	C	B	D
Approach Delay (s)		52.2				45.3				26.3		
Approach LOS		D				D				C		

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	117.5	Sum of lost time (s)	19.8
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1187	43
Future Volume (vph)	1187	43
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.3	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3452	
Flt Permitted	1.00	
Satd. Flow (perm)	3452	
Peak-hour factor, PHF	0.94	0.94
Adj. Flow (vph)	1263	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1308	0
Confl. Peds. (#/hr)		1
Confl. Bikes (#/hr)		1
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	62.6	
Effective Green, g (s)	62.6	
Actuated g/C Ratio	0.53	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	1839	
v/s Ratio Prot	c0.38	
v/s Ratio Perm		
v/c Ratio	0.71	
Uniform Delay, d1	20.7	
Progression Factor	1.00	
Incremental Delay, d2	1.4	
Delay (s)	22.1	
Level of Service	C	
Approach Delay (s)	29.2	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	41	13	25	39	7	60	6	31	968	51	63	1141
Future Volume (vph)	41	13	25	39	7	60	6	31	968	51	63	1141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Lane Util. Factor		1.00			1.00			1.00	0.95		1.00	0.95
Frpb, ped/bikes		0.99			0.97			1.00	1.00		1.00	1.00
Flpb, ped/bikes		0.99			1.00			1.00	1.00		1.00	1.00
Frt		0.96			0.92			1.00	0.99		1.00	1.00
Flt Protected		0.97			0.98			0.95	1.00		0.95	1.00
Satd. Flow (prot)		1368			1641			1775	3440		1770	3399
Flt Permitted		0.61			0.82			0.95	1.00		0.95	1.00
Satd. Flow (perm)		854			1375			1775	3440		1770	3399
Peak-hour factor, PHF	0.74	0.74	0.74	0.58	0.58	0.58	0.81	0.81	0.81	0.81	0.89	0.89
Adj. Flow (vph)	55	18	34	67	12	103	7	38	1195	63	71	1282
RTOR Reduction (vph)	0	18	0	0	52	0	0	0	2	0	0	1
Lane Group Flow (vph)	0	89	0	0	130	0	0	45	1256	0	71	1319
Confl. Peds. (#/hr)	29		11	11		29		2		11	11	
Confl. Bikes (#/hr)			2			1				3		
Heavy Vehicles (%)	51%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA		Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8								
Actuated Green, G (s)		13.3			13.3			4.5	69.8		6.8	72.1
Effective Green, g (s)		13.3			13.3			4.5	69.8		6.8	72.1
Actuated g/C Ratio		0.13			0.13			0.04	0.66		0.06	0.69
Clearance Time (s)		4.9			4.9			4.9	5.3		4.9	5.3
Vehicle Extension (s)		1.5			1.5			1.0	4.0		1.0	4.5
Lane Grp Cap (vph)		108			174			76	2286		114	2333
v/s Ratio Prot								0.03	0.37		c0.04	c0.39
v/s Ratio Perm		c0.10			0.09							
v/c Ratio		0.82			0.75			0.59	0.55		0.62	0.57
Uniform Delay, d1		44.7			44.2			49.3	9.3		47.9	8.4
Progression Factor		1.00			1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2		35.8			14.3			8.0	1.0		7.4	1.0
Delay (s)		80.5			58.6			57.3	10.2		55.2	9.4
Level of Service		F			E			E	B		E	A
Approach Delay (s)		80.5			58.6				11.9			11.8
Approach LOS		F			E				B			B

Intersection Summary			
HCM 2000 Control Delay	17.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.1
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	34
Future Volume (vph)	34
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.89
Adj. Flow (vph)	38
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	2
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	62%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	86	58	31	8	12	72	20	243	17	745	97	5
Future Volume (vph)	86	58	31	8	12	72	20	243	17	745	97	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.98	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.97				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3363				1746	1863	1518	1770	3471	1529	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3363				1746	1863	1518	1770	3471	1529	
Peak-hour factor, PHF	0.83	0.83	0.83	0.71	0.71	0.71	0.71	0.71	0.76	0.76	0.76	0.86
Adj. Flow (vph)	104	70	37	11	17	101	28	342	22	980	128	6
RTOR Reduction (vph)	0	130	0	0	0	0	0	297	0	0	0	0
Lane Group Flow (vph)	0	81	0	0	0	129	28	45	22	980	128	0
Confl. Peds. (#/hr)	13					3		13	3		2	
Confl. Bikes (#/hr)											2	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Effective Green, g (s)		8.0				11.9	11.9	11.9	2.4	38.2	38.2	
Actuated g/C Ratio		0.09				0.13	0.13	0.13	0.03	0.42	0.42	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		296				229	244	199	46	1463	644	
v/s Ratio Prot		c0.02				c0.07	0.02		0.01	c0.28		
v/s Ratio Perm								0.03			0.08	
v/c Ratio		0.27				0.56	0.11	0.23	0.48	0.67	0.20	
Uniform Delay, d1		38.6				36.9	34.7	35.2	43.5	21.1	16.5	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.5				1.9	0.1	0.2	2.8	1.3	0.2	
Delay (s)		39.1				38.8	34.8	35.4	46.3	22.4	16.7	
Level of Service		D				D	C	D	D	C	B	
Approach Delay (s)		39.1					36.3			22.2		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	20.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	235	16	814	24	45
Future Volume (vph)	235	16	814	24	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9	5.3		4.9
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	1.00		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1582	1653	3456		1589
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1582	1653	3456		1589
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.75
Adj. Flow (vph)	273	19	947	28	60
RTOR Reduction (vph)	0	0	1	0	52
Lane Group Flow (vph)	148	150	974	0	8
Confl. Peds. (#/hr)	2	2		3	
Confl. Bikes (#/hr)					1
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	12.5	12.5	48.3		11.9
Effective Green, g (s)	12.5	12.5	48.3		11.9
Actuated g/C Ratio	0.14	0.14	0.53		0.13
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	218	228	1842		208
v/s Ratio Prot	c0.09	0.09	0.28		
v/s Ratio Perm					0.00
v/c Ratio	0.68	0.66	0.53		0.04
Uniform Delay, d1	37.1	37.0	13.8		34.4
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	6.5	5.1	0.4		0.0
Delay (s)	43.6	42.2	14.1		34.4
Level of Service	D	D	B		C
Approach Delay (s)			20.8		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	23	24	16	178	12	5	9	595	143	2	6	936
Future Volume (vph)	23	24	16	178	12	5	9	595	143	2	6	936
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Lane Util. Factor		1.00		0.95	0.95	1.00	1.00	0.95	1.00		1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98	1.00	1.00	0.98		1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt		0.96		1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected		0.98		0.95	0.96	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)		1721		1681	1696	1555	1766	3471	1550		1770	3462
Flt Permitted		0.85		0.83	0.78	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)		1483		1461	1372	1555	1766	3471	1550		1770	3462
Peak-hour factor, PHF	0.78	0.78	0.78	0.68	0.68	0.68	0.74	0.74	0.74	0.79	0.79	0.79
Adj. Flow (vph)	29	31	21	262	18	7	12	804	193	3	8	1185
RTOR Reduction (vph)	0	12	0	0	0	6	0	0	62	0	0	0
Lane Group Flow (vph)	0	69	0	139	141	1	12	804	131	0	11	1190
Confl. Peds. (#/hr)	4					4	7					
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	9%	2%	2%	2%	2%	2%	2%	4%	2%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases		4			8		5	2		1	1	6
Permitted Phases	4			8		8			2			
Actuated Green, G (s)		11.6		11.6	11.6	11.6	0.8	36.3	36.3		0.8	36.3
Effective Green, g (s)		11.6		11.6	11.6	11.6	0.8	36.3	36.3		0.8	36.3
Actuated g/C Ratio		0.18		0.18	0.18	0.18	0.01	0.57	0.57		0.01	0.57
Clearance Time (s)		4.9		4.9	4.9	4.9	4.9	5.7	5.7		4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0	1.0	4.0	4.0		1.0	4.0
Lane Grp Cap (vph)		267		263	247	280	22	1962	876		22	1957
v/s Ratio Prot							c0.01	0.23			0.01	c0.34
v/s Ratio Perm		0.05		0.10	c0.10	0.00			0.08			
v/c Ratio		0.26		0.53	0.57	0.00	0.55	0.41	0.15		0.50	0.61
Uniform Delay, d1		22.6		23.8	24.0	21.6	31.5	7.9	6.6		31.5	9.2
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.2		0.9	2.0	0.0	14.0	0.2	0.1		6.4	0.6
Delay (s)		22.8		24.7	26.0	21.6	45.5	8.1	6.7		37.9	9.9
Level of Service		C		C	C	C	D	A	A		D	A
Approach Delay (s)		22.8			25.3			8.3				10.1
Approach LOS		C			C			A				B

Intersection Summary			
HCM 2000 Control Delay	11.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	64.2	Sum of lost time (s)	15.5
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	4
Future Volume (vph)	4
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.79
Adj. Flow (vph)	5
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	50%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBT	WBR	WBR2	NBL2	NBT	NBR	SBU	SBL	SBR
Lane Configurations												
Traffic Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Future Volume (vph)	724	765	233	751	208	267	180	635	131	48	179	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	2.6	4.0	4.0	4.0	4.0	4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.95	1.00	1.00	1.00	0.95			1.00	0.88
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.85	0.85	1.00	0.97			1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (prot)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Flt Permitted	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00			0.95	1.00
Satd. Flow (perm)	3127	3223	1392	3223	1442	1408	1543	3132			1649	2538
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.89	0.89	0.89	0.94	0.94	0.94
Adj. Flow (vph)	823	869	265	791	219	281	202	713	147	51	190	612
RTOR Reduction (vph)	0	0	0	0	0	112	0	14	0	0	0	40
Lane Group Flow (vph)	823	869	265	791	219	169	202	846	0	0	241	603
Confl. Peds. (#/hr)	9					9			4		4	
Heavy Vehicles (%)	12%	12%	16%	12%	12%	12%	17%	12%	12%	0%	12%	12%
Turn Type	Prot	NA	Free	NA	Prot	Perm	Split	NA		Prot	Prot	pt+ov
Protected Phases	5	2		6	6		8	8		7	7	7 5
Permitted Phases			Free			6						
Actuated Green, G (s)	26.0	62.1	130.0	32.4	32.4	32.4	35.6	35.6			17.4	47.8
Effective Green, g (s)	25.7	63.5	130.0	33.8	33.8	33.8	36.7	36.7			17.8	48.2
Actuated g/C Ratio	0.20	0.49	1.00	0.26	0.26	0.26	0.28	0.28			0.14	0.37
Clearance Time (s)	3.7	5.4		5.4	5.4	5.4	5.1	5.1			4.4	
Vehicle Extension (s)	2.0	4.0		4.0	4.0	4.0	2.0	2.0			2.0	
Lane Grp Cap (vph)	618	1574	1392	837	374	366	435	884			225	941
v/s Ratio Prot	c0.26	0.27		c0.25	0.15		0.13	c0.27			c0.15	0.24
v/s Ratio Perm			0.19			0.12						
v/c Ratio	1.33	0.55	0.19	0.95	0.59	0.46	0.46	0.96			1.07	0.64
Uniform Delay, d1	52.1	23.3	0.0	47.2	42.0	40.5	38.5	45.9			56.1	33.8
Progression Factor	0.72	1.03	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2	156.3	0.9	0.2	20.3	6.6	4.2	0.3	20.3			80.1	1.1
Delay (s)	194.0	24.8	0.2	67.5	48.6	44.6	38.8	66.1			136.2	34.9
Level of Service	F	C	A	E	D	D	D	E			F	C
Approach Delay (s)		92.6		59.3				60.9				
Approach LOS		F		E				E				

Intersection Summary			
HCM 2000 Control Delay	72.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.6%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR2
Lane Configurations	
Traffic Volume (vph)	29
Future Volume (vph)	29
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.94
Adj. Flow (vph)	31
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	
Heavy Vehicles (%)	12%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Future Volume (vph)	420	513	289	300	104	340	255	866	146	4	479	747
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lane Util. Factor	0.91	0.91	1.00	0.95	0.95	1.00	0.97	0.95	1.00		0.97	0.95
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85		1.00	1.00
Flt Protected	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Flt Permitted	0.95	0.99	1.00	0.95	0.98	1.00	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1550	3232	1583	1681	1638	1423	3433	3539	1583		3129	3539
Peak-hour factor, PHF	0.96	0.96	0.96	0.95	0.95	0.95	0.92	0.92	0.92	0.91	0.91	0.91
Adj. Flow (vph)	438	534	301	316	109	358	277	941	159	4	526	821
RTOR Reduction (vph)	0	0	189	0	0	222	0	0	95	0	0	0
Lane Group Flow (vph)	315	657	112	209	216	136	277	941	64	0	530	821
Confl. Peds. (#/hr)							10					
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	6%	6%	2%	2%	13%	12%	2%	2%	2%	0%	12%	2%
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	Prot	NA
Protected Phases	7	7		8	8		5	2		1	1	6
Permitted Phases			7			8			2			
Actuated Green, G (s)	29.7	29.7	29.7	20.0	20.0	20.0	14.5	36.0	36.0		24.0	45.5
Effective Green, g (s)	31.0	31.0	31.0	20.9	20.9	20.9	15.2	37.4	37.4		24.7	46.9
Actuated g/C Ratio	0.24	0.24	0.24	0.16	0.16	0.16	0.12	0.29	0.29		0.19	0.36
Clearance Time (s)	5.3	5.3	5.3	4.9	4.9	4.9	4.7	5.4	5.4		4.7	5.4
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0		2.0	3.0
Lane Grp Cap (vph)	369	770	377	270	263	228	401	1018	455		594	1276
v/s Ratio Prot	0.20	c0.20		0.12	c0.13		0.08	c0.27			c0.17	0.23
v/s Ratio Perm			0.07			0.10			0.04			
v/c Ratio	0.85	0.85	0.30	0.77	0.82	0.59	0.69	0.92	0.14		0.89	0.64
Uniform Delay, d1	47.3	47.3	40.6	52.3	52.7	50.6	55.1	44.9	34.4		51.4	34.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		0.95	0.83
Incremental Delay, d2	16.6	8.8	0.2	11.9	17.5	2.8	4.1	15.0	0.6		11.2	1.7
Delay (s)	63.9	56.1	40.7	64.2	70.2	53.4	59.3	59.9	35.0		59.7	30.5
Level of Service	E	E	D	E	E	D	E	E	D		E	C
Approach Delay (s)		54.4			60.9			56.9				42.5
Approach LOS		D			E			E				D

Intersection Summary			
HCM 2000 Control Delay	52.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.7
Intersection Capacity Utilization	89.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	352
Future Volume (vph)	352
Ideal Flow (vphpl)	1900
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frpb, ped/bikes	0.97
Flpb, ped/bikes	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1469
Flt Permitted	1.00
Satd. Flow (perm)	1469
Peak-hour factor, PHF	0.91
Adj. Flow (vph)	387
RTOR Reduction (vph)	247
Lane Group Flow (vph)	140
Confl. Peds. (#/hr)	10
Confl. Bikes (#/hr)	7
Heavy Vehicles (%)	7%
Turn Type	Perm
Protected Phases	
Permitted Phases	6
Actuated Green, G (s)	45.5
Effective Green, g (s)	46.9
Actuated g/C Ratio	0.36
Clearance Time (s)	5.4
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	529
v/s Ratio Prot	
v/s Ratio Perm	0.10
v/c Ratio	0.26
Uniform Delay, d1	29.4
Progression Factor	1.49
Incremental Delay, d2	0.8
Delay (s)	44.6
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Future Volume (vph)	87	119	70	2	178	34	347	2	17	1342	181	417
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			3.3	4.0	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			0.97	1.00	1.00		1.00	0.95	1.00	0.97
Frpb, ped/bikes	1.00	0.99			1.00	1.00	0.98		1.00	1.00	0.99	1.00
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Frt	1.00	0.94			1.00	1.00	0.85		1.00	1.00	0.85	1.00
Flt Protected	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (prot)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Flt Permitted	0.95	1.00			0.95	1.00	1.00		0.95	1.00	1.00	0.95
Satd. Flow (perm)	1770	3322			3049	1863	1527		1773	3471	1386	3367
Peak-hour factor, PHF	0.71	0.71	0.71	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.88
Adj. Flow (vph)	123	168	99	2	198	38	386	2	19	1508	203	474
RTOR Reduction (vph)	0	76	0	0	0	0	253	0	0	0	62	0
Lane Group Flow (vph)	123	191	0	0	200	38	133	0	21	1508	141	474
Confl. Peds. (#/hr)	4		4		4		4		3		1	1
Confl. Bikes (#/hr)												
Heavy Vehicles (%)	2%	2%	2%	0%	15%	2%	4%	0%	2%	4%	15%	4%
Turn Type	Prot	NA		Prot	Prot	NA	Perm	Prot	Prot	NA	Perm	Prot
Protected Phases	7	4		3	3	8		5	5	2		1
Permitted Phases							8				2	
Actuated Green, G (s)	14.0	16.9			13.9	16.8	16.8		6.0	55.2	55.2	28.2
Effective Green, g (s)	14.6	18.2			15.2	18.1	18.1		6.6	56.5	56.5	28.8
Actuated g/C Ratio	0.11	0.14			0.11	0.14	0.14		0.05	0.42	0.42	0.21
Clearance Time (s)	4.6	5.3			4.6	5.3	5.3		4.6	5.3	5.3	4.6
Vehicle Extension (s)	3.0	2.0			3.0	2.0	2.0		2.0	4.0	4.0	2.0
Lane Grp Cap (vph)	192	451			345	251	206		87	1463	584	723
v/s Ratio Prot	c0.07	0.06			0.07	0.02			0.01	c0.43		c0.14
v/s Ratio Perm							c0.09				0.10	
v/c Ratio	0.64	0.42			0.58	0.15	0.64		0.24	1.03	0.24	0.66
Uniform Delay, d1	57.2	53.1			56.4	51.2	54.9		61.3	38.8	25.0	48.1
Progression Factor	1.00	1.00			1.00	1.00	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	0.2			2.4	0.1	5.1		0.5	31.8	1.0	1.6
Delay (s)	64.3	53.3			58.7	51.3	60.0		61.8	70.5	25.9	49.7
Level of Service	E	D			E	D	E		E	E	C	D
Approach Delay (s)		56.8				59.0				65.2		
Approach LOS		E				E				E		

Intersection Summary			
HCM 2000 Control Delay	49.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	134.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	80.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1130	10
Future Volume (vph)	1130	10
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	1.00	
Flt Protected	1.00	
Satd. Flow (prot)	3466	
Flt Permitted	1.00	
Satd. Flow (perm)	3466	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	1284	11
RTOR Reduction (vph)	0	0
Lane Group Flow (vph)	1295	0
Confl. Peds. (#/hr)		3
Confl. Bikes (#/hr)		4
Heavy Vehicles (%)	4%	2%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	77.4	
Effective Green, g (s)	78.7	
Actuated g/C Ratio	0.59	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.0	
Lane Grp Cap (vph)	2035	
v/s Ratio Prot	0.37	
v/s Ratio Perm		
v/c Ratio	0.64	
Uniform Delay, d1	18.2	
Progression Factor	1.00	
Incremental Delay, d2	1.5	
Delay (s)	19.7	
Level of Service	B	
Approach Delay (s)	27.8	
Approach LOS	C	

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL
Lane Configurations												
Traffic Volume (vph)	40	15	31	21	14	22	12	44	1231	26	7	44
Future Volume (vph)	40	15	31	21	14	22	12	44	1231	26	7	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0	4.0			4.0
Lane Util. Factor		1.00			1.00			1.00	0.95			1.00
Frpb, ped/bikes		0.99			0.99			1.00	1.00			1.00
Flpb, ped/bikes		1.00			1.00			1.00	1.00			1.00
Frt		0.95			0.95			1.00	1.00			1.00
Flt Protected		0.98			0.98			0.95	1.00			0.95
Satd. Flow (prot)		1391			1714			1777	3456			1774
Flt Permitted		0.76			0.82			0.95	1.00			0.12
Satd. Flow (perm)		1084			1429			1777	3456			232
Peak-hour factor, PHF	0.75	0.75	0.75	0.65	0.65	0.65	0.93	0.93	0.93	0.93	0.96	0.96
Adj. Flow (vph)	53	20	41	32	22	34	13	47	1324	28	7	46
RTOR Reduction (vph)	0	20	0	0	22	0	0	0	2	0	0	0
Lane Group Flow (vph)	0	94	0	0	66	0	0	60	1350	0	0	53
Confl. Peds. (#/hr)	7		7	7		7		6		22		22
Confl. Bikes (#/hr)						2				1		
Heavy Vehicles (%)	53%	2%	2%	2%	2%	2%	0%	2%	4%	2%	0%	2%
Turn Type	Perm	NA		Perm	NA		Prot	Prot	NA			Prot
Protected Phases		4			8		5	5	2			1
Permitted Phases	4			8								
Actuated Green, G (s)		12.8			12.8			6.6	55.8			31.3
Effective Green, g (s)		13.7			13.7			7.5	57.1			32.2
Actuated g/C Ratio		0.12			0.12			0.07	0.50			0.28
Clearance Time (s)		4.9			4.9			4.9	5.3			4.9
Vehicle Extension (s)		1.5			1.5			1.0	4.0			1.0
Lane Grp Cap (vph)		129			170			115	1715			64
v/s Ratio Prot								0.03	c0.39			
v/s Ratio Perm		c0.09			0.05							c0.23
v/c Ratio		0.73			0.39			0.52	0.79			0.83
Uniform Delay, d1		48.8			46.8			52.0	23.9			38.8
Progression Factor		1.00			1.00			1.00	1.00			1.00
Incremental Delay, d2		15.8			0.5			2.0	3.7			54.0
Delay (s)		64.6			47.3			54.0	27.7			92.8
Level of Service		E			D			D	C			F
Approach Delay (s)		64.6			47.3				28.8			
Approach LOS		E			D				C			

Intersection Summary			
HCM 2000 Control Delay	23.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	1188	44
Future Volume (vph)	1188	44
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3396	
Flt Permitted	1.00	
Satd. Flow (perm)	3396	
Peak-hour factor, PHF	0.96	0.96
Adj. Flow (vph)	1238	46
RTOR Reduction (vph)	1	0
Lane Group Flow (vph)	1283	0
Confl. Peds. (#/hr)		6
Confl. Bikes (#/hr)		5
Heavy Vehicles (%)	4%	48%
Turn Type	NA	
Protected Phases	6	
Permitted Phases		
Actuated Green, G (s)	80.5	
Effective Green, g (s)	81.8	
Actuated g/C Ratio	0.71	
Clearance Time (s)	5.3	
Vehicle Extension (s)	4.5	
Lane Grp Cap (vph)	2415	
v/s Ratio Prot	0.38	
v/s Ratio Perm		
v/c Ratio	0.53	
Uniform Delay, d1	7.7	
Progression Factor	1.00	
Incremental Delay, d2	0.8	
Delay (s)	8.5	
Level of Service	A	
Approach Delay (s)	11.9	
Approach LOS	B	

Intersection Summary

Movement	EBL	EBT	EBR2	WBU	WBL2	WBL	WBT	WBR	NBL	NBT	NBR	SBU
Lane Configurations												
Traffic Volume (vph)	31	42	8	9	14	40	52	227	12	1007	88	17
Future Volume (vph)	31	42	8	9	14	40	52	227	12	1007	88	17
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0				4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		0.95				1.00	1.00	1.00	1.00	0.95	1.00	
Frpb, ped/bikes		1.00				1.00	1.00	0.98	1.00	1.00	0.99	
Flpb, ped/bikes		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Frt		0.99				1.00	1.00	0.85	1.00	1.00	0.85	
Flt Protected		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (prot)		3418				1752	1863	1526	1770	3471	1532	
Flt Permitted		0.98				0.95	1.00	1.00	0.95	1.00	1.00	
Satd. Flow (perm)		3418				1752	1863	1526	1770	3471	1532	
Peak-hour factor, PHF	0.70	0.70	0.70	0.95	0.95	0.95	0.95	0.95	0.92	0.92	0.92	0.88
Adj. Flow (vph)	44	60	11	9	15	42	55	239	13	1095	96	19
RTOR Reduction (vph)	0	106	0	0	0	0	0	214	0	0	0	0
Lane Group Flow (vph)	0	9	0	0	0	66	55	25	13	1095	96	0
Confl. Peds. (#/hr)	4		2			2		4			1	
Confl. Bikes (#/hr)								1			1	
Heavy Vehicles (%)	2%	2%	2%	0%	2%	4%	2%	4%	2%	4%	4%	0%
Turn Type	Split	NA		Split	Split	Split	NA	Perm	Prot	NA	Perm	Prot
Protected Phases	4	4		8	8	8	8		5	2		1
Permitted Phases								8			2	
Actuated Green, G (s)		6.2				8.4	8.4	8.4	1.1	40.7	40.7	
Effective Green, g (s)		7.1				9.3	9.3	9.3	2.0	42.0	42.0	
Actuated g/C Ratio		0.08				0.10	0.10	0.10	0.02	0.46	0.46	
Clearance Time (s)		4.9				4.9	4.9	4.9	4.9	5.3	5.3	
Vehicle Extension (s)		3.0				2.0	2.0	2.0	2.0	4.0	4.0	
Lane Grp Cap (vph)		267				179	191	156	39	1609	710	
v/s Ratio Prot		c0.00				c0.04	0.03		0.01	c0.32		
v/s Ratio Perm								0.02			0.06	
v/c Ratio		0.03				0.37	0.29	0.16	0.33	0.68	0.14	
Uniform Delay, d1		38.6				37.9	37.6	37.1	43.6	19.0	13.9	
Progression Factor		1.00				1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		0.1				0.5	0.3	0.2	1.8	1.3	0.1	
Delay (s)		38.6				38.4	37.9	37.2	45.5	20.3	14.0	
Level of Service		D				D	D	D	D	C	B	
Approach Delay (s)		38.6					37.6			20.1		
Approach LOS		D					D			C		

Intersection Summary			
HCM 2000 Control Delay	25.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL2	SBL	SBT	SBR	NWR2
Lane Configurations					
Traffic Volume (vph)	383	20	733	68	31
Future Volume (vph)	383	20	733	68	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0
Lane Util. Factor	0.91	0.95	0.95		1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00
Frt	1.00	1.00	0.99		0.86
Flt Protected	0.95	0.95	1.00		1.00
Satd. Flow (prot)	1584	1652	3426		1611
Flt Permitted	0.95	0.95	1.00		1.00
Satd. Flow (perm)	1584	1652	3426		1611
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.60
Adj. Flow (vph)	435	23	833	77	52
RTOR Reduction (vph)	0	0	3	0	47
Lane Group Flow (vph)	254	223	907	0	5
Confl. Peds. (#/hr)	1	1			
Confl. Bikes (#/hr)				5	
Heavy Vehicles (%)	4%	2%	4%	2%	2%
Turn Type	Prot	Prot	NA		Perm
Protected Phases	1	1	6		
Permitted Phases					8
Actuated Green, G (s)	15.3	15.3	54.9		8.4
Effective Green, g (s)	16.2	16.2	56.2		9.3
Actuated g/C Ratio	0.18	0.18	0.62		0.10
Clearance Time (s)	4.9	4.9	5.3		4.9
Vehicle Extension (s)	1.0	1.0	4.0		2.0
Lane Grp Cap (vph)	283	295	2125		165
v/s Ratio Prot	c0.16	0.13	0.26		
v/s Ratio Perm					0.00
v/c Ratio	0.90	0.76	0.43		0.03
Uniform Delay, d1	36.4	35.3	8.9		36.6
Progression Factor	1.00	1.00	1.00		1.00
Incremental Delay, d2	27.9	9.4	0.2		0.0
Delay (s)	64.2	44.7	9.1		36.6
Level of Service	E	D	A		D
Approach Delay (s)			24.9		
Approach LOS			C		

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	7	22	6	124	20	2	1	16	1066	390	13	619
Future Volume (vph)	7	22	6	124	20	2	1	16	1066	390	13	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	3.2	4.0
Lane Util. Factor		1.00		0.95	0.95	1.00		1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes		1.00		1.00	1.00	0.98		1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt		0.98		1.00	1.00	0.85		1.00	1.00	0.85	1.00	1.00
Flt Protected		0.99		0.95	0.96	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		1706		1681	1706	1557		1772	3471	1548	1770	3453
Flt Permitted		0.92		0.93	0.79	1.00		0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		1589		1654	1398	1557		1772	3471	1548	1770	3453
Peak-hour factor, PHF	0.57	0.57	0.57	0.91	0.91	0.91	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	12	39	11	136	22	2	1	17	1146	419	14	666
RTOR Reduction (vph)	0	8	0	0	0	2	0	0	0	83	0	0
Lane Group Flow (vph)	0	54	0	72	86	0	0	18	1146	336	14	677
Confl. Peds. (#/hr)	5					5		4		2	2	
Confl. Bikes (#/hr)			3									
Heavy Vehicles (%)	29%	2%	2%	2%	2%	2%	0%	2%	4%	2%	2%	4%
Turn Type	Perm	NA		Perm	NA	Perm	Prot	Prot	NA	Perm	Prot	NA
Protected Phases		4			8		5	5	2		1	6
Permitted Phases	4			8		8				2		
Actuated Green, G (s)		6.9		6.9	6.9	6.9		0.8	33.8	33.8	0.7	33.7
Effective Green, g (s)		7.8		7.8	7.8	7.8		1.7	35.5	35.5	2.4	35.4
Actuated g/C Ratio		0.14		0.14	0.14	0.14		0.03	0.62	0.62	0.04	0.62
Clearance Time (s)		4.9		4.9	4.9	4.9		4.9	5.7	5.7	4.9	5.7
Vehicle Extension (s)		2.0		2.0	2.0	2.0		1.0	4.0	4.0	1.0	4.0
Lane Grp Cap (vph)		217		226	191	213		52	2165	965	74	2148
v/s Ratio Prot								c0.01	c0.33		0.01	0.20
v/s Ratio Perm		0.03		0.04	c0.06	0.00				0.22		
v/c Ratio		0.25		0.32	0.45	0.00		0.35	0.53	0.35	0.19	0.32
Uniform Delay, d1		21.9		22.2	22.6	21.2		27.1	6.0	5.1	26.3	5.1
Progression Factor		1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.2		0.3	0.6	0.0		1.5	0.3	0.3	0.5	0.1
Delay (s)		22.2		22.4	23.2	21.2		28.5	6.3	5.4	26.8	5.2
Level of Service		C		C	C	C		C	A	A	C	A
Approach Delay (s)		22.2			22.8				6.3			5.6
Approach LOS		C			C				A			A

Intersection Summary			
HCM 2000 Control Delay	7.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	56.9	Sum of lost time (s)	12.9
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	10
Future Volume (vph)	10
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.93
Adj. Flow (vph)	11
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	4
Confl. Bikes (#/hr)	
Heavy Vehicles (%)	20%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

APPENDIX I

AIR QUALITY AND GREENHOUSE GAS CALCULATIONS

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APPENDIX I

AIR QUALITY AND GREENHOUSE GAS CALCULATIONS

Part 1

Alternative B1/B2, C1/C2, D1/D2 Construction:

Subsequent Construction

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Table 1. Air Quality Emissions Summary

Emission Sources	ROG	CO	NOX	PM10 (exhaust)	PM2.5 (exhaust)	PM10 (Total)	PM2.5 (Total)
Average Daily Emissions (lbs/day)*							
Alt B	2.89	25.98	29.36	1.29	1.19	14.62	5.84
Alt C	2.75	23.37	27.88	1.25	1.16	7.85	1.99
Alt D	3.31	30.68	32.56	1.39	1.29	16.45	6.58
Total Tons							
Alt B	0.60	5.43	6.14	0.27	0.25	3.06	1.22
Alt C	0.55	4.63	5.52	0.25	0.23	1.55	0.39
Alt D	0.62	5.74	6.09	0.25	0.24	3.08	1.23
Total Tons/Year							
Alt B	0.38	3.43	3.88	0.17	0.16	1.93	0.77
Alt C	0.34	2.92	3.49	0.16	0.15	0.98	0.25
Alt D	0.39	3.62	3.85	0.16	0.15	1.94	0.78
Total Construction Emissions							
Alt B Average Daily Emissions* (lbs/day)	2.89	25.98	29.36	1.29	1.19	14.62	5.84
Alt C Average Daily Emissions* (lbs/day)	2.75	23.37	27.88	1.25	1.16	7.85	1.99
Alt D Average Daily Emissions* (lbs/day)	3.31	30.68	32.56	1.39	1.29	16.45	6.58
Thresholds of Significance	54	-	54	82	54	BMPs	BMPs
Exceeds Thresholds	No	-	No	No	No	_	_

Notes:

*Average Daily Emissions are calculated based on the following construction durations with 22 working days per month: Alt B 19 months; Alt C 18 months; and Alt D 17 months. Detailed modeling outputs provided in Attachment A.

ROG = reactive organic gases; NOX = oxides of nitrogen; PM10 = particulate matter with aerodynamic diameter less than 10 microns; PM2.5 = particulate matter with aerodynamic diameter less than 2.5 microns; lbs/day = pounds per day; BAAQMD = Bay Area Air Quality Management District

Table 2. Project – GHG Construction Emissions

Emissions Source	Proposed Project (MTCO2e)
Alt B	
Total Construction Emissions	665.75
Amortized Construction Emissions*	22.19
Alt C	
Total Construction Emissions	634.68
Amortized Construction Emissions*	21.16
Alt D	
Total Construction Emissions	694.12
Amortized Construction Emissions*	23.14

Note:

* Construction emissions were amortized over the lifetime of the project (assumed to be 30 years) for comparison with thresholds.

Detailed modeling outputs provided in Attachment A.

Table 3. Construction

Alt B

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio-CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
	tons/yr										MT/yr					
2018	**0.60**	**6.14**	**5.43**	**0.01**	**2.79**	**0.27**	**3.06**	**0.97**	**0.25**	**1.22**	**0.00**	**662.88**	**662.88**	**0.14**	**0.00**	**665.75**
Total	**0.60**	**6.14**	**5.43**	**0.01**	**2.79**	**0.27**	**3.06**	**0.97**	**0.25**	**1.22**	**0.00**	**662.88**	**662.88**	**0.14**	**0.00**	**665.75**

Alt C

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio-CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
	tons/yr										MT/yr					
2018	**0.55**	**5.52**	**4.63**	**0.01**	**1.31**	**0.25**	**1.55**	**0.16**	**0.23**	**0.39**	**0.00**	**632.02**	**632.02**	**0.13**	**0.00**	**634.68**
Total	**0.55**	**5.52**	**4.63**	**0.01**	**1.31**	**0.25**	**1.55**	**0.16**	**0.23**	**0.39**	**0.00**	**632.02**	**632.02**	**0.13**	**0.00**	**634.68**

Alt D

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio-CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
	tons/yr										MT/yr					
2018	**0.62**	**6.09**	**5.74**	**0.01**	**2.82**	**0.26**	**3.08**	**0.99**	**0.24**	**1.23**	**0.00**	**691.35**	**691.35**	**0.13**	**0.00**	**694.12**
Total	**0.62**	**6.09**	**5.74**	**0.01**	**2.82**	**0.26**	**3.08**	**0.99**	**0.24**	**1.23**	**0.00**	**691.35**	**691.35**	**0.13**	**0.00**	**694.12**

Carbon Sequestration

Carbon sequestration rate (g carbon/year) = [(sequestration rate, g C/m2yr)*(proposed project area, m2)]-(fossil fuel emissions, grams carbon/year)

Sequestration rate 79 g C/m2-yr (Callaway et al. 2012)

Area conversion factor 4046.86 m2/acre

Mass conversion factor 907185 g/ton

Table 4. Carbon Sequestration

Pond Cluster	Alternative	Area (acres)	Carbon sequestration rate (g carbon/year)	Carbon sequestration rate (ton carbon/year)
Eden Landing	B	2,270	7.26E+08	800
Eden Landing	C	1,375	4.40E+08	485
Eden Landing	D (Low End Estimate)	1,375	4.40E+08	485
Eden Landing	D (High End Estimate)	2,270	7.26E+08	800

Note: Carbon sequestion rate calculated does not include fossil fuel emissions from operation and maintenance. Values presented are for gross carbon sequestration potential of the pond cluster.

Carbon sequestration potential calculated for the ponds that would become tidal marsh. Assumed tidal marsh ponds by alternative are as follows:

Alt B: ALL 11 of them.

Alt C: Bay Ponds only (E1, E2, E4, E7)

Alt D: Bay Ponds only (E1, E2, E4, E7) in the initial 10-20 years (Low End Estimate), with the potential to restore marsh in the remaining 7 ponds after (High End Estimate).

Table 1-2 Phase 2 Eden Landing Pond Complex Acreage

Pond	Acres
E1	290
E2	680
E4	190
E5	165
E6	200
E7	215
E1C	150
E2C	30
E4C	175
E5C	95
E6C	80
Total Area	**2,270**

APPENDIX I

AIR QUALITY AND GREENHOUSE GAS CALCULATIONS

Part 2

Alternative B1/B2, C1/C2, D1/D2 Construction:

Dredged Material Placement

Subsequent Construction

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Table 1. Construction Emissions Summary – Alternative B

Diesel

	Emissions (lbs)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	1007.59	7970.74	6812.21	315.13	293.92	694.19
Dredged Material Placement	21741.62	293247.11	95310.39	7050.04	6989.67	21582.75
Decomissioning	475.43	3602.96	2906.48	130.57	120.14	290.75
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	129.13	1364.39	1256.68	63.11	58.07	86.37
Total Project	23387.30	306426.46	106500.69	7565.90	7468.29	22676.54
Average Emissions (lbs)	**48.08**	**629.91**	**218.93**	**15.55**	**15.35**	
486						
Amortized GHG Emissions						453.53

Electric

	Emissions (lbs/day)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	1007.59	7970.74	6812.21	315.13	293.92	694.19
Dredged Material Placement	2433.34	19324.13	16238.38	755.40	695.03	10330.17
Decomissioning	578.27	4500.08	3471.10	164.23	151.12	351.30
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	129.13	1364.39	1256.68	63.11	58.07	86.37
Total Project	4181.85	33400.60	27993.30	1304.92	1204.62	11484.51
Average Daily Emissions (lbs/day)	**8.60**	**68.66**	**57.54**	**2.68**	**2.48**	
Amortized GHG Emissions						229.69

Table 2. Construction Emissions Summary – Alternative C

Diesel

			Emissions (lbs)			Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	976.32	7694.33	6394.07	300.08	279.33	647.01
Dredged Material Placement	17119.26	230494.97	74900.70	5538.20	5490.80	16967.30
Decomissioning	468.99	3541.31	2793.59	127.74	117.54	276.96
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	69.84	737.89	679.63	34.13	31.41	46.71
Total Project	18667.92	242709.75	84982.92	6007.21	5925.57	17960.47
Average Emissions (lbs)	**46.33**	**602.38**	**210.92**	**14.91**	**14.71**	
403						
Amortized GHG Emissions						359.21

Electric

			Emissions (lbs/day)			Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	976.32	7694.33	6394.07	300.08	279.33	647.01
Dredged Material Placement	1950.51	15298.76	12781.06	593.08	545.68	8127.18
Decomissioning	571.58	4437.13	3346.66	161.38	148.49	335.30
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	69.84	737.89	679.63	34.13	31.41	46.71
Total Project	3601.77	28409.37	23416.36	1095.72	1011.40	9178.70
Average Daily Emissions (lbs/day)	**8.94**	**70.51**	**58.12**	**2.72**	**2.51**	
Amortized GHG Emissions						305.96

Table 3. Construction Emissions Summary – Alternative D

Diesel

			Emissions (lbs)			Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.57	119.59	98.23	3.51	3.23	9.48
Site Preparation	1021.13	8198.86	6196.22	325.54	303.49	564.77
Dredged Material Placement	21780.52	293993.29	94076.33	7076.07	7014.67	21320.57
Decomissioning	469.66	3572.26	2633.42	130.02	119.63	238.58
Demobilization	16.57	119.59	98.23	3.51	3.23	9.48
Restoration Project	124.62	1326.57	1142.32	61.65	56.72	67.66
Total Project	23429.07	307330.18	104244.75	7600.29	7500.98	22210.53
Average Emissions (lbs)	**48.13**	**631.35**	**214.15**	**15.61**	**15.41**	
487						
Amortized GHG Emissions						444.21

Electric

			Emissions (lbs/day)			Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.57	119.59	98.23	3.51	3.23	9.48
Site Preparation	1021.13	8198.86	6196.22	325.54	303.49	564.77
Dredged Material Placement	2430.90	19483.94	14835.06	767.95	706.56	10043.90
Decomissioning	572.26	4468.08	3186.49	163.65	150.59	296.92
Demobilization	16.57	119.59	98.23	3.51	3.23	9.48
Restoration Project	124.62	1326.57	1142.32	61.65	56.72	67.66
Total Project	4182.05	33716.65	25556.55	1325.81	1223.82	10992.21
Average Daily Emissions (lbs/day)	**8.59**	**69.26**	**52.50**	**2.72**	**2.51**	
Amortized GHG Emissions						366.41

Table 4. Emission Factors

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Aerial Lifts	2019	6	15	0.204518	0.1719	3.11451	3.07945	0.0054	0.0417	0.0384	536.7427	0.1698
Aerial Lifts	2019	16	25	0.204518	0.1719	3.11451	3.07945	0.0054	0.0417	0.0384	536.7427	0.1698
Aerial Lifts	2019	26	50	0.204518	0.1719	3.11451	3.07945	0.0054	0.0417	0.0384	536.7427	0.1698
Aerial Lifts	2019	51	120	0.14071	0.1182	3.17254	1.97658	0.0049	0.0485	0.0446	482.6056	0.1527
Aerial Lifts	2019	251	500	0.077988	0.0655	0.94139	0.63586	0.0049	0.0089	0.0082	482.5446	0.1527
Aerial Lifts	2019	501	750	28.429	0.212	1.023	2.117	0.005	0.064	0.064	568.299	0.019
Air Compressors	2019	6	15	1.951	0.748	3.562	4.647	0.008	0.241	0.241	568.299	0.067
Air Compressors	2019	16	25	4.106	0.787	2.501	4.596	0.007	0.222	0.222	568.299	0.071
Air Compressors	2019	26	50	9.076	1.129	5.283	4.546	0.007	0.287	0.287	568.299	0.101
Air Compressors	2019	51	120	9.123	0.538	3.718	3.706	0.006	0.26	0.26	568.299	0.048
Air Compressors	2019	121	175	12.833	0.401	3.204	2.874	0.006	0.15	0.15	568.299	0.036
Air Compressors	2019	176	250	14.416	0.304	1.132	2.469	0.006	0.078	0.078	568.299	0.027
Air Compressors	2019	251	500	24.559	0.293	1.086	2.193	0.005	0.075	0.075	568.299	0.026
Air Compressors	2019	501	750	38.104	0.294	1.086	2.247	0.005	0.076	0.076	568.299	0.026
Air Compressors	2019	751	1000	56.984	0.324	1.182	4.073	0.005	0.102	0.102	568.299	0.029
Bore/Drill Rigs	2019	6	15	0.858717	0.7216	4.49723	4.71795	0.0055	0.3025	0.2783	545.293	0.1725
Bore/Drill Rigs	2019	16	25	0.858717	0.7216	4.49723	4.71795	0.0055	0.3025	0.2783	545.293	0.1725
Bore/Drill Rigs	2019	26	50	0.858717	0.7216	4.49723	4.71795	0.0055	0.3025	0.2783	545.293	0.1725
Bore/Drill Rigs	2019	51	120	0.317934	0.2672	3.33202	3.32102	0.0048	0.1802	0.1658	472.4527	0.1495
Bore/Drill Rigs	2019	121	175	0.215784	0.1813	2.95563	2.01775	0.0049	0.0876	0.0806	487.3552	0.1542
Bore/Drill Rigs	2019	176	250	0.170614	0.1434	1.06058	1.8943	0.0048	0.0537	0.0494	475.7896	0.1505
Bore/Drill Rigs	2019	251	500	0.153732	0.1292	1.03449	1.55098	0.0048	0.0479	0.0441	477.0462	0.1509
Bore/Drill Rigs	2019	501	750	0.138617	0.1165	0.97074	1.44865	0.0049	0.0478	0.044	481.8363	0.1524
Bore/Drill Rigs	2019	751	1000	0.153944	0.1294	0.98342	3.04139	0.0049	0.0609	0.056	482.3593	0.1526
Cement and Mortar Mixers	2019	6	15	1.075	0.661	3.469	4.142	0.008	0.162	0.162	568.299	0.059
Cement and Mortar Mixers	2019	16	25	3.321	0.735	2.417	4.469	0.007	0.196	0.196	568.299	0.066
Concrete/Industrial Saws	2019	16	25	1.532	0.685	2.339	4.332	0.007	0.161	0.161	568.299	0.061
Concrete/Industrial Saws	2019	26	50	3.686	0.899	4.645	4.338	0.007	0.242	0.242	568.299	0.081
Concrete/Industrial Saws	2019	51	120	4.463	0.443	3.55	3.441	0.006	0.22	0.22	568.3	0.04
Concrete/Industrial Saws	2019	121	175	7.177	0.33	3.072	2.618	0.006	0.128	0.128	568.299	0.029
Cranes	2019	26	50	2.434147	2.0454	7.24465	5.95197	0.0053	0.6148	0.5657	529.4626	0.1675

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Cranes	2019	51	120	0.955908	0.8032	4.26491	6.95786	0.0048	0.5005	0.4604	480.3251	0.152
Cranes	2019	121	175	0.675554	0.5677	3.5982	5.94857	0.0049	0.3177	0.2923	485.1817	0.1535
Cranes	2019	176	250	0.50769	0.4266	1.94079	5.0842	0.0049	0.2155	0.1983	483.4616	0.153
Cranes	2019	251	500	0.415431	0.3491	2.96893	4.29654	0.0049	0.173	0.1592	483.1422	0.1529
Cranes	2019	501	750	0.299943	0.252	1.44568	3.42803	0.0049	0.1238	0.1139	481.1192	0.1522
Cranes	2019	1001	9999	0.205078	0.1723	0.9912	2.34854	0.0049	0.0595	0.0547	482.5446	0.1527
Crawler Tractors	2019	26	50	2.648469	2.2254	7.58896	5.85476	0.0053	0.6404	0.5892	525.9767	0.1664
Crawler Tractors	2019	51	120	0.901167	0.7572	4.08842	6.39347	0.0049	0.5347	0.4919	486.9909	0.1541
Crawler Tractors	2019	121	175	0.615173	0.5169	3.37886	5.38191	0.0049	0.2996	0.2756	481.6222	0.1524
Crawler Tractors	2019	176	250	0.45175	0.3796	1.60445	4.9721	0.0049	0.1875	0.1725	483.4489	0.153
Crawler Tractors	2019	251	500	0.37933	0.3187	2.21938	3.93412	0.0049	0.1528	0.1406	485.8645	0.1537
Crawler Tractors	2019	501	750	0.316919	0.2663	1.35585	3.34253	0.0049	0.123	0.1132	483.3879	0.1529
Crawler Tractors	2019	751	1000	0.547243	0.4598	2.02037	7.21215	0.0049	0.2106	0.1938	486.2545	0.1538
Crushing/Proc. Equipment	2019	26	50	2.798	1.064	5.316	4.495	0.007	0.269	0.269	568.299	0.096
Crushing/Proc. Equipment	2019	51	120	2.577	0.519	3.739	3.544	0.006	0.241	0.241	568.299	0.046
Crushing/Proc. Equipment	2019	121	175	3.938	0.394	3.233	2.7	0.006	0.141	0.141	568.299	0.035
Crushing/Proc. Equipment	2019	176	250	4.451	0.304	1.134	2.3	0.006	0.074	0.074	568.299	0.027
Crushing/Proc. Equipment	2019	251	500	6.592	0.295	1.087	2.046	0.005	0.071	0.071	568.299	0.026
Crushing/Proc. Equipment	2019	501	750	10.352	0.294	1.085	2.085	0.005	0.071	0.071	568.299	0.026
Crushing/Proc. Equipment	2019	1001	9999	26.978	0.345	1.173	3.927	0.005	0.098	0.098	568.299	0.031
Dumpers/Tenders	2019	16	25	0.82	0.686	2.339	4.341	0.007	0.167	0.167	568.299	0.061
Excavators	2019	16	25	0.75855	0.6374	4.59698	4.19867	0.0054	0.2503	0.2303	536.9132	0.1699
Excavators	2019	26	50	0.75855	0.6374	4.59698	4.19867	0.0054	0.2503	0.2303	536.9132	0.1699
Excavators	2019	51	120	0.386598	0.3248	3.52421	3.36874	0.0048	0.2107	0.1938	478.2452	0.1513
Excavators	2019	121	175	0.293021	0.2462	3.08163	2.53264	0.0049	0.1221	0.1124	482.6838	0.1527
Excavators	2019	176	250	0.220917	0.1856	1.12671	2.24187	0.0049	0.068	0.0625	482.2503	0.1526
Excavators	2019	251	500	0.192898	0.1621	1.1135	1.77986	0.0049	0.0578	0.0532	481.2361	0.1523
Excavators	2019	501	750	0.209677	0.1762	1.17289	1.98661	0.0048	0.0671	0.0618	479.2876	0.1516
Forklifts	2019	26	50	1.480074	1.2437	5.88034	4.86189	0.0054	0.4009	0.3688	537.1608	0.17
Forklifts	2019	51	120	0.606336	0.5095	3.80391	4.54965	0.0049	0.3525	0.3243	482.0069	0.1525
Forklifts	2019	121	175	0.454984	0.3823	3.28831	3.86458	0.0049	0.2102	0.1934	482.5975	0.1527
Forklifts	2019	176	250	0.445406	0.3743	1.6773	4.2498	0.0049	0.1753	0.1613	483.8438	0.1531

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Forklifts	2019	251	500	0.31829	0.2675	1.814	2.75148	0.0049	0.112	0.103	484.1399	0.1532
Generator Sets	2019	6	15	1.758	0.662	3.562	4.617	0.008	0.224	0.224	568.299	0.059
Generator Sets	2019	16	25	3.356	0.731	2.501	4.596	0.007	0.214	0.214	568.299	0.066
Generator Sets	2019	26	50	6.208	0.779	4.076	4.215	0.007	0.222	0.222	568.299	0.07
Generator Sets	2019	51	120	8.233	0.405	3.396	3.446	0.006	0.206	0.206	568.299	0.036
Generator Sets	2019	121	175	10.727	0.29	2.929	2.669	0.006	0.118	0.118	568.299	0.026
Generator Sets	2019	176	250	11.695	0.211	1.036	2.285	0.006	0.064	0.064	568.299	0.019
Generator Sets	2019	251	500	17.492	0.199	1.015	2.056	0.005	0.062	0.062	568.299	0.018
Generator Sets	2019	501	750	28.675	0.202	1.015	2.104	0.005	0.062	0.062	568.299	0.018
Generator Sets	2019	1001	9999	71.228	0.261	1.103	3.829	0.005	0.087	0.087	568.299	0.023
Graders	2019	26	50	3.11378	2.6164	8.27912	5.94463	0.005	0.7367	0.6778	503.7509	0.1594
Graders	2019	51	120	1.228249	1.0321	4.6424	8.1592	0.0048	0.6653	0.612	479.9011	0.1518
Graders	2019	121	175	0.724541	0.6088	3.65586	6.01354	0.0049	0.3365	0.3096	489.0419	0.1547
Graders	2019	176	250	0.428358	0.3599	1.35927	4.86575	0.0049	0.1562	0.1437	486.3288	0.1539
Graders	2019	251	500	0.384059	0.3227	1.52849	3.21794	0.0049	0.1244	0.1145	482.5879	0.1527
Graders	2019	501	750	13.635	0.335	1.255	2.276	0.005	0.08	0.08	568.299	0.03
Off-Highway Tractors	2019	51	120	0.562974	0.4731	3.79465	4.42145	0.0049	0.3311	0.3046	484.2693	0.1532
Off-Highway Tractors	2019	121	175	0.350048	0.2941	3.21895	3.20755	0.0049	0.1586	0.1459	483.4306	0.153
Off-Highway Tractors	2019	176	250	0.283777	0.2385	1.21832	2.9142	0.0049	0.0976	0.0898	481.2751	0.1523
Off-Highway Tractors	2019	501	750	0.244248	0.2052	1.12934	2.17682	0.0049	0.082	0.0754	482.3091	0.1526
Off-Highway Tractors	2019	751	1000	0.166166	0.1396	1.00978	2.37757	0.0049	0.0616	0.0567	482.5446	0.1527
Off-Highway Trucks	2019	121	175	0.38382	0.3225	3.32598	2.82463	0.0049	0.1494	0.1375	480.3623	0.152
Off-Highway Trucks	2019	176	250	0.365362	0.307	1.46079	2.98481	0.0049	0.119	0.1095	480.1703	0.1519
Off-Highway Trucks	2019	251	500	0.313575	0.2635	1.48346	2.66851	0.0049	0.097	0.0893	485.3832	0.1536
Off-Highway Trucks	2019	501	750	0.389037	0.3269	2.04129	3.32044	0.0049	0.1286	0.1183	483.2182	0.1529
Off-Highway Trucks	2019	751	1000	0.351304	0.2952	1.3561	4.76495	0.0049	0.1242	0.1142	480.3479	0.152
Other Construction Equipment	2019	6	15	1.370834	1.1519	5.54123	5.20338	0.0054	0.4374	0.4024	539.7349	0.1708
Other Construction Equipment	2019	16	25	1.370834	1.1519	5.54123	5.20338	0.0054	0.4374	0.4024	539.7349	0.1708
Other Construction Equipment	2019	26	50	1.370834	1.1519	5.54123	5.20338	0.0054	0.4374	0.4024	539.7349	0.1708
Other Construction Equipment	2019	51	120	0.655004	0.5504	3.7535	5.04831	0.0049	0.3789	0.3486	482.2177	0.1526
Other Construction Equipment	2019	121	175	0.490382	0.4121	3.25619	4.4331	0.0049	0.2335	0.2148	480.4518	0.152
Other Construction Equipment	2019	251	500	0.277883	0.2335	1.66739	2.85547	0.0049	0.1026	0.0944	485.4127	0.1536

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Other General Industrial Equipment	2019	6	15	1.240314	1.0422	5.66186	4.80683	0.0054	0.3737	0.3438	537.8689	0.1702
Other General Industrial Equipment	2019	16	25	1.240314	1.0422	5.66186	4.80683	0.0054	0.3737	0.3438	537.8689	0.1702
Other General Industrial Equipment	2019	26	50	1.240314	1.0422	5.66186	4.80683	0.0054	0.3737	0.3438	537.8689	0.1702
Other General Industrial Equipment	2019	51	120	0.594634	0.4997	3.82128	4.49674	0.0048	0.3429	0.3155	480.4442	0.152
Other General Industrial Equipment	2019	121	175	0.359068	0.3017	3.24129	2.99891	0.0049	0.1565	0.144	482.3357	0.1526
Other General Industrial Equipment	2019	176	250	0.307665	0.2585	1.29893	3.01996	0.0049	0.1058	0.0973	483.7392	0.153
Other General Industrial Equipment	2019	251	500	0.283854	0.2385	1.56115	2.57531	0.0049	0.0923	0.0849	483.4385	0.153
Other General Industrial Equipment	2019	501	750	0.236758	0.1989	1.47441	2.11518	0.0049	0.0758	0.0697	483.9852	0.1531
Other General Industrial Equipment	2019	751	1000	0.31421	0.264	1.07573	4.83364	0.0049	0.1172	0.1079	482.5446	0.1527
Other Material Handling Equipment	2019	26	50	1.5177	1.2753	6.13945	5.17904	0.0054	0.4519	0.4158	535.3468	0.1694
Other Material Handling Equipment	2019	51	120	0.428699	0.3602	3.63634	3.56573	0.0049	0.2307	0.2123	484.1126	0.1532
Other Material Handling Equipment	2019	121	175	0.332757	0.2796	3.1852	2.77369	0.0049	0.1388	0.1277	482.7131	0.1527
Other Material Handling Equipment	2019	176	250	0.357063	0.3	1.34052	3.81716	0.0049	0.1231	0.1133	481.9594	0.1525
Other Material Handling Equipment	2019	251	500	0.346245	0.2909	1.61951	3.37078	0.0049	0.1278	0.1175	480.7483	0.1521
Other Material Handling Equipment	2019	1001	9999	0.226018	0.1899	1.03609	3.58277	0.0049	0.0763	0.0702	482.5446	0.1527
Pavers	2019	16	25	1.687019	1.4176	5.65687	4.91634	0.0054	0.4361	0.4012	538.3246	0.1703
Pavers	2019	26	50	1.687019	1.4176	5.65687	4.91634	0.0054	0.4361	0.4012	538.3246	0.1703
Pavers	2019	51	120	0.589904	0.4957	3.62215	4.67048	0.0048	0.3455	0.3178	480.2509	0.1519
Pavers	2019	121	175	0.355588	0.2988	3.01323	3.24473	0.0049	0.1589	0.1462	483.3938	0.1529

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Pavers	2019	176	250	0.222293	0.1868	1.03181	3.11084	0.0049	0.0842	0.0774	483.5743	0.153
Pavers	2019	251	500	0.198123	0.1665	0.98586	2.26992	0.0048	0.081	0.0746	476.9707	0.1509
Paving Equipment	2019	16	25	0.838543	0.7046	4.40798	4.23779	0.0054	0.2697	0.2481	531.8612	0.1683
Paving Equipment	2019	26	50	0.838543	0.7046	4.40798	4.23779	0.0054	0.2697	0.2481	531.8612	0.1683
Paving Equipment	2019	51	120	0.50594	0.4251	3.59849	4.04152	0.0049	0.2808	0.2584	484.387	0.1533
Paving Equipment	2019	121	175	0.302373	0.2541	3.0109	2.6924	0.0049	0.1336	0.1229	481.2251	0.1523
Paving Equipment	2019	176	250	0.286526	0.2408	1.24449	3.25106	0.0049	0.1116	0.1027	482.6441	0.1527
Plate Compactors	2019	6	15	0.79	0.661	3.469	4.142	0.008	0.161	0.161	568.299	0.059
Pressure Washers	2019	6	15	1.824	0.662	3.562	4.617	0.008	0.224	0.224	568.299	0.059
Pressure Washers	2019	16	25	2.947	0.731	2.501	4.596	0.007	0.214	0.214	568.299	0.066
Pressure Washers	2019	26	50	4.585	0.569	3.457	4.053	0.007	0.184	0.184	568.299	0.051
Pressure Washers	2019	51	120	4.575	0.337	3.24	3.295	0.006	0.174	0.174	568.299	0.03
Pressure Washers	2019	121	175	18.102	0.28	2.907	2.67	0.006	0.117	0.117	568.299	0.025
Pressure Washers	2019	176	250	8.005	0.098	0.986	0.265	0.006	0.009	0.009	568.299	0.008
Pumps	2019	6	15	1.63	0.748	3.562	4.647	0.008	0.241	0.241	568.3	0.067
Pumps	2019	16	25	4.503	0.787	2.501	4.596	0.007	0.222	0.222	568.3	0.071
Pumps	2019	26	50	8.56	0.849	4.284	4.269	0.007	0.235	0.235	568.299	0.076
Pumps	2019	51	120	9.812	0.429	3.449	3.497	0.006	0.217	0.217	568.299	0.038
Pumps	2019	121	175	12.706	0.309	2.974	2.711	0.006	0.124	0.124	568.299	0.027
Pumps	2019	176	250	13.378	0.226	1.052	2.323	0.006	0.067	0.067	568.299	0.02
Pumps	2019	251	500	21.711	0.214	1.027	2.084	0.005	0.064	0.064	568.3	0.019
Pumps	2019	501	750	36.35	0.217	1.027	2.133	0.005	0.065	0.065	568.299	0.019
Pumps	2019	1001	9999	108.825	0.273	1.118	3.873	0.005	0.089	0.089	568.299	0.024
Rollers	2019	6	15	1.156606	0.9719	4.77841	4.64491	0.0054	0.3493	0.3213	537.546	0.1701
Rollers	2019	16	25	1.156606	0.9719	4.77841	4.64491	0.0054	0.3493	0.3213	537.546	0.1701
Rollers	2019	26	50	1.156606	0.9719	4.77841	4.64491	0.0054	0.3493	0.3213	537.546	0.1701
Rollers	2019	51	120	0.502836	0.4225	3.55726	4.17949	0.0049	0.2748	0.2528	484.3362	0.1532
Rollers	2019	121	175	0.27475	0.2309	2.93251	2.69941	0.0049	0.1239	0.114	482.4531	0.1526
Rollers	2019	176	250	0.250477	0.2105	1.24854	2.88327	0.0049	0.0918	0.0844	483.7769	0.1531
Rollers	2019	251	500	0.278634	0.2341	2.10142	2.90839	0.005	0.1109	0.102	489.9774	0.155
Rough Terrain Forklifts	2019	26	50	1.200779	1.009	4.67405	4.55745	0.0054	0.3277	0.3015	537.3287	0.17
Rough Terrain Forklifts	2019	51	120	0.240277	0.2019	3.25848	2.6222	0.0049	0.1168	0.1075	483.3105	0.1529

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Rough Terrain Forklifts	2019	121	175	0.177689	0.1493	2.84092	2.05752	0.0049	0.0753	0.0693	482.1188	0.1525
Rough Terrain Forklifts	2019	176	250	0.130153	0.1094	0.97423	1.63905	0.0049	0.0364	0.0335	483.0882	0.1528
Rough Terrain Forklifts	2019	251	500	0.138302	0.1162	0.95034	1.96109	0.0048	0.0429	0.0395	477.2539	0.151
Rubber Tired Dozers	2019	121	175	0.90312	0.7589	3.94854	7.52037	0.0049	0.4326	0.398	483.5585	0.153
Rubber Tired Dozers	2019	176	250	0.774882	0.6511	2.45855	6.92923	0.0049	0.3379	0.3108	485.172	0.1535
Rubber Tired Dozers	2019	251	500	0.680848	0.5721	4.74309	6.14335	0.0049	0.2828	0.2602	490.383	0.1552
Rubber Tired Dozers	2019	501	750	0.541107	0.4547	2.59814	6.12249	0.0049	0.2181	0.2007	483.5786	0.153
Rubber Tired Dozers	2019	751	1000	8.196	0.547	2.281	5.528	0.005	0.171	0.171	568.299	0.049
Rubber Tired Loaders	2019	16	25	1.906195	1.6017	6.97769	5.43193	0.0054	0.5176	0.4762	536.2254	0.1697
Rubber Tired Loaders	2019	26	50	1.906195	1.6017	6.97769	5.43193	0.0054	0.5176	0.4762	536.2254	0.1697
Rubber Tired Loaders	2019	51	120	0.707701	0.5947	3.97887	5.00611	0.0048	0.402	0.3698	475.8636	0.1506
Rubber Tired Loaders	2019	121	175	0.482139	0.4051	3.38084	3.85918	0.0049	0.2133	0.1962	481.7364	0.1524
Rubber Tired Loaders	2019	176	250	0.368194	0.3094	1.30248	3.74452	0.0048	0.1255	0.1155	480.0997	0.1519
Rubber Tired Loaders	2019	251	500	0.363843	0.3057	1.7248	3.28755	0.0048	0.1227	0.1129	477.0415	0.1509
Rubber Tired Loaders	2019	501	750	0.348958	0.2932	1.45157	3.01875	0.0048	0.1184	0.109	471.1874	0.1491
Rubber Tired Loaders	2019	751	1000	0.384887	0.3234	1.20834	5.45926	0.0049	0.1462	0.1345	480.523	0.152
Scrapers	2019	51	120	0.854498	0.718	4.19661	6.84136	0.005	0.5255	0.4834	494.1	0.1563
Scrapers	2019	121	175	0.606989	0.51	3.53297	5.26356	0.0049	0.2833	0.2606	489.2546	0.1548
Scrapers	2019	176	250	0.596624	0.5013	2.23321	5.83102	0.0048	0.2567	0.2361	479.0317	0.1516
Scrapers	2019	251	500	0.40804	0.3429	2.59466	4.15646	0.0049	0.1629	0.1498	482.7319	0.1527
Scrapers	2019	501	750	0.329384	0.2768	1.82903	3.43103	0.0049	0.1232	0.1133	482.5963	0.1527
Signal Boards	2019	6	15	1.04	0.661	3.47	4.142	0.008	0.161	0.161	568.299	0.059
Signal Boards	2019	26	50	8.189	0.887	4.538	4.272	0.007	0.236	0.236	568.3	0.08
Signal Boards	2019	51	120	8.938	0.437	3.519	3.41	0.006	0.216	0.216	568.299	0.039
Signal Boards	2019	121	175	12.677	0.321	3.043	2.601	0.006	0.125	0.125	568.299	0.029
Signal Boards	2019	176	250	15.682	0.291	1.292	2.676	0.007	0.08	0.08	686.695	0.026
Skid Steer Loaders	2019	16	25	0.531282	0.4464	3.73957	3.75009	0.0054	0.1536	0.1413	539.2667	0.1706
Skid Steer Loaders	2019	26	50	0.531282	0.4464	3.73957	3.75009	0.0054	0.1536	0.1413	539.2667	0.1706
Skid Steer Loaders	2019	51	120	0.2373	0.1994	3.27736	2.65586	0.0049	0.1217	0.1119	482.3844	0.1526
Surfacing Equipment	2019	26	50	0.765383	0.6431	4.0998	4.41999	0.0055	0.2503	0.2303	547.0462	0.1731
Surfacing Equipment	2019	51	120	0.42278	0.3553	3.44856	3.82306	0.0049	0.2256	0.2076	484.0757	0.1532
Surfacing Equipment	2019	121	175	0.425034	0.3571	2.97177	4.23866	0.0048	0.2036	0.1873	479.6717	0.1518

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Surfacing Equipment	2019	176	250	0.257694	0.2165	1.21576	3.39993	0.0049	0.1007	0.0927	486.8417	0.154
Surfacing Equipment	2019	251	500	0.173135	0.1455	1.2143	1.89944	0.0049	0.0681	0.0626	481.8965	0.1525
Surfacing Equipment	2019	501	750	0.168821	0.1419	0.99372	2.17879	0.0049	0.0763	0.0702	480.166	0.1519
Sweepers/Scrubbers	2019	6	15	1.703052	1.431	6.26782	5.22487	0.0054	0.4912	0.4519	537.0023	0.1699
Sweepers/Scrubbers	2019	16	25	1.703052	1.431	6.26782	5.22487	0.0054	0.4912	0.4519	537.0023	0.1699
Sweepers/Scrubbers	2019	26	50	1.703052	1.431	6.26782	5.22487	0.0054	0.4912	0.4519	537.0023	0.1699
Sweepers/Scrubbers	2019	51	120	0.654062	0.5496	3.84602	4.77259	0.0049	0.3872	0.3563	484.6516	0.1533
Sweepers/Scrubbers	2019	121	175	0.62277	0.5233	3.4491	5.30082	0.0049	0.2772	0.255	483.6359	0.153
Sweepers/Scrubbers	2019	176	250	0.279258	0.2347	1.23013	2.86598	0.0049	0.0989	0.091	480.5735	0.152
Tractors/Loaders/Backhoes	2019	16	25	1.095082	0.9202	5.20327	4.60928	0.0053	0.33	0.3036	527.6843	0.167
Tractors/Loaders/Backhoes	2019	26	50	1.095082	0.9202	5.20327	4.60928	0.0053	0.33	0.3036	527.6843	0.167
Tractors/Loaders/Backhoes	2019	51	120	0.437701	0.3678	3.63777	3.69257	0.0049	0.2465	0.2268	485.8548	0.1537
Tractors/Loaders/Backhoes	2019	121	175	0.321856	0.2704	3.12158	2.78412	0.0048	0.1401	0.1289	477.9151	0.1512
Tractors/Loaders/Backhoes	2019	176	250	0.291458	0.2449	1.22027	3.14683	0.0049	0.102	0.0938	481.4206	0.1523
Tractors/Loaders/Backhoes	2019	251	500	0.245176	0.206	1.38918	2.34458	0.0048	0.0816	0.0751	479.0826	0.1516
Tractors/Loaders/Backhoes	2019	501	750	0.311873	0.2621	1.6025	3.12046	0.0048	0.1168	0.1074	478.9216	0.1515
Trenchers	2019	6	15	1.136688	0.9551	4.89183	4.78464	0.0054	0.3767	0.3466	539.1037	0.1706
Trenchers	2019	16	25	1.136688	0.9551	4.89183	4.78464	0.0054	0.3767	0.3466	539.1037	0.1706
Trenchers	2019	26	50	1.136688	0.9551	4.89183	4.78464	0.0054	0.3767	0.3466	539.1037	0.1706
Trenchers	2019	51	120	0.751452	0.6314	3.83677	5.69508	0.0049	0.4306	0.3961	485.3635	0.1536
Trenchers	2019	121	175	0.547248	0.4598	3.34151	4.95976	0.0048	0.2547	0.2343	478.1294	0.1513
Trenchers	2019	176	250	0.481784	0.4048	1.81019	5.04653	0.0049	0.2032	0.187	484.1167	0.1532
Trenchers	2019	251	500	0.302803	0.2544	1.98689	3.12824	0.0049	0.1181	0.1086	482.1648	0.1526
Trenchers	2019	501	750	0.09296	0.0781	0.95644	0.70662	0.0049	0.0152	0.014	484.5422	0.1533
Welders	2019	6	15	1.877	0.748	3.562	4.647	0.008	0.241	0.241	568.299	0.067
Welders	2019	16	25	3.592	0.787	2.501	4.596	0.007	0.222	0.222	568.299	0.071
Welders	2019	26	50	11.071	1.055	4.95	4.449	0.007	0.273	0.273	568.299	0.095
Welders	2019	51	120	8.032	0.503	3.623	3.648	0.006	0.25	0.25	568.299	0.045
Welders	2019	121	175	14.693	0.37	3.122	2.832	0.006	0.143	0.143	568.3	0.033
Welders	2019	176	250	13.284	0.276	1.104	2.432	0.006	0.075	0.075	568.299	0.024
Welders	2019	251	500	17.937	0.264	1.065	2.163	0.005	0.072	0.072	568.3	0.023

Table 5. Offroad Factors

Equipment Type	Year	Low HP	High HP	TOG (g/bhp-hr)	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	SO2 (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)	CO2 (g/bhp-hr)	CH4 (g/bhp-hr)
Rubber Tired Dozers	2019	251	500	0.680848	0.5721	4.74309	6.14335	0.0049	0.2828	0.2602	490.383	0.1552
Excavators	2019	121	175	0.293021	0.2462	3.08163	2.53264	0.0049	0.1221	0.1124	482.6838	0.1527
Plate Compactors	2019	6	15	0.79	0.661	3.469	4.142	0.008	0.161	0.161	568.299	0.059
Cranes	2019	176	250	0.50769	0.4266	1.94079	5.0842	0.0049	0.2155	0.1983	483.4616	0.153
Off-Highway Trucks	2019	251	500	0.313575	0.2635	1.48346	2.66851	0.0049	0.097	0.0893	485.3832	0.1536
Other Construction Equipment	2019	121	175	0.490382	0.4121	3.25619	4.4331	0.0049	0.2335	0.2148	480.4518	0.152
Pumps	2019	51	120	9.812	0.429	3.449	3.497	0.006	0.217	0.217	568.299	0.038
Generator Sets	2019	51	120	8.233	0.405	3.396	3.446	0.006	0.206	0.206	568.299	0.036
Tractors/Loaders/Backhoes	2019	501	750	0.311873	0.2621	1.6025	3.12046	0.0048	0.1168	0.1074	478.9216	0.1515
Pumps >1001 and <9999	2019	1001	9999	108.825	0.273	1.118	3.873	0.005	0.089	0.089	568.299	0.024

	Low HP	High HP	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)
Tier 3	25	49	0.29	4.1	4.63	0.28	0.28
Tier 3	50	74	0.12	3.7	2.74	0.192	0.192
Tier 3	75	119	0.12	3.7	2.74	0.192	0.192
Tier 3	120	174	0.12	3.7	2.32	0.112	0.112
Tier 3	175	299	0.12	2.6	2.32	0.088	0.088
Tier 3	300	599	0.12	2.6	2.32	0.088	0.088
Tier 3	600	750	0.12	2.6	2.32	0.088	0.088
Tier 3	751	2000	0.12	2.6	2.32	0.088	0.088
Tier 4 Interim	25	49	0.12	4.1	4.55	0.128	0.128
Tier 4 Interim	50	74	0.12	3.7	2.74	0.112	0.112
Tier 4 Interim	75	119	0.11	3.7	2.14	0.008	0.008

Tier 4 Interim	120	174	0.06	3.7	2.15	0.008	0.008
Tier 4 Interim	175	299	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	300	599	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	600	750	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	751	2000	0.12	2.6	2.24	0.048	0.048
Tier 4	25	49	0.12	4.1	2.75	0.008	0.008
Tier 4	50	74	0.12	3.7	2.74	0.008	0.008
Tier 4	75	119	0.06	3.7	0.26	0.008	0.008
Tier 4	120	174	0.06	3.7	0.26	0.008	0.008
Tier 4	175	299	0.06	2.2	0.26	0.008	0.008
Tier 4	300	599	0.06	2.2	0.26	0.008	0.008
Tier 4	600	750	0.06	2.2	0.26	0.008	0.008
Tier 4	751	2000	0.06	2.6	2.24	0.016	0.016

Table 6. Cal EE Mod. Equipment

Equipment Type	HP	Load Factor
Aerial Lifts	63	0.31
Air Compressors	78	0.48
Bore/Drill Rigs	206	0.5
Cement and Mortar Mixers	9	0.56
Concrete/Industrial Saws	81	0.73
Cranes	226	0.29
Crawler Tractors	208	0.43
Crushing/Proc. Equipment	85	0.78
Dumpers/Tenders	16	0.38
Excavators	163	0.38
Forklifts	89	0.2
Generator Sets	84	0.74
Graders	175	0.41
Off-Highway Tractors	123	0.44
Off-Highway Trucks	400	0.38
Other Construction Equipment	172	0.42
Other General Industrial Equipment	88	0.34
Other Material Handling Equipment	167	0.4
Pavers	126	0.42
Paving Equipment	131	0.36
Plate Compactors	8	0.43
Pressure Washers	13	0.3
Pumps	84	0.74
Rollers	81	0.38
Rough Terrain Forklifts	100	0.4
Rubber Tired Dozers	255	0.4
Rubber Tired Loaders	200	0.36
Scrapers	362	0.48
Signal Boards	6	0.82
Skid Steer Loaders	65	0.37
Surfacing Equipment	254	0.3
Sweepers/Scrubbers	64	0.46
Tractors/Loaders/Backhoes	98	0.37
Trenchers	81	0.5
Welders	46	0.45

Table 7. Alameda County 2019 On-Road Emission Factors

Veh_Class	Fuel	MdlYr	Speed (miles/hr)	Population (vehicles)	VMT (miles/day)	Percent VMT	Trips (trips/day)
LDA	GAS	Aggregated	Aggregated	630179.0709	23135044.8	69.96%	3978067.902
LDA	DSL	Aggregated	Aggregated	3135.399386	109528.6651	0.33%	19192.99895
LDT1	GAS	Aggregated	Aggregated	71734.58614	2657830.829	8.04%	434719.7607
LDT1	DSL	Aggregated	Aggregated	101.6956373	3791.303837	0.01%	579.147129
LDT2	GAS	Aggregated	Aggregated	182086.4394	7158606.203	21.65%	1144840.468
LDT2	DSL	Aggregated	Aggregated	90.6234226	3567.077353	0.01%	558.2269126
Total				887327.8149	33068368.88		5577958.504
Average							
Veh_Class	Fuel	MdlYr	Speed	Population	VMT	Trips	
T7 tractor	DSL	Aggregated	Aggregated	3808.477731	617782.042	0	

Veh_Class	ROG_RUNEX (gms/mile)	CO_RUNEX (gms/mile)	NOX_RUNEX (gms/mile)	CO2_RUNEX (gms/mile)	PM10_RUNEX (gms/mile)	PM2_5_RUNEX (gms/mile)
LDA	0.016637189	0.80358625	0.083541126	340.5888828	0.001765757	0.001636861
LDA	0.024529409	0.152328328	0.446035267	355.3985725	0.017213743	0.015836645
LDT1	0.048779122	2.083021626	0.234843306	393.179958	0.003438173	0.003186006
LDT1	0.044211868	0.215668141	0.506244265	359.66517	0.035622524	0.032772721
LDT2	0.02252008	1.118412005	0.140442609	463.7144236	0.001740389	0.001612612
LDT2	0.028100152	0.160580945	0.48394342	355.9157639	0.019345996	0.017798317
Total						
Average	0.020524619	0.972278645	0.109312136	371.5228102	0.001951628	0.001808467
Veh_Class	ROG_RUNEX	CO_RUNEX	NOX_RUNEX	CO2_RUNEX	PM10_RUNEX	PM2_5_RUNEX
T7 tractor	0.226618154	1.024496709	5.340895989	1734.197307	0.079514364	0.073153215

Table 8. Equipment Barge

Assumptions		
Main Generator Engine	300	bhp
	223.7	kW
Aux Generator Engines	0	bhp
	0.0	kW
Number	1.0	

Emissions (pounds per hour)

Activity	Number of Construction Days	Time (hours per day)	ROG	NOx	CO	PM10	PM2.5	CO2e*
Emissions Per Hour	1.00	1.00	0.20	1.47	1.01	0.04	0.04	151.94

*To account for N20 and CH4 emissions, an extra 5% was added to the CO2 emissions.

Main Engine - 2018 Average Emission Factors (g/bhp-hr)

	ROG	NOx	CO	PM10	PM2.5	CO2	Fuel
300 hp	0.68	5.21	3.38	0.17	0.16	652	184.16

Note: CO2 emission factor in g/kWh
Source: ARB Harborcraft Emission Inventory Database

CO2 emissions factor from Port of Long Beach. 2011 Emissions Inventory. Available at http://www.polb.com/environment/air/emissions.asp.

Auxiliary Engine - 2018 Average Emission Factors (g/bhp-hr)

	ROG	NOx	CO	PM10	PM2.5	CO2	Fuel
3300 hp	0.81	3.54	5.21	0.16	0.15	652	184.16

Note: CO_2 emission factor in g/kWh
Source: ARB Harborcraft Emission Inventory Database

CO_2 emissions factor from Port of Long Beach. 2011 Emissions Inventory. Available at http://www.polb.com/environment/air/emissions.asp.

Load Factor

Engine	Load factor
Propulsion	0.45
Auxiliary	0.43

Source: ARB. Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Calendar Years	Horsepower Range	Model Years	NOx	PM
2007+	All	2011+	0.948	0.852

Source: ARB, Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Table 9. Work Tug

Assumptions		
Main Generator Engine	1000	bhp
	745.7	kW
Aux Generator Engines	50	bhp
	37.3	kW
Number	1.0	

Emissions (pounds per hour)

Activity	Number of Construction Days	Time (hours per day)	ROG	NOx	CO	PM10	PM2.5	CO2e*
Emissions Per Hour	1.00	1.00	0.70	5.03	3.36	0.18	0.17	530.65

*To account for N20 and CH4 emissions, an extra 5% was added to the CO2 emissions.

Main Engine - 2018 Average Emission Factors (g/bhp-hr)

	ROG	NOx	CO	PM10	PM2.5	CO2	Fuel
1000 hp	0.60	5.16	3.11	0.20	0.18	652	184.16

Note: CO2 emission factor in g/kWh

Source: ARB Harborcraft Emission Inventory Database

CO2 emissions factor from Port of Long Beach. 2011 Emissions Inventory. Available at http://www.polb.com/environment/air/emissions.asp.

Auxiliary Engine - 2018 Average Emission Factors (g/bhp-hr)

	ROG	NOx	CO	PM10	PM2.5	CO2	Fuel
50 hp	2.14	4.09	5.72	0.34	0.31	652	184.16

Note: CO2 emission factor in g/kWh

Source: ARB Harborcraft Emission Inventory Database

CO2 emissions factor from Port of Long Beach. 2011 Emissions Inventory. Available at http://www.polb.com/environment/air/emissions.asp.

Load Factor

Engine	Load factor
Propulsion	0.45
Auxiliary	0.43

Source: ARB. Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Calendar Years	Horsepower Range	Model Years	NOx	PM
2007+	All	2011+	0.948	0.852

Source: ARB, Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Table 10. Cable Reel Barge

Assumptions		
Main Generator Engine	240	bhp
	179.0	kW
Aux Generator Engines	0	bhp
	0.0	kW
Number	1.0	

Emissions (pounds per hour)

Activity	Number of Construction Days	Time (hours per day)	ROG	NOx	CO	PM10	PM2.5	CO2e*
SO-6 2012	1.00	1.00	0.16	1.18	0.80	0.03	0.03	121.55

*To account for N20 and CH4 emissions, an extra 5% was added to the CO2 emissions.

Main Engine - 2018 Average Emission Factors (g/bhp-hr)

	ROG	NOx	CO	PM10	PM2.5	CO2	Fuel

240 hp	0.68	5.21	3.38	0.17	0.16	652	184.16

Note: CO_2 emission factor in g/kWh

Source: ARB Harborcraft Emission Inventory Database

CO_2 emissions factor from Port of Long Beach. 2011 Emissions Inventory. Available at http://www.polb.com/environment/air/emissions.asp.

Load Factor

Engine	Load factor
Propulsion	0.45
Auxiliary	0.43

Source: ARB. Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Calendar Years	Horsepower Range	Model Years	NOx	PM
2007+	All	2011+	0.948	0.852

Source: ARB, Appendix B. Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

Estimated Travel Time	Offshore Placement	Miles	Miles Per Hour	Total Hours
Loaded Barge	SO-6 2012	0.76	0.82	0.924
	SO-6 2001	1.14	0.82	1.386

Note: Assumes average travel speed consistent with information provided by Moffett and Nichol that includes idling and loading/unloading activities.

Total One-Way Trips	8
Construction Days	4
Trips per Day	2

Table 11. Barge Emission Factors

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
1	- Implies 25-50 hp	1	50	1987	MY1987HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
2	- Implies 25-50 hp	1	50	1988	MY1988HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
3	- Implies 25-50 hp	1	50	1989	MY1989HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
4	- Implies 25-50 hp	1	50	1990	MY1990HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
5	- Implies 25-50 hp	1	50	1991	MY1991HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
6	- Implies 25-50 hp	1	50	1992	MY1992HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
7	- Implies 25-50 hp	1	50	1993	MY1993HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
8	- Implies 25-50 hp	1	50	1994	MY1994HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
9	- Implies 25-50 hp	1	50	1995	MY1995HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
10	- Implies 25-50 hp	1	50	1996	MY1996HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
11	- Implies 25-50 hp	1	50	1997	MY1997HP1	1.84	3.65	8.142	0.722	2.1896	5.15	6.9	0.638	184.158502
12	- Implies 25-50 hp	1	50	1998	MY1998HP1	1.8	3.65	8.142	0.722	2.142	5.15	6.9	0.638	184.158502
13	- Implies 25-50 hp	1	50	1999	MY1999HP1	1.8	3.65	8.142	0.722	2.142	5.15	6.9	0.638	184.158502
14	- Implies 25-50 hp	1	50	2000	MY2000HP1	1.8	3.65	7.31	0.722	2.142	5.15	6.9	0.638	184.158502
15	- Implies 25-50 hp	1	50	2001	MY2001HP1	1.8	3.65	7.31	0.722	2.142	5.15	6.9	0.638	184.158502
16	- Implies 25-50 hp	1	50	2002	MY2002HP1	1.8	3.65	7.31	0.722	2.142	5.15	6.9	0.638	184.158502
17	- Implies 25-50 hp	1	50	2003	MY2003HP1	1.8	3.65	7.31	0.722	2.142	5.15	6.9	0.638	184.158502
18	- Implies 25-50 hp	1	50	2004	MY2004HP1	1.8	3.65	7.31	0.722	2.142	5.15	6.9	0.638	184.158502
19	- Implies 25-50 hp	1	50	2005	MY2005HP1	1.8	3.73	5.32	0.3	2.142	3.73	5.32	0.3	184.158502
20	- Implies 25-50 hp	1	50	2006	MY2006HP1	1.8	3.73	5.32	0.3	2.142	3.73	5.32	0.3	184.158502
21	- Implies 25-50 hp	1	50	2007	MY2007HP1	1.8	3.73	5.32	0.3	2.142	3.73	5.32	0.3	184.158502
22	- Implies 25-50 hp	1	50	2008	MY2008HP1	1.8	3.73	5.32	0.3	2.142	3.73	5.32	0.3	184.158502
23	- Implies 25-50 hp	1	50	2009	MY2009HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
24	- Implies 25-50 hp	1	50	2010	MY2010HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
25	- Implies 25-50 hp	1	50	2011	MY2011HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
26	- Implies 25-50 hp	1	50	2012	MY2012HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
27	- Implies 25-50 hp	1	50	2013	MY2013HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
28	- Implies 25-50 hp	1	50	2014	MY2014HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
29	- Implies 25-50 hp	1	50	2015	MY2015HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
30	- Implies 25-50 hp	1	50	2016	MY2016HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
31	- Implies 25-50 hp	1	50	2017	MY2017HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
32	- Implies 25-50 hp	1	50	2018	MY2018HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
33	- Implies 25-50 hp	1	50	2019	MY2019HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
34	- Implies 25-50 hp	1	50	2020	MY2020HP1	1.8	3.73	5.32	0.22	2.142	3.73	5.32	0.22	184.158502
35	- Implies 51-120 hp	2	120	1987	MY1987HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
36	- Implies 51-120 hp	2	120	1988	MY1988HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
37	- Implies 51-120 hp	2	120	1989	MY1989HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
38	- Implies 51-120 hp	2	120	1990	MY1990HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
39	- Implies 51-120 hp	2	120	1991	MY1991HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
40	- Implies 51-120 hp	2	120	1992	MY1992HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
41	- Implies 51-120 hp	2	120	1993	MY1993HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
42	- Implies 51-120 hp	2	120	1994	MY1994HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
43	- Implies 51-120 hp	2	120	1995	MY1995HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
44	- Implies 51-120 hp	2	120	1996	MY1996HP2	1.44	3.504	15.34	0.798	1.7136	4.944	13	0.706	184.158502
45	- Implies 51-120 hp	2	120	1997	MY1997HP2	0.99	2.548	10.325	0.656	1.1781	3.595	8.75	0.58	184.158502
46	- Implies 51-120 hp	2	120	1998	MY1998HP2	0.99	2.548	10.325	0.656	1.1781	3.595	8.75	0.58	184.158502
47	- Implies 51-120 hp	2	120	1999	MY1999HP2	0.99	2.548	10.325	0.656	1.1781	3.595	8.75	0.58	184.158502
48	- Implies 51-120 hp	2	120	2000	MY2000HP2	0.99	2.548	7.31	0.656	1.1781	3.595	7.31	0.58	184.158502
49	- Implies 51-120 hp	2	120	2001	MY2001HP2	0.99	2.548	7.31	0.656	1.1781	3.595	7.31	0.58	184.158502
50	- Implies 51-120 hp	2	120	2002	MY2002HP2	0.99	2.548	7.31	0.656	1.1781	3.595	7.31	0.58	184.158502
51	- Implies 51-120 hp	2	120	2003	MY2003HP2	0.99	2.548	7.31	0.656	1.1781	3.595	7.31	0.58	184.158502
52	- Implies 51-120 hp	2	120	2004	MY2004HP2	0.99	2.548	7.31	0.656	1.1781	3.595	7.31	0.58	184.158502
53	- Implies 51-120 hp	2	120	2005	MY2005HP2	0.99	3.73	5.32	0.3	1.1781	3.73	5.32	0.3	184.158502
54	- Implies 51-120 hp	2	120	2006	MY2006HP2	0.99	3.73	5.32	0.3	1.1781	3.73	5.32	0.3	184.158502
55	- Implies 51-120 hp	2	120	2007	MY2007HP2	0.99	3.73	5.32	0.3	1.1781	3.73	5.32	0.3	184.158502
56	- Implies 51-120 hp	2	120	2008	MY2008HP2	0.99	3.73	5.32	0.3	1.1781	3.73	5.32	0.3	184.158502
57	- Implies 51-120 hp	2	120	2009	MY2009HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
58	- Implies 51-120 hp	2	120	2010	MY2010HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
59	- Implies 51-120 hp	2	120	2011	MY2011HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
60	- Implies 51-120 hp	2	120	2012	MY2012HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
61	- Implies 51-120 hp	2	120	2013	MY2013HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
62	- Implies 51-120 hp	2	120	2014	MY2014HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
63	- Implies 51-120 hp	2	120	2015	MY2015HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
64	- Implies 51-120 hp	2	120	2016	MY2016HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
65	- Implies 51-120 hp	2	120	2017	MY2017HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
66	- Implies 51-120 hp	2	120	2018	MY2018HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
67	- Implies 51-120 hp	2	120	2019	MY2019HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
68	- Implies 51-120 hp	2	120	2020	MY2020HP2	0.99	3.73	5.32	0.22	1.1781	3.73	5.32	0.22	184.158502
69	- Implies 121-175 hp	3	175	1969	MY1969HP3	1.32	3.212	16.52	0.732	1.5708	4.532	14	0.647	184.158502
70	- Implies 121-175 hp	3	175	1970	MY1970HP3	1.32	3.212	16.52	0.732	1.5708	4.532	14	0.647	184.158502
71	- Implies 121-175 hp	3	175	1971	MY1971HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
72	- Implies 121-175 hp	3	175	1972	MY1972HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
73	- Implies 121-175 hp	3	175	1973	MY1973HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
74	- Implies 121-175 hp	3	175	1974	MY1974HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
75	- Implies 121-175 hp	3	175	1975	MY1975HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
76	- Implies 121-175 hp	3	175	1976	MY1976HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
77	- Implies 121-175 hp	3	175	1977	MY1977HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
78	- Implies 121-175 hp	3	175	1978	MY1978HP3	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
79	- Implies 121-175 hp	3	175	1979	MY1979HP3	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
80	- Implies 121-175 hp	3	175	1980	MY1980HP3	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
81	- Implies 121-175 hp	3	175	1981	MY1981HP3	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
82	- Implies 121-175 hp	3	175	1982	MY1982HP3	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
83	- Implies 121-175 hp	3	175	1983	MY1983HP3	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
84	- Implies 121-175 hp	3	175	1984	MY1984HP3	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502
85	- Implies 121-175 hp	3	175	1985	MY1985HP3	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502
86	- Implies 121-175 hp	3	175	1986	MY1986HP3	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502
87	- Implies 121-175 hp	3	175	1987	MY1987HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
88	- Implies 121-175 hp	3	175	1988	MY1988HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
89	- Implies 121-175 hp	3	175	1989	MY1989HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
90	- Implies 121-175 hp	3	175	1990	MY1990HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
91	- Implies 121-175 hp	3	175	1991	MY1991HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
92	- Implies 121-175 hp	3	175	1992	MY1992HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
93	- Implies 121-175 hp	3	175	1993	MY1993HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
94	- Implies 121-175 hp	3	175	1994	MY1994HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
95	- Implies 121-175 hp	3	175	1995	MY1995HP3	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
96	- Implies 121-175 hp	3	175	1996	MY1996HP3	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
97	- Implies 121-175 hp	3	175	1997	MY1997HP3	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
98	- Implies 121-175 hp	3	175	1998	MY1998HP3	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
99	- Implies 121-175 hp	3	175	1999	MY1999HP3	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
100	- Implies 121-175 hp	3	175	2000	MY2000HP3	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
101	- Implies 121-175 hp	3	175	2001	MY2001HP3	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
102	- Implies 121-175 hp	3	175	2002	MY2002HP3	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
103	- Implies 121-175 hp	3	175	2003	MY2003HP3	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
104	- Implies 121-175 hp	3	175	2004	MY2004HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
105	- Implies 121-175 hp	3	175	2005	MY2005HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
106	- Implies 121-175 hp	3	175	2006	MY2006HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
107	- Implies 121-175 hp	3	175	2007	MY2007HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
108	- Implies 121-175 hp	3	175	2008	MY2008HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
109	- Implies 121-175 hp	3	175	2009	MY2009HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
110	- Implies 121-175 hp	3	175	2010	MY2010HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
111	- Implies 121-175 hp	3	175	2011	MY2011HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
112	- Implies 121-175 hp	3	175	2012	MY2012HP3	0.68	3.73	5.1015	0.22	0.8092	3.73	5.102	0.22	184.158502
113	- Implies 121-175 hp	3	175	2013	MY2013HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
114	- Implies 121-175 hp	3	175	2014	MY2014HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
115	- Implies 121-175 hp	3	175	2015	MY2015HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
116	- Implies 121-175 hp	3	175	2016	MY2016HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
117	- Implies 121-175 hp	3	175	2017	MY2017HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
118	- Implies 121-175 hp	3	175	2018	MY2018HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
119	- Implies 121-175 hp	3	175	2019	MY2019HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
120	- Implies 121-175 hp	3	175	2020	MY2020HP3	0.68	3.73	3.8	0.09	0.8092	3.73	3.8	0.09	184.158502
121	- Implies 176-250 hp	4	250	1969	MY1969HP4	1.32	3.212	16.52	0.732	1.5708	4.532	14	0.647	184.158502
122	- Implies 176-250 hp	4	250	1970	MY1970HP4	1.32	3.212	16.52	0.732	1.5708	4.532	14	0.647	184.158502
123	- Implies 176-250 hp	4	250	1971	MY1971HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
124	- Implies 176-250 hp	4	250	1972	MY1972HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
125	- Implies 176-250 hp	4	250	1973	MY1973HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
126	- Implies 176-250 hp	4	250	1974	MY1974HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
127	- Implies 176-250 hp	4	250	1975	MY1975HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
128	- Implies 176-250 hp	4	250	1976	MY1976HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
129	- Implies 176-250 hp	4	250	1977	MY1977HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
130	- Implies 176-250 hp	4	250	1978	MY1978HP4	1.1	3.212	15.34	0.627	1.309	4.532	13	0.554	184.158502
131	- Implies 176-250 hp	4	250	1979	MY1979HP4	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
132	- Implies 176-250 hp	4	250	1980	MY1980HP4	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
133	- Implies 176-250 hp	4	250	1981	MY1981HP4	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
134	- Implies 176-250 hp	4	250	1982	MY1982HP4	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
135	- Implies 176-250 hp	4	250	1983	MY1983HP4	1	3.212	14.16	0.523	1.19	4.532	12	0.462	184.158502
136	- Implies 176-250 hp	4	250	1984	MY1984HP4	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502
137	- Implies 176-250 hp	4	250	1985	MY1985HP4	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
138	- Implies 176-250 hp	4	250	1986	MY1986HP4	0.94	3.139	12.98	0.523	1.1186	4.429	11	0.462	184.158502
139	- Implies 176-250 hp	4	250	1987	MY1987HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
140	- Implies 176-250 hp	4	250	1988	MY1988HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
141	- Implies 176-250 hp	4	250	1989	MY1989HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
142	- Implies 176-250 hp	4	250	1990	MY1990HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
143	- Implies 176-250 hp	4	250	1991	MY1991HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
144	- Implies 176-250 hp	4	250	1992	MY1992HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
145	- Implies 176-250 hp	4	250	1993	MY1993HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
146	- Implies 176-250 hp	4	250	1994	MY1994HP4	0.88	3.066	12.98	0.523	1.0472	4.326	11	0.462	184.158502
147	- Implies 176-250 hp	4	250	1995	MY1995HP4	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
148	- Implies 176-250 hp	4	250	1996	MY1996HP4	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
149	- Implies 176-250 hp	4	250	1997	MY1997HP4	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
150	- Implies 176-250 hp	4	250	1998	MY1998HP4	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
151	- Implies 176-250 hp	4	250	1999	MY1999HP4	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
152	- Implies 176-250 hp	4	250	2000	MY2000HP4	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
153	- Implies 176-250 hp	4	250	2001	MY2001HP4	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
154	- Implies 176-250 hp	4	250	2002	MY2002HP4	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
155	- Implies 176-250 hp	4	250	2003	MY2003HP4	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
156	- Implies 176-250 hp	4	250	2004	MY2004HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
157	- Implies 176-250 hp	4	250	2005	MY2005HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
158	- Implies 176-250 hp	4	250	2006	MY2006HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
159	- Implies 176-250 hp	4	250	2007	MY2007HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
160	- Implies 176-250 hp	4	250	2008	MY2008HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
161	- Implies 176-250 hp	4	250	2009	MY2009HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
162	- Implies 176-250 hp	4	250	2010	MY2010HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
163	- Implies 176-250 hp	4	250	2011	MY2011HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
164	- Implies 176-250 hp	4	250	2012	MY2012HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
165	- Implies 176-250 hp	4	250	2013	MY2013HP4	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
166	- Implies 176-250 hp	4	250	2014	MY2014HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
167	- Implies 176-250 hp	4	250	2015	MY2015HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
168	- Implies 176-250 hp	4	250	2016	MY2016HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
169	- Implies 176-250 hp	4	250	2017	MY2017HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
170	- Implies 176-250 hp	4	250	2018	MY2018HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
171	- Implies 176-250 hp	4	250	2019	MY2019HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
172	- Implies 176-250 hp	4	250	2020	MY2020HP4	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
173	- Implies 251-500 hp	5	500	1969	MY1969HP5	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
174	- Implies 251-500 hp	5	500	1970	MY1970HP5	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
175	- Implies 251-500 hp	5	500	1971	MY1971HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
176	- Implies 251-500 hp	5	500	1972	MY1972HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
177	- Implies 251-500 hp	5	500	1973	MY1973HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
178	- Implies 251-500 hp	5	500	1974	MY1974HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
179	- Implies 251-500 hp	5	500	1975	MY1975HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
180	- Implies 251-500 hp	5	500	1976	MY1976HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
181	- Implies 251-500 hp	5	500	1977	MY1977HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
182	- Implies 251-500 hp	5	500	1978	MY1978HP5	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
183	- Implies 251-500 hp	5	500	1979	MY1979HP5	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
184	- Implies 251-500 hp	5	500	1980	MY1980HP5	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
185	- Implies 251-500 hp	5	500	1981	MY1981HP5	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
186	- Implies 251-500 hp	5	500	1982	MY1982HP5	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
187	- Implies 251-500 hp	5	500	1983	MY1983HP5	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
188	- Implies 251-500 hp	5	500	1984	MY1984HP5	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
189	- Implies 251-500 hp	5	500	1985	MY1985HP5	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
190	- Implies 251-500 hp	5	500	1986	MY1986HP5	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
191	- Implies 251-500 hp	5	500	1987	MY1987HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
192	- Implies 251-500 hp	5	500	1988	MY1988HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
193	- Implies 251-500 hp	5	500	1989	MY1989HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
194	- Implies 251-500 hp	5	500	1990	MY1990HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
195	- Implies 251-500 hp	5	500	1991	MY1991HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
196	- Implies 251-500 hp	5	500	1992	MY1992HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
197	- Implies 251-500 hp	5	500	1993	MY1993HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
198	- Implies 251-500 hp	5	500	1994	MY1994HP5	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
199	- Implies 251-500 hp	5	500	1995	MY1995HP5	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
200	- Implies 251-500 hp	5	500	1996	MY1996HP5	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
201	- Implies 251-500 hp	5	500	1997	MY1997HP5	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
202	- Implies 251-500 hp	5	500	1998	MY1998HP5	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
203	- Implies 251-500 hp	5	500	1999	MY1999HP5	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
204	- Implies 251-500 hp	5	500	2000	MY2000HP5	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
205	- Implies 251-500 hp	5	500	2001	MY2001HP5	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
206	- Implies 251-500 hp	5	500	2002	MY2002HP5	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
207	- Implies 251-500 hp	5	500	2003	MY2003HP5	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
208	- Implies 251-500 hp	5	500	2004	MY2004HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
209	- Implies 251-500 hp	5	500	2005	MY2005HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
210	- Implies 251-500 hp	5	500	2006	MY2006HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
211	- Implies 251-500 hp	5	500	2007	MY2007HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
212	- Implies 251-500 hp	5	500	2008	MY2008HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
213	- Implies 251-500 hp	5	500	2009	MY2009HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
214	- Implies 251-500 hp	5	500	2010	MY2010HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
215	- Implies 251-500 hp	5	500	2011	MY2011HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
216	- Implies 251-500 hp	5	500	2012	MY2012HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
217	- Implies 251-500 hp	5	500	2013	MY2013HP5	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
218	- Implies 251-500 hp	5	500	2014	MY2014HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
219	- Implies 251-500 hp	5	500	2015	MY2015HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
220	- Implies 251-500 hp	5	500	2016	MY2016HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
221	- Implies 251-500 hp	5	500	2017	MY2017HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
222	- Implies 251-500 hp	5	500	2018	MY2018HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
223	- Implies 251-500 hp	5	500	2019	MY2019HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
224	- Implies 251-500 hp	5	500	2020	MY2020HP5	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
225	- Implies 501-750 hp	6	750	1969	MY1969HP6	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
226	- Implies 501-750 hp	6	750	1970	MY1970HP6	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
227	- Implies 501-750 hp	6	750	1971	MY1971HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
228	- Implies 501-750 hp	6	750	1972	MY1972HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
229	- Implies 501-750 hp	6	750	1973	MY1973HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
230	- Implies 501-750 hp	6	750	1974	MY1974HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
231	- Implies 501-750 hp	6	750	1975	MY1975HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
232	- Implies 501-750 hp	6	750	1976	MY1976HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
233	- Implies 501-750 hp	6	750	1977	MY1977HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
234	- Implies 501-750 hp	6	750	1978	MY1978HP6	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
235	- Implies 501-750 hp	6	750	1979	MY1979HP6	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
236	- Implies 501-750 hp	6	750	1980	MY1980HP6	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
237	- Implies 501-750 hp	6	750	1981	MY1981HP6	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
238	- Implies 501-750 hp	6	750	1982	MY1982HP6	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
239	- Implies 501-750 hp	6	750	1983	MY1983HP6	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
240	- Implies 501-750 hp	6	750	1984	MY1984HP6	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
241	- Implies 501-750 hp	6	750	1985	MY1985HP6	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
242	- Implies 501-750 hp	6	750	1986	MY1986HP6	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
243	- Implies 501-750 hp	6	750	1987	MY1987HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
244	- Implies 501-750 hp	6	750	1988	MY1988HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
245	- Implies 501-750 hp	6	750	1989	MY1989HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
246	- Implies 501-750 hp	6	750	1990	MY1990HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
247	- Implies 501-750 hp	6	750	1991	MY1991HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
248	- Implies 501-750 hp	6	750	1992	MY1992HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
249	- Implies 501-750 hp	6	750	1993	MY1993HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
250	- Implies 501-750 hp	6	750	1994	MY1994HP6	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
251	- Implies 501-750 hp	6	750	1995	MY1995HP6	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
252	- Implies 501-750 hp	6	750	1996	MY1996HP6	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
253	- Implies 501-750 hp	6	750	1997	MY1997HP6	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
254	- Implies 501-750 hp	6	750	1998	MY1998HP6	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
255	- Implies 501-750 hp	6	750	1999	MY1999HP6	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
256	- Implies 501-750 hp	6	750	2000	MY2000HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
257	- Implies 501-750 hp	6	750	2001	MY2001HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
258	- Implies 501-750 hp	6	750	2002	MY2002HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
259	- Implies 501-750 hp	6	750	2003	MY2003HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
260	- Implies 501-750 hp	6	750	2004	MY2004HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
261	- Implies 501-750 hp	6	750	2005	MY2005HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
262	- Implies 501-750 hp	6	750	2006	MY2006HP6	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
263	- Implies 501-750 hp	6	750	2007	MY2007HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
264	- Implies 501-750 hp	6	750	2008	MY2008HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
265	- Implies 501-750 hp	6	750	2009	MY2009HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
266	- Implies 501-750 hp	6	750	2010	MY2010HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
267	- Implies 501-750 hp	6	750	2011	MY2011HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
268	- Implies 501-750 hp	6	750	2012	MY2012HP6	0.68	3.73	5.1015	0.15	0.8092	3.73	5.102	0.15	184.158502
269	- Implies 501-750 hp	6	750	2013	MY2013HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
270	- Implies 501-750 hp	6	750	2014	MY2014HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
271	- Implies 501-750 hp	6	750	2015	MY2015HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
272	- Implies 501-750 hp	6	750	2016	MY2016HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
273	- Implies 501-750 hp	6	750	2017	MY2017HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
274	- Implies 501-750 hp	6	750	2018	MY2018HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
275	- Implies 501-750 hp	6	750	2019	MY2019HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
276	- Implies 501-750 hp	6	750	2020	MY2020HP6	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08	184.158502
277	- Implies 751-1900 hp	7	1900	1969	MY1969HP7	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
278	- Implies 751-1900 hp	7	1900	1970	MY1970HP7	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
279	- Implies 751-1900 hp	7	1900	1971	MY1971HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
280	- Implies 751-1900 hp	7	1900	1972	MY1972HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
281	- Implies 751-1900 hp	7	1900	1973	MY1973HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
282	- Implies 751-1900 hp	7	1900	1974	MY1974HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
283	- Implies 751-1900 hp	7	1900	1975	MY1975HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
284	- Implies 751-1900 hp	7	1900	1976	MY1976HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
285	- Implies 751-1900 hp	7	1900	1977	MY1977HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
286	- Implies 751-1900 hp	7	1900	1978	MY1978HP7	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
287	- Implies 751-1900 hp	7	1900	1979	MY1979HP7	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
288	- Implies 751-1900 hp	7	1900	1980	MY1980HP7	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
289	- Implies 751-1900 hp	7	1900	1981	MY1981HP7	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
290	- Implies 751-1900 hp	7	1900	1982	MY1982HP7	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
291	- Implies 751-1900 hp	7	1900	1983	MY1983HP7	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
292	- Implies 751-1900 hp	7	1900	1984	MY1984HP7	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
293	- Implies 751-1900 hp	7	1900	1985	MY1985HP7	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
294	- Implies 751-1900 hp	7	1900	1986	MY1986HP7	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
295	- Implies 751-1900 hp	7	1900	1987	MY1987HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
296	- Implies 751-1900 hp	7	1900	1988	MY1988HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
297	- Implies 751-1900 hp	7	1900	1989	MY1989HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
298	- Implies 751-1900 hp	7	1900	1990	MY1990HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
299	- Implies 751-1900 hp	7	1900	1991	MY1991HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
300	- Implies 751-1900 hp	7	1900	1992	MY1992HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
301	- Implies 751-1900 hp	7	1900	1993	MY1993HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
302	- Implies 751-1900 hp	7	1900	1994	MY1994HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
303	- Implies 751-1900 hp	7	1900	1995	MY1995HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
304	- Implies 751-1900 hp	7	1900	1996	MY1996HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
305	- Implies 751-1900 hp	7	1900	1997	MY1997HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
306	- Implies 751-1900 hp	7	1900	1998	MY1998HP7	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
307	- Implies 751-1900 hp	7	1900	1999	MY1999HP7	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
308	- Implies 751-1900 hp	7	1900	2000	MY2000HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
309	- Implies 751-1900 hp	7	1900	2001	MY2001HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
310	- Implies 751-1900 hp	7	1900	2002	MY2002HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
311	- Implies 751-1900 hp	7	1900	2003	MY2003HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
312	- Implies 751-1900 hp	7	1900	2004	MY2004HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
313	- Implies 751-1900 hp	7	1900	2005	MY2005HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
314	- Implies 751-1900 hp	7	1900	2006	MY2006HP7	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
315	- Implies 751-1900 hp	7	1900	2007	MY2007HP7	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
316	- Implies 751-1900 hp	7	1900	2008	MY2008HP7	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
317	- Implies 751-1900 hp	7	1900	2009	MY2009HP7	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
318	- Implies 751-1900 hp	7	1900	2010	MY2010HP7	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
319	- Implies 751-1900 hp	7	1900	2011	MY2011HP7	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
320	- Implies 751-1900 hp	7	1900	2012	MY2012HP7	0.68	3.73	4.085	0.08	0.8092	3.73	4.085	0.08	184.158502
321	- Implies 751-1900 hp	7	1900	2013	MY2013HP7	0.68	3.73	4.085	0.08	0.8092	3.73	4.085	0.08	184.158502
322	- Implies 751-1900 hp	7	1900	2014	MY2014HP7	0.68	3.73	4.085	0.08	0.8092	3.73	4.085	0.08	184.158502
323	- Implies 751-1900 hp	7	1900	2015	MY2015HP7	0.68	3.73	4.085	0.08	0.8092	3.73	4.085	0.08	184.158502
324	- Implies 751-1900 hp	7	1900	2016	MY2016HP7	0.68	3.73	4.085	0.08	0.8092	3.73	4.085	0.08	184.158502
325	- Implies 751-1900 hp	7	1900	2017	MY2017HP7	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
326	- Implies 751-1900 hp	7	1900	2018	MY2018HP7	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
327	- Implies 751-1900 hp	7	1900	2019	MY2019HP7	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
328	- Implies 751-1900 hp	7	1900	2020	MY2020HP7	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
329	- Implies 1901-3300 hp	8	3300	1969	MY1969HP8	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
330	- Implies 1901-3300 hp	8	3300	1970	MY1970HP8	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
331	- Implies 1901-3300 hp	8	3300	1971	MY1971HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
332	- Implies 1901-3300 hp	8	3300	1972	MY1972HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
333	- Implies 1901-3300 hp	8	3300	1973	MY1973HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
334	- Implies 1901-3300 hp	8	3300	1974	MY1974HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
335	- Implies 1901-3300 hp	8	3300	1975	MY1975HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
336	- Implies 1901-3300 hp	8	3300	1976	MY1976HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
337	- Implies 1901-3300 hp	8	3300	1977	MY1977HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
338	- Implies 1901-3300 hp	8	3300	1978	MY1978HP8	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
339	- Implies 1901-3300 hp	8	3300	1979	MY1979HP8	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
340	- Implies 1901-3300 hp	8	3300	1980	MY1980HP8	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
341	- Implies 1901-3300 hp	8	3300	1981	MY1981HP8	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
342	- Implies 1901-3300 hp	8	3300	1982	MY1982HP8	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
343	- Implies 1901-3300 hp	8	3300	1983	MY1983HP8	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
344	- Implies 1901-3300 hp	8	3300	1984	MY1984HP8	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
345	- Implies 1901-3300 hp	8	3300	1985	MY1985HP8	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
346	- Implies 1901-3300 hp	8	3300	1986	MY1986HP8	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
347	- Implies 1901-3300 hp	8	3300	1987	MY1987HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
348	- Implies 1901-3300 hp	8	3300	1988	MY1988HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
349	- Implies 1901-3300 hp	8	3300	1989	MY1989HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
350	- Implies 1901-3300 hp	8	3300	1990	MY1990HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
351	- Implies 1901-3300 hp	8	3300	1991	MY1991HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
352	- Implies 1901-3300 hp	8	3300	1992	MY1992HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
353	- Implies 1901-3300 hp	8	3300	1993	MY1993HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
354	- Implies 1901-3300 hp	8	3300	1994	MY1994HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
355	- Implies 1901-3300 hp	8	3300	1995	MY1995HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
356	- Implies 1901-3300 hp	8	3300	1996	MY1996HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
357	- Implies 1901-3300 hp	8	3300	1997	MY1997HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
358	- Implies 1901-3300 hp	8	3300	1998	MY1998HP8	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
359	- Implies 1901-3300 hp	8	3300	1999	MY1999HP8	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
360	- Implies 1901-3300 hp	8	3300	2000	MY2000HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
361	- Implies 1901-3300 hp	8	3300	2001	MY2001HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
362	- Implies 1901-3300 hp	8	3300	2002	MY2002HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
363	- Implies 1901-3300 hp	8	3300	2003	MY2003HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
364	- Implies 1901-3300 hp	8	3300	2004	MY2004HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
365	- Implies 1901-3300 hp	8	3300	2005	MY2005HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
366	- Implies 1901-3300 hp	8	3300	2006	MY2006HP8	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
367	- Implies 1901-3300 hp	8	3300	2007	MY2007HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
368	- Implies 1901-3300 hp	8	3300	2008	MY2008HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
369	- Implies 1901-3300 hp	8	3300	2009	MY2009HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
370	- Implies 1901-3300 hp	8	3300	2010	MY2010HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
371	- Implies 1901-3300 hp	8	3300	2011	MY2011HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
372	- Implies 1901-3300 hp	8	3300	2012	MY2012HP8	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
373	- Implies 1901-3300 hp	8	3300	2013	MY2013HP8	0.68	3.73	4.37	0.1	0.8092	3.73	4.37	0.1	184.158502
374	- Implies 1901-3300 hp	8	3300	2014	MY2014HP8	0.68	3.73	4.37	0.1	0.8092	3.73	4.37	0.1	184.158502
375	- Implies 1901-3300 hp	8	3300	2015	MY2015HP8	0.68	3.73	4.37	0.1	0.8092	3.73	4.37	0.1	184.158502
376	- Implies 1901-3300 hp	8	3300	2016	MY2016HP8	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
377	- Implies 1901-3300 hp	8	3300	2017	MY2017HP8	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
378	- Implies 1901-3300 hp	8	3300	2018	MY2018HP8	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
379	- Implies 1901-3300 hp	8	3300	2019	MY2019HP8	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
380	- Implies 1901-3300 hp	8	3300	2020	MY2020HP8	0.177295	3.73	1.3	0.03	0.177295	3.73	1.3	0.03	184.158502
381	- Implies >3301-5000 hp	9	5000	1969	MY1969HP9	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502
382	- Implies >3301-5000 hp	9	5000	1970	MY1970HP9	1.26	3.066	16.52	0.703	1.4994	4.326	14	0.622	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
383	- Implies >3301-5000 hp	9	5000	1971	MY1971HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
384	- Implies >3301-5000 hp	9	5000	1972	MY1972HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
385	- Implies >3301-5000 hp	9	5000	1973	MY1973HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
386	- Implies >3301-5000 hp	9	5000	1974	MY1974HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
387	- Implies >3301-5000 hp	9	5000	1975	MY1975HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
388	- Implies >3301-5000 hp	9	5000	1976	MY1976HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
389	- Implies >3301-5000 hp	9	5000	1977	MY1977HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
390	- Implies >3301-5000 hp	9	5000	1978	MY1978HP9	1.05	3.066	15.34	0.599	1.2495	4.326	13	0.529	184.158502
391	- Implies >3301-5000 hp	9	5000	1979	MY1979HP9	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
392	- Implies >3301-5000 hp	9	5000	1980	MY1980HP9	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
393	- Implies >3301-5000 hp	9	5000	1981	MY1981HP9	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
394	- Implies >3301-5000 hp	9	5000	1982	MY1982HP9	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
395	- Implies >3301-5000 hp	9	5000	1983	MY1983HP9	0.95	3.066	14.16	0.504	1.1305	4.326	12	0.445	184.158502
396	- Implies >3301-5000 hp	9	5000	1984	MY1984HP9	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
397	- Implies >3301-5000 hp	9	5000	1985	MY1985HP9	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
398	- Implies >3301-5000 hp	9	5000	1986	MY1986HP9	0.9	3.066	12.98	0.504	1.071	4.326	11	0.445	184.158502
399	- Implies >3301-5000 hp	9	5000	1987	MY1987HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
400	- Implies >3301-5000 hp	9	5000	1988	MY1988HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
401	- Implies >3301-5000 hp	9	5000	1989	MY1989HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
402	- Implies >3301-5000 hp	9	5000	1990	MY1990HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
403	- Implies >3301-5000 hp	9	5000	1991	MY1991HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
404	- Implies >3301-5000 hp	9	5000	1992	MY1992HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
405	- Implies >3301-5000 hp	9	5000	1993	MY1993HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
406	- Implies >3301-5000 hp	9	5000	1994	MY1994HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
407	- Implies >3301-5000 hp	9	5000	1995	MY1995HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
408	- Implies >3301-5000 hp	9	5000	1996	MY1996HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
409	- Implies >3301-5000 hp	9	5000	1997	MY1997HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
410	- Implies >3301-5000 hp	9	5000	1998	MY1998HP9	0.84	2.993	12.98	0.504	0.9996	4.223	11	0.445	184.158502
411	- Implies >3301-5000 hp	9	5000	1999	MY1999HP9	0.68	1.971	9.6406	0.361	0.8092	2.781	8.17	0.319	184.158502
412	- Implies >3301-5000 hp	9	5000	2000	MY2000HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
413	- Implies >3301-5000 hp	9	5000	2001	MY2001HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
414	- Implies >3301-5000 hp	9	5000	2002	MY2002HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
415	- Implies >3301-5000 hp	9	5000	2003	MY2003HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
416	- Implies >3301-5000 hp	9	5000	2004	MY2004HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
417	- Implies >3301-5000 hp	9	5000	2005	MY2005HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502

ID	HP Range	HP Category	MaxHP	Model Year	MY HP Group	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
418	- Implies >3301-5000 hp	9	5000	2006	MY2006HP9	0.68	1.971	7.31	0.361	0.8092	2.781	7.31	0.319	184.158502
419	- Implies >3301-5000 hp	9	5000	2007	MY2007HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
420	- Implies >3301-5000 hp	9	5000	2008	MY2008HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
421	- Implies >3301-5000 hp	9	5000	2009	MY2009HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
422	- Implies >3301-5000 hp	9	5000	2010	MY2010HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
423	- Implies >3301-5000 hp	9	5000	2011	MY2011HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
424	- Implies >3301-5000 hp	9	5000	2012	MY2012HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
425	- Implies >3301-5000 hp	9	5000	2013	MY2013HP9	0.68	3.73	5.529	0.2	0.8092	3.73	5.529	0.2	184.158502
426	- Implies >3301-5000 hp	9	5000	2014	MY2014HP9	0.68	3.73	4.94	0.25	0.8092	3.75	4.94	0.25	184.158502
427	- Implies >3301-5000 hp	9	5000	2015	MY2015HP9	0.68	3.73	4.94	0.25	0.8092	3.75	4.94	0.25	184.158502
428	- Implies >3301-5000 hp	9	5000	2016	MY2016HP9	0.177295	3.73	1.3	0.03	0.177295	3.75	1.3	0.03	184.158502
429	- Implies >3301-5000 hp	9	5000	2017	MY2017HP9	0.177295	3.73	1.3	0.03	0.177295	3.75	1.3	0.03	184.158502
430	- Implies >3301-5000 hp	9	5000	2018	MY2018HP9	0.177295	3.73	1.3	0.03	0.177295	3.75	1.3	0.03	184.158502
431	- Implies >3301-5000 hp	9	5000	2019	MY2019HP9	0.177295	3.73	1.3	0.03	0.177295	3.75	1.3	0.03	184.158502
432	- Implies >3301-5000 hp	9	5000	2020	MY2020HP9	0.177295	3.73	1.3	0.03	0.177295	3.75	1.3	0.03	184.158502

Fleet Average

			ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
		50	1.80	3.71	5.82	0.36	2.14	4.09	5.72	0.34	184.16
2018 Avg. Emission Factors	500 hp	500	0.68	3.38	5.21	0.17	0.81	3.54	5.21	0.16	184.16
	1000 hp	1000	0.60	3.11	5.16	0.20	0.71	3.40	5.16	0.19	184.16
		3300	0.58	3.11	5.13	0.21	0.68	3.40	5.13	0.19	184.16
		5000	0.58	3.11	5.25	0.23	0.68	3.40	5.25	0.21	184.16

		ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
2020 Avg. Emission Factors	500	0.68	3.47	5.04	0.16	0.81	3.59	5.04	0.15	184.16
	1000	0.58	3.20	4.86	0.18	0.68	3.45	4.86	0.17	184.16
	3300	0.55	3.20	4.83	0.19	0.65	3.45	4.83	0.18	184.16
	5000	0.55	3.20	4.95	0.21	0.65	3.45	4.95	0.20	184.16

Mitigated Emission Factors		ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE NOx	AE PM	Fuel
	Tier 2	0.39		4.17	0.16	0.39		4.17	0.16	

Table 12. Tier Emission Factors

	Low HP	High HP	ROG (g/bhp-hr)	CO (g/bhp-hr)	NOX (g/bhp-hr)	PM10 (g/bhp-hr)	PM2.5 (g/bhp-hr)
Tier 1	25	49	1.74	4.1	5.26	0.48	0.48
Tier 1	50	74	1.19	6.9	6.54	0.552	0.552
Tier 1	75	119	1.19	6.9	6.54	0.552	0.552
Tier 1	120	174	0.82	6.9	6.54	0.274	0.274
Tier 1	175	299	0.38	6.9	5.93	0.108	0.108
Tier 1	300	599	0.38	6.9	5.93	0.108	0.108
Tier 1	600	750	0.38	6.9	5.93	0.108	0.108
Tier 1	751	2000	0.38	6.9	5.93	0.108	0.108
Tier 2	25	49	0.29	4.1	4.63	0.28	0.28
Tier 2	50	74	0.23	3.7	4.75	0.192	0.192
Tier 2	75	119	0.23	3.7	4.75	0.192	0.192
Tier 2	120	174	0.19	3.7	4.17	0.128	0.128
Tier 2	175	299	0.12	2.6	4.15	0.088	0.088
Tier 2	300	599	0.12	2.6	3.79	0.088	0.088
Tier 2	600	750	0.12	2.6	3.79	0.088	0.088
Tier 2	751	2000	0.12	2.6	3.79	0.088	0.088
Tier 3	25	49	0.29	4.1	4.63	0.28	0.28
Tier 3	50	74	0.12	3.7	2.74	0.192	0.192
Tier 3	75	119	0.12	3.7	2.74	0.192	0.192
Tier 3	120	174	0.12	3.7	2.32	0.112	0.112
Tier 3	175	299	0.12	2.6	2.32	0.088	0.088
Tier 3	300	599	0.12	2.6	2.32	0.088	0.088
Tier 3	600	750	0.12	2.6	2.32	0.088	0.088
Tier 3	751	2000	0.12	2.6	2.32	0.088	0.088
Tier 4 Interim	25	49	0.12	4.1	4.55	0.128	0.128
Tier 4 Interim	50	74	0.12	3.7	2.74	0.112	0.112
Tier 4 Interim	75	119	0.11	3.7	2.14	0.008	0.008
Tier 4 Interim	120	174	0.06	3.7	2.15	0.008	0.008
Tier 4 Interim	175	299	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	300	599	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	600	750	0.08	2.6	1.29	0.008	0.008
Tier 4 Interim	751	2000	0.12	2.6	2.24	0.048	0.048
Tier 4	25	49	0.12	4.1	2.75	0.008	0.008
Tier 4	50	74	0.12	3.7	2.74	0.008	0.008
Tier 4	75	119	0.06	3.7	0.26	0.008	0.008
Tier 4	120	174	0.06	3.7	0.26	0.008	0.008
Tier 4	175	299	0.06	2.2	0.26	0.008	0.008
Tier 4	300	599	0.06	2.2	0.26	0.008	0.008
Tier 4	600	750	0.06	2.2	0.26	0.008	0.008
Tier 4	751	2000	0.06	2.6	2.24	0.016	0.016

APPENDIX I

AIR QUALITY AND GREENHOUSE GAS CALCULATIONS

Part 3

Alternative B1/B2, C1/C2, D1/D2 Mitigated Construction:

Dredged Material Placement

Subsequent Construction

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Table 1. Construction Emissions Summary – Alternative B

Diesel

	Emissions (lbs)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	794.15	6023.25	7121.07	187.30	172.86	694.19
Dredged Material Placement	21245.39	287546.08	92846.11	6783.75	6745.28	21582.75
Decomissioning	437.42	3120.51	3003.00	108.19	99.64	290.75
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	18.91	83.85	874.53	2.45	2.44	86.37
Total Project	22529.40	297014.97	104059.65	7088.75	7026.71	22676.54
Average Daily Emissions (lbs/day)	**46.31**	**610.56**	**213.91**	**14.57**	**14.44**	
Average Annual Emissions (tons)	**2.55**	**33.62**	**11.78**	**0.80**	**0.80**	
Amortized GHG Emissions						755.88
CEQA Construction Days	**486**					
NEPA Construction Months	**53**					

Electric

	Emissions (lbs/day)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	794.15	6023.25	7121.07	187.30	172.86	694.19
Dredged Material Placement	1937.11	13623.10	13774.10	489.11	450.64	10330.17
Decomissioning	504.55	3577.21	3671.51	123.94	114.23	351.30
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	18.91	83.85	874.53	2.45	2.44	86.37
Total Project	3288.24	23548.68	25656.15	809.86	746.66	11484.51
Average Daily Emissions (lbs/day)	**6.76**	**48.41**	**52.74**	**1.66**	**1.53**	
Average Annual Emissions (tons)	**0.37**	**2.67**	**2.90**	**0.09**	**0.08**	
Amortized GHG Emissions						382.82

Table 2. Construction Emissions Summary – Alternative C

Diesel

	Emissions (lbs)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	783.65	5876.08	6663.36	186.37	171.95	647.01
Dredged Material Placement	16770.01	226482.52	73166.31	5350.79	5318.80	16967.30
Decomissioning	435.15	3109.76	2876.26	107.92	99.38	276.96
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	10.23	45.35	472.96	1.32	1.32	46.71
Total Project	18032.56	235754.97	83393.84	5653.46	5597.94	17960.47
Average Daily Emissions (lbs/day)	**44.75**	**585.12**	**206.97**	**14.03**	**13.89**	
Average Annual Emissions (tons)	**2.58**	**33.68**	**11.91**	**0.81**	**0.80**	
Amortized GHG Emissions						598.68
CEQA Construction Days	**403**					
NEPA Construction Months	**42**					

Electric

	Emissions (lbs/day)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.76	120.63	107.47	3.53	3.25	11.24
Site Preparation	783.65	5876.08	6663.36	186.37	171.95	647.01
Dredged Material Placement	1601.26	11286.31	11046.67	405.66	373.68	8127.18
Decomissioning	502.03	3565.16	3533.22	123.65	113.95	335.30
Demobilization	16.76	120.63	107.47	3.53	3.25	11.24
Restoration Project	10.23	45.35	472.96	1.32	1.32	46.71
Total Project	2930.69	21014.16	21931.16	724.07	667.39	9178.70
Average Daily Emissions (lbs/day)	**7.27**	**52.15**	**54.43**	**1.80**	**1.66**	
Average Annual Emissions (tons)	**0.42**	**3.00**	**3.13**	**0.10**	**0.10**	
Amortized GHG Emissions						305.96

Table 3. Construction Emissions Summary – Alternative D

Diesel

	Emissions (lbs)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.57	119.59	98.23	3.51	3.23	9.48
Site Preparation	783.96	5971.71	6550.91	186.72	172.39	564.77
Dredged Material Placement	21256.12	287968.72	91472.20	6794.67	6756.42	21320.57
Decomissioning	431.66	3089.82	2729.94	107.64	99.13	238.58
Demobilization	16.57	119.59	98.23	3.51	3.23	9.48
Restoration Project	16.65	72.17	767.98	2.22	2.22	67.66
Total Project	22521.53	297341.61	101717.48	7098.27	7036.62	22210.53
Average Daily Emissions (lbs/day)	**46.27**	**610.83**	**208.96**	**14.58**	**14.46**	
Average Annual Emissions (tons)	**2.55**	**33.66**	**11.52**	**0.80**	**0.80**	
Amortized GHG Emissions						740.35
CEQA Construction Days	**487**					
NEPA Construction Months	**53**					

Electric

	Emissions (lbs/day)					Metric Tons
Construction Phase/Emissions Source	**ROG**	**NO_X**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Mobilization	16.57	119.59	98.23	3.51	3.23	9.48
Site Preparation	783.96	5971.71	6550.91	186.72	172.39	564.77
Dredged Material Placement	1906.51	13459.37	12230.92	486.56	448.30	10043.90
Decomissioning	498.54	3545.21	3386.90	123.37	113.70	296.92
Demobilization	16.57	119.59	98.23	3.51	3.23	9.48
Restoration Project	16.65	72.17	767.98	2.22	2.22	67.66
Total Project	3238.79	23287.66	23133.17	805.89	743.07	10992.21
Average Daily Emissions (lbs/day)	**6.65**	**47.84**	**47.52**	**1.66**	**1.53**	
Average Annual Emissions (tons)	**0.37**	**2.64**	**2.62**	**0.09**	**0.08**	
Amortized GHG Emissions						366.41

APPENDIX J

RESPONSES TO COMMENTS ON DRAFT EIS/R

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1. INTRODUCTION

1.1 Purpose of the Response to Comments Document

This Response to Comments document responds to comments received on the South Bay Salt Pond (SBSP) Restoration Project Draft Environmental Impact Statement/Report (EIS/R) for Phase 2 at Eden Landing Ecological Reserve (ELER or the Reserve). The Draft EIS/R identified the environmental consequences associated with the implementation of project actions, as well as mitigation measures to reduce significant and potentially significant impacts. As a result of comments received, the Draft EIS/R has been revised. The revised environmental analysis, together with this Response to Comments document and full set of appendices, constitutes the Final Environmental Impact Report (EIR) for the proposed SBSP Restoration Project for Phase 2 at ELER.

This Final EIR was prepared by the California Department of Fish and Wildlife (CDFW), the California Environmental Quality Act (CEQA) lead agency, in partnership with the U.S. Fish and Wildlife Service (USFWS) and the California State Coastal Conservancy (SCC). The USFWS acted as the National Environmental Policy Act (NEPA) lead agency during preparation of the draft environmental document but has withdrawn as the NEPA lead agency for the final environmental document. Because this site-specific project is located on the CDFW-owned and managed ELER, and because the USFWS is not issuing a permit or funding the restoration, the USFWS does not have a decision to make under NEPA. However, the USFWS has worked closely with CDFW and partners in preparing the environmental documents and intends to work closely with partners on this Phase 2 Project and future restoration efforts.

The Final EIR is an informational document prepared by CDFW that must be considered by decision-makers before approving or denying the proposed project. The Final EIR has been prepared so that it is compliant with both CEQA and NEPA requirements to facilitate permitting by a federal agency in the future and to remain consistent with previous documents.

Section 1502.9(b) of the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA (CEQ Regulations) states:

> Final environmental impact statements shall respond to comments as required in Part 1503 of this chapter. The agency shall discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised.

CEQA Guidelines (Section 15132) specify that a Final EIR shall consist of:

> (a) The Draft EIR or a revision of the draft.
>
> (b) Comments and recommendations received on the Draft EIR either verbatim or in summary.
>
> (c) A list of persons, organizations, and public agencies commenting on the Draft EIR.
>
> (d) The response of the lead agency to significant environmental points raised in the review and consultation process.
>
> (e) Any other information added by the lead agency.

1.2 Environmental Review Process

On April 6, 2018, the lead agencies for the Draft EIS/R, USFWS and CDFW, released the Draft EIS/R for the SBSP Restoration Project Phase 2 at ELER for public review (State Clearinghouse No. 2016052051). The public review and comment period on the Draft EIS/R began on April 6, 2018 and closed on May 21, 2018 for comments addressed to federal agencies and June 5, 2018 for comments addressed to state agencies.

The lead agencies provided a Notice of Availability notifying the public of the publication of the Draft EIS/R. This notice was mailed to the individuals and organizations that have been involved in the SBSP Restoration Project planning effort as well as those who previously requested such notice in writing. The notice and the Draft EIS/R were also posted on the Project website (www.southbayrestoration.org).

One public meeting was held to discuss the proposed project and receive comments on the Draft EIS/R during the public comment period. The meeting was held at the Don Edwards San Francisco Bay National Wildlife Refuge 3rd Floor Auditorium on May 8, 2018. The date, time, and place of the meeting were identified in the publicly-circulated Notice of Availability of the Draft EIS/R.

1.3 Report Organization

Chapter 2 of this Response to Comments document contains copies of comments received during the comment period followed by the lead agencies' responses to those comments. Master Comment Responses (MCRs) that address multiple comments with similar concerns are provided below in Section 2.1. Each comment in a comment letter was assigned a number, in sequential order (note that some letters have more than one comment). The numbers were then combined with an abbreviation for affiliation type as well as an abbreviation for each commenting entity. These alphanumeric codes are indicated in the margin of each comment letter. Responses to the comments follow the comment letter, and are also coded to correspond to the comment codes assigned in the letter.

A number of comments that were received addressed similar concerns. Responses to these comments were consolidated into MCRs. Eight MCRs were prepared in response to these common issues/concerns. These master responses cover the following topics:

- Selection or description of the Preferred Alternative including process and rationale
- Details of designs
- Sea-level rise
- Beneficial reuse of dredge material, including placement locations, purpose, timing, and impacts
- Fish habitat restoration
- Public access bridge over the Alameda Creek Flood Control Channel (ACFCC)
- Public access trails including routes, elevations, and parking
- Maintenance responsibilities

Where a response includes a change to the text of the Draft EIS/R, the text has been revised in the Final EIR. The responses to comments note where in the revised text of the Final EIR the relevant changes have been made.

Table 1-1 below lists all persons and organizations that submitted comments on the Draft EIS/R during the comment period, the date of the letters, and the code used to identify each letter. One organization submitted a comment letter after the close of the comment period. This organization is listed below for completeness.

Table 1-1. Persons and Organizations that Submitted Comments on the Draft EIS/R

Commenter	Affiliation	Code	Date
Federal and State Agencies			
Goforth, Kathleen	Environmental Protection Agency, Region 9	F-EPA	5/17/2018
Van Atta, Alecia	NOAA Fisheries	F-NMFS	6/4/2018
Oggins, Cy R	California State Lands Commission	S-CSLC	6/5/2018
Regional and Local Agencies			
Ackerman, Hank	Alameda County Flood Control & Water Conservation District	L-AFCD1	5/21/2018
Ackerman, Hank	Alameda County Flood Control & Water Conservation District	L-AFCD2	6/5/2018
Attiogbe, Kwablah	Alameda County Flood Control & Water Conservation District	L-AFCD3	6/5/2018
Castillo, Erika	Alameda County Mosquito Abatement District	L-ACMAD	6/5/2018
Inn, Steven	Alameda County Water District	L-ACWD	6/5/2018
Malloy, Joan	City of Union City	L-CUC	5/21/2018
Hamlat, Sandra	East Bay Regional Park District	L-EBRP	5/21/2018
Giari, Michael	Port of Redwood City	L-PRC	6/5/2018
Huo, Lee Chien	Bay Area Metro, San Francisco Bay Trail Project	L-SFBT	5/18/2018
Organizations and Businesses			
Miller, Jeff	Alameda Creek Alliance	O-ACA	4/25/2018
Coleman, John	Bay Planning Coalition	O-BPC	6/5/2018
High, Carin	Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper, and Ohlone Audubon Society	O-CR1	5/21/2018
High, Carin	Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper, and Ohlone Audubon Society	O-CR2	6/5/2018
Samuel, Patrick	California Trout	O-CT	5/4/2018
Schwartz, Susan	Friends of Five Creeks	O-FFC	5/29/2018
Wirth, Gena	Public Sediment Team via SCAPE / Landscape Architecture DPC	O-PST	6/5/2018
Pearl, Benjamin	San Francisco Bay Bird Observatory	O-SFBBO	6/5/2018
Mangarella, Peter	Trout Unlimited, John Muir Chapter	O-JMTU	5/8/2018
Stauffer-Olsen, Natalie	Trout Unlimited	O-TU	5/11/2018
Bodensteiner, Scott	Haley & Aldrich, Inc on behalf of Pacific Gas and Electric Company	B-HA	6/5/2018
Caldwell, Tim	McBain Associates	B-MBA	6/4/2018
Stout, Steve	Staten Solar	B-SS	5/1/2018
Spalding, Jewell	Sierra Club, San Francisco Bay	O-SC	6/15/2018 (late submittal)

Table 1-1. Persons and Organizations that Submitted Comments on the Draft EIS/R

Commenter	Affiliation	Code	Date
Individuals			
Baye, Peter	Consultant on behalf of Citizens Committee to Complete the Refuge	I-PB1	5/21/2018
Baye, Peter	Consultant on behalf of Citizens Committee to Complete the Refuge	I-PB2	5/30/2018
Ervin, Jim	Individual	I-JE	5/21/2018
Bogios, Constantine	Individual	I-CB1	5/17/2018
Bogios, Constantine	Individual	I-CB2	5/17/2018
Boniello, Ralph	Individual	I-RB	6/5/2018
Clegg, James	Individual	I-JC	6/5/2018
Cook, J.	Individual	I-JPC	6/5/2018
Copper, Elizabeth	Individual	I-EC	6/5/2018
Coyne, Brian	Individual	I-BC	6/5/2018
Dalal, Namita	Individual	I-ND	5/17/2018
Devine, Timothy	Individual	I-TD	4/13/2018
Galvan, Stonetree	Individual	I-SG	5/21/2018
Johnson, Ralph	Individual	I-RJ	6/5/2018
Knopf, Clay	Individual	I-CK	5/26/2018
Marshak, Bob	Individual	I-BM	5/22/2018
Morelli, Leslie	Individual	I-LM	4/12/2018
Nicholas, Myasha	Individual	I-MN	5/26/2018
Phillips, Barbara	Individual	I-BP	5/14/2018
Richardson, Matt	Individual	I-MR	4/13/2018
Scordelis, Philip	Individual	I-PS	5/18/2018
Tepe, Alan	Individual	I-AT	6/5/2018
Thompson, Lawrence	Individual	I-LT	4/21/2018
V, S	Individual	I-SV	4/16/2018
Woodcock, Charlene	Individual	I-CW	5/18/2018

2. COMMENTS AND RESPONSES

2.1 Master Comment Responses (MCRs)

The responses to the individual comments and the specific topics or points made in them are addressed in the individual responses that follow. A complete relisting of those discussions here is unnecessary. However, there are broader and more general points that should be made here to provide some additional context and background for those individual responses. Note that many responses to individual comments cannot be wholly addressed simply by referring to an MCR. Rather, the MCRs provide a common base of explanation for the responses to many comments; from that base, the rest of the responses are expanded.

2.1.1 MCR 1: Selection of the Preferred Alternative

Only a few comments asked directly about the Preferred Alternative and the methods or process by which it will be selected. But indirectly, a majority of the comments either expressed a preference or made an argument for or against a particular project element included in the action alternatives analyzed in the Draft EIS/R. This MCR is intended to address questions specific to the Preferred Alternative. It also provides a simple overview of the Preferred Alternative and how it was developed. Chapter 6 of the Final EIR presents the description of the Preferred Alternative and its combination of elements from the three action alternatives presented in the Draft EIS/R. The reader is directed to Chapter 6 for more details.

The state lead agency, CDFW, along with the Project Management Team and other project partners decided not to specify a Preferred Alternative in the Draft EIS/R for Phase 2 at ELER. By waiting until the Final EIR to make that decision, the project proponents were able to incorporate input received from the public, regulatory agencies, and other stakeholders on the Draft EIS/R into the decision regarding which components to select for the Preferred Alternative. That intended process and outcome is how the Preferred Alternative was determined.

Many of the comments on the Draft EIS/R contained statements supporting or opposing particular components of the action alternatives. Those arguments informed and shaped the selection of individual elements as well as their recombination into the Preferred Alternative. Further, as was described in the 2007 Final EIS/R and other project planning documents, the SBSP Restoration Project's approach has been to allow the lessons learned from each project phase and from ongoing applied studies and other scientific research and monitoring to inform future phases of the project and to determine the ultimate outcome. These resources and results were used to shape the selection of components.

It is important to note that, although the Preferred Alternative is not exactly one of the action alternatives in the Draft EIS/R, it is made up of individual components that were presented and analyzed in the document with some modifications. Although the combination of the components is different in the Preferred Alternative than those presented in the action alternatives, there are no new significant impacts and no new mitigation measures are required.

For reader convenience, Table 2-1 summarizes the components of the Preferred Alternative. The Preferred Alternative provides habitat restoration, maintains or improves flood risk management, and provides wildlife compatible public access and recreation features, consistent with the Project's Phase 2 goals and objectives. In a few cases, clarifications and refinements to the individual components were made in response to comments and suggestions received on the Draft EIS/R. These changes do not increase, and often decrease, the potential for significant environmental impacts.

Table 2-1. Comparison of the Action Alternatives to the Preferred Alternative

Component	Alternative Eden B	Alternative Eden C	Alternative Eden D	Preferred Alternative
Restoration goal	Tidal restoration of the Bay, Inland, and Southern Ponds	Tidal restoration of the Bay Ponds and the Inland and Southern Ponds become permanent enhanced managed ponds	Tidal restoration of the Bay Ponds and adaptive management-informed phased restoration of the Inland and Southern Ponds (managed ponds then tidal marsh)	Similar to Alternative Eden D except Pond E6C is a permanent enhanced managed pond and the Southern Ponds receive muted tidal flows via culverts during the initial phase of restoration
Perimeter levee breaches and pilot channels	Levee breaches in Ponds E1, E6 and E2 with associated pilot channels	Levee breaches in Ponds E1 and E4 with associated pilot channels	Levee breaches at Pond E1 with associated pilot channels	Similar to Alternatives Eden B and C with an armored breach in the ACFCC near Pond E2, small breaches in Pond E1, and adaptive management-informed phased restoration that can include a breach in Pond E6 and a breach between Ponds E5 and E7
Internal levee breaches	Internal levee breaches and habitat islands/mounds in the Bay, Inland, and Southern Ponds	Internal levee breaches in the Bay and Southern Ponds; habitat islands/mounds in the Bay Ponds	Internal levee breaches and habitat islands/mounds in the Bay and Southern Ponds	Similar to Alternative Eden D with internal breaches in the Inland Ponds implemented if needed during phased restoration
Water control structures	New or repaired water control structures in the Southern Ponds and the ACFCC	New or repaired water control structures in the Inland and Southern Ponds and the ACFCC	New or repaired water control structures in the Inland and Southern Ponds and the ACFCC	Similar to Alternative Eden C with fewer water control structures in the Inland and Southern Ponds
Lowered levees	Lowered levees at Pond E1 north, Pond E2 south, and west levees	Lowered levees at Pond E1 north, Pond E2 south, and west levees	Lowered levees at Pond E1 north and Pond E2 south	Similar to Alternative Eden D
Landside levees	Improved landside levee and habitat transition zone at Ponds E6, E5, E6C, and E4C	Landside levee not improved	Improved landside levee	Similar to Alternative Eden B with a steeper habitat transition zone, if needed, and no habitat transition zone in Pond E6C
Mid-complex levee(s)	Internal levee breaches, habitat islands/mounds, and pilot channels at the boundary between the Bay and Inland Ponds.	Improved mid-complex levee and habitat transition zone at the boundary between the Bay and Inland Ponds	Temporary mid-complex levee and pilot channels at the boundary between the Bay and Inland Ponds	Similar to Alternative Eden C with a steeper habitat transition zone, if needed

Table 2-1. Comparison of the Action Alternatives to the Preferred Alternative

Component	Alternative Eden B	Alternative Eden C	Alternative Eden D	Preferred Alternative
Bayward levees	Lowered levees at Pond E1 west and northwest Pond E2 (bordering Cargill Mitigation Marsh and Southern Whale's Tale Marsh)	Improved bayside levee at Pond E2; levee lowering on Pond E1 west and northwest Pond E2	Improved bayside levee and habitat transition zone at Pond E1 and E2	Similar to Alternative Eden D with a steeper habitat transition zone, if needed
Southern levees	Improved southern levees at Ponds E4C and E5C and connections to Turk Island and Cal Hill	Southern levees not improved	Improved southern levees at Ponds E4C and E5C and connections to Turk Island and Cal Hill	Similar to Alternatives Eden B and D
Other levee improvements (recreational trails)	Improved levees at Ponds E6C south, E5C north, and E1C north	Improved levee at a section of Pond E1C (at mid-complex)	Improved levee at a section of Pond E1C (at mid-complex)	Similar to Alternative Eden B except that the northern levee at Pond E4C and a section of Pond E5C would be improved instead of the southern levee at Pond E6C
Recreational trail alignment	Through-trail from northern Eden Landing to the Southern Ponds, three trail route options, and two community connectors	Through-trail from northern Eden Landing to the Southern Ponds, three trail route options, two community connectors, and a spur trail to the Alvarado Salt Works	Through-trail from northern Eden Landing to the Southern Ponds, three trail route options, and two community connectors	Similar to Alternative Eden B with Trail Route 1 and one community connector at Veasy Street
Bridges	Two footbridges over the connection to the J-ponds	Bridge over the ACFCC at the Alameda Creek Regional Trail and two footbridges over the connection the J-ponds	Two footbridges over the J-pond connector	Similar to Alternative Eden C except with only one footbridge over the connection to the J-ponds
Dredge materials	Beneficial reuse of dredge materials in the Bay and Inland Ponds	Beneficial reuse of dredge materials in the Bay Ponds	Beneficial reuse of dredge materials in the Bay and Inland Ponds	Similar to Alternative Eden B and D, except no material would be placed in Pond E6C
Water use connections	Water reuse connections on the landside levee	No water reuse connections	No water reuse connections	Similar to Alternatives Eden C and D
Root-wads and enhancement features	Root-wad enhancement features on Pond E2's bay-facing levee	No rootwads and enhancement features on Pond E2's bay-facing levee	No rootwads and enhancement features on Pond E2's bay-facing levee	Similar to Alternative Eden B with rootwads and related enhancement features (gravels/coarse grain materials) located on Pond E2's bay-facing levee north of the existing shoal

2.1.2 MCR 2: Details of Designs

Many comments include one or more requests for a level of specificity greater than that available at the current design stage. Examples of this type of comment are requests for a description of the planting plan that would be developed for the slopes of the habitat transition zones or for details of how the rootwads would be anchored to the outer levee of Pond E2. This MCR is intended to explain the current state of design, what level of detail NEPA and CEQA require, and the plan for refining and advancing the design as the project proceeds.

The level of detail provided in the EIR is sufficient to analyze the environmental impacts of the project under NEPA and CEQA. This EIR is based on the preliminary design for the Project (an approximate 10 to 30 percent level of design). This is consistent with both CEQA and NEPA, in which the environmental analysis process occurs before completion of final design. Section 1501.2 of the CEQ Regulations states that "agencies shall integrate the NEPA process with other planning at the earliest possible time to ensure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts" (40 Code of Federal Regulations [CFR] 1501.2). Similarly, the State CEQA Guidelines indicate that environmental analysis "should be prepared as early as feasible in the planning process to enable environmental considerations to influence project program and design and yet late enough to provide meaningful information for environmental assessment" (State CEQA Guidelines, §15004). As provided in State CEQA Guidelines Section 15146, the level of detail in the environmental analysis is to "correspond to the degree of specificity involved in the underlying activity which is described in the EIR." The EIR is based on the level of engineering and planning currently available and is adequate to identify potential environmental impacts of the alternatives and identify appropriate mitigation measures.

Both NEPA and CEQA require the development and analysis of a range of alternatives. The comparison of alternatives is not required by NEPA or CEQA so that the "best" alternative for assuring the project's "success" can be identified, but rather so that the adverse impacts from different alternatives can be compared.

Permitting and other regulatory processes generally require more detailed design with more refined estimates of areas, volumes of fill, and habitat conversion. Many of the comments from the regulatory agencies spell out the type of detailed information that will be required to proceed with permitting. These processes typically proceed with designs ranging between 30 and 60 percent, depending on the regulation and agency involved. That level of specificity is necessary to address specific topics under each agency's purview and authorizing legislation.

The SBSP Restoration Project proponents have developed and included in the Phase 2 Draft EIS/R designs sufficient to inform the necessary environmental impact analyses and to compare the action alternatives and the no-project/no-action alternative against the current environmental baseline and against expected long-term trends in the environment. Designs sufficient for permitting will occur in the next step of the process.

Comments on a project's merits or that make suggestions to increase its chance of successful long-term outcomes are greatly appreciated. However, responding to questions on specific details that will be developed during detailed design is beyond the intent of NEPA and CEQA. It should be noted that, as designs proceed, many of the suggested refinements will be incorporated into the design, as feasible and appropriate. The SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan (or AMP) as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. It is precisely this sort of input that we hope to gain by engaging our stakeholders and the project proponents fully intend to use this input to inform the final design.

2.1.3 MCR 3: Sea-Level Rise

Several comment letters and individual comments asked about sea-level rise. The SBSP Restoration Project proponents share these concerns and realize that there are uncertainties in several key aspects of sea-level rise. This MCR addresses how successful the particulars of various restoration efforts and concepts would be with sea-level rise. MCR 7, Public Access Trails, and MCR 8, Maintenance Responsibilities, also discuss whether levee elevation increases and other improvements would be sufficient to support long-term trails on those levees in the face of sea-level rise, and how CDFW and the SBSP Restoration Project team would maintain levee-top trails and other project features in the face of sea-level rise. Many of the specifics are also addressed in the individual responses to comments. This high-level summary of sea-level rise-related issues is presented here to provide context for the subsequent individual comments and responses that follow.

SBSP Restoration Project Flood Risk Management Responsibilities

In the 2007 Final EIS/R and in various visioning documents written before and after that time, the SBSP Restoration Project has listed, as one of its three primary goals, maintain or increase the existing levels of flood protection. The language around that goal has shifted to be about “flood risk management” instead of “flood protection”, but the intent is the same: the Project is obligated to not increase flood risk over baseline conditions, but it is not obligated to increase flood protection or provide long-term flood risk management beyond that which the two landowners (CDFW and USFWS) would do in the absence of the Project.

Following that logic, neither CDFW on its own nor the larger, combined set of agencies forming the SBSP Restoration Project Management Team has a responsibility to provide long-term flood protection against dynamics related to sea-level rise. CDFW, as the land owner at Eden Landing, is responsible for maintaining its levees and other lands/waters so that flood risks on adjacent properties are not increased from actions taken on the ELER property. But CDFW is not a flood management or flood protection agency and has very limited capacity and funding to provide long-term flood protection beyond basic levee maintenance and operation of water control structures to manage pond levels.

Estimates of Future Sea Level Rise and Climate Change Impacts on Marsh Restoration

It is important to first consider the changes to estimates of future sea-level rise in the South Bay. The 2007 Final EIS/R utilized the 2001 Intergovernmental Panel on Climate Change (IPCC) mid-range sea level rise estimate of 6 inches by 2050 (3 millimeters [mm] per year average) and 18 inches by 2100 (6 mm per year average between 2050 and 2100) (IPCC 2001). The higher rates in the second half of the century reflect the effects of accelerated sea level rise. However, more recent studies indicate that projections done even a decade or so ago are likely to risk underestimating the magnitude, rates, and timing of sea-level rise and other climate change-related effects.

Several researchers have investigated the predicted response of tidal marshes to future rates of sea-level rise in San Francisco Bay. While there is considerable uncertainty to the rate of sea level rise, particularly after about 2050 due to uncertainties in global carbon emission rates, there is a general consensus among scientists that sea levels near San Francisco are likely to increase by 4 to 6 inches by 2030, 7 to 13 inches by 2050, and 12 to 41 inches by 2100, relative to levels in 2000 (Ocean Protection Council [OPC] 2018)[1].

Different approaches to modeling the effect of sea level rise on tidal marsh sustainability have been investigated. Diana Stralberg[2] of Point Blue Conservation Science, estimated the spatial distribution of marsh accretion using the Marsh98 model, and considered the variation in tidal range throughout the San Francisco Bay. They varied the rate of sea level rise (20 to 65 inches) and varied the amount of organic matter and suspended sediment that was available for marsh accretion based on regions in the Bay. They found that marshes with low suspended sediment would not be sustained for more than 40 years under any of the sea-level rise rates. At the other end of the spectrum, marshes with a high level of suspended sediment (such as the South Bay) were sustained up to 80 years, but not over the full 100 years. The model projected that even under the most pessimistic of assumptions (low suspended sediment, high rates of sea level rise), that there would be a Bay-wide increase in marsh habitat until about 2050, suggesting that a large-scale effect of sea level rise may not be seen until close to 2100. After 2100, with predicted increased rates of sea level rise, loss of marsh habitat would also increase. To minimize marsh loss, the authors recommend conserving adjacent uplands for marsh migration, redistributing dredged sediment to raise existing elevations of ponds prior to restoration, and concentrating restoration efforts in sediment-rich areas.

Lisa Schile of the University of California, Berkeley, and others[3] used another modeling approach, which built upon the work of Diana Stralberg by incorporating plant productivity to predict marsh resiliency using the Marsh Equilibrium Model, and calibrating the model with extensive data collected from four tidal marshes in San Francisco Bay Estuary (all collected from the Delta or North Bay). The Marsh Equilibrium Model was run using five rates of sea level rise (approximately 22 inches to 70 inches per century) and three suspended sediment concentrations and sea level elevations were projected for 2030, 2060, 2080, and 2110. As with the Marsh98 model, marsh accretion did not keep pace with sea level rise under low suspended sediment concentrations. Model results found that tidal wetlands were able to keep pace with sea level rise up to a "tipping point", specifically when the sea level rise rate was greater than 39 inches per century. Researchers stressed that adjacent upland areas could provide space for the marsh to migrate under the highest rates of sea level rise.

John Takekawa and Karen Thorne of the U.S. Geological Survey (USGS)[4] took a different approach by collecting detailed and site-specific elevation, tidal inundation, and vegetation data at 12 marshes around San Francisco Bay, along with sediment cores, to provide inputs to the Wetland Accretion Rate Model for Ecosystem Resilience (WARMER). Model results indicated that 96 percent of the areas studied would

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[1] State of California Ocean Protection Council. 2018. State of California Sea-Level Rise Guidance. 2018 Update.

[2] Stralberg D, Brennan M, Callaway JC, Wood JK, Schile LM, et al. 2011. Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay. PLoS ONE 6(11): e27388. doi:10.1371/journal.pone.0027388.

[3] Schile LM, Callaway JC, Morris JT, Stralberg D, Parker VT, et al. (2014) Modeling Tidal Marsh Distribution with Sea-Level Rise: Evaluating the Role of Vegetation, Sediment, and Upland Habitat in Marsh Resiliency. PLoS ONE 9(2): e88760. doi:10.1371/journal.pone.0088760

[4] Takekawa, J.Y., Thorne, K.M., Buffington, K.J., Spragens, K.A., Swanson, K.M., Drexler J.Z., Schoellhamer, D.H., Overton, C.T., Casazza M.L. 2013. Final report for sea-level rise response for San Francisco Bay estuary tidal marshes. U.S. Geological Survey Open File Report 2012-1081, 161 p.

become mudflat habitat by 2100, assuming a 49-inch sea level rise rate. Variations in tidal range, marsh accretion rates, and initial marsh elevation at the different study sites resulted in varying risks to sea level rise. They found that marsh accretion rates were relatively high in South Bay, and thus those tidal marshes withstood sea level rise effects longer, but with many areas transitioning to only low marsh by 2100. The two study sites that are closest to the project area are Cogswell Marsh along the Hayward Regional Shoreline (just north of ELER) and Laumeister Marsh owned by the City of Palo Alto (located north of the Alviso Complex). The WARMER model results showed that Cogswell Marsh had a gradual reduction in elevation, with an increased decline after 2060. Due to high accretion rates, due partly to high suspended sediment levels in South Bay, mid-marsh habitat was maintained through 2070 (assuming approximately 26 inches of sea level rise), but Cogswell Marsh was projected to transition to low-marsh habitat by 2100 (48 inches of sea level rise). Model results for Laumeister Marsh showed it was able to sustain itself longer due to its high initial elevation and marsh accretion rates, and partly to high suspended sediment. Laumeister Marsh is expected to sustain high-marsh habitat through 2060 (approximately 22 inches of sea level rise), would transition to mid-marsh habitat by 2080, and by 2100 (48 inches of sea level rise) would be mostly low-marsh habitat.

While these model results are encouraging for the sustainability of marshes in South Bay relative to other areas of the Bay, it is unknown what the sustainability of subsided managed ponds will be under future restoration efforts.

Karen Thorne, USGS, applied a structured decision-making process and expert judgment to develop alternative management strategies to increase tidal marsh resiliency through 2050. They sought to optimize a strategy for tidal marsh conservation which took into account future marsh accretion uncertainties, along with social and economic risks, ecological benefits and trade-offs. This prototype effort sought to answer the question, "[t]o conserve San Francisco Bay tidal marshes in light of future climate change, what management, restoration, and protection actions, if any, should be conducted, and where, when, and how should they be conducted?" The results of this process found the greatest utility would be from a "climate-smart" restoration allocation of resources. Such an approach includes increasing resiliency of tidal marshes to climate effects by exploring engineering options to improve resiliency of future marshes, retrofit ongoing or past marsh restorations, and enhance historic marshes; accelerate the timeline for tidal marsh restoration using fill to raise marsh elevations; and the restoration of areas with the highest marsh accretion potential.

One intriguing climate-smart adaptation strategy is shallow-water dredged material placements to allow natural processes to replenish sediments to marsh and mudflat habitats. Aaron Bever and Michael MacWilliams, both of Delta Modeling Associates at the time, in collaboration with the U.S. Army Corps of Engineers, studied the in-Bay placement of dredge material at two locations in San Francisco Bay: one in San Pablo Bay and the other in far South Bay[5]. Authors applied a three-dimensional hydrodynamic, wave, and sediment transport model to evaluate whether shallow-water dredged material placements in less dispersive areas adjacent to existing marshes or breached ponds would result in an increase in sediment deposition within these areas through natural dispersal processes. Dredged material placement simulations in far South San Francisco Bay indicated that the natural dispersal of sediment from open water in-Bay placement has the potential to be used to augment mudflat, marsh, and pond sedimentation.

[5] Bever, A., Michael L. MacWilliams, Frank Wu, Lisa Andes, and Craig S. Conner. 2014. Numerical Modeling of Sediment Dispersal Following Dredge Material Placements to Examine Possible Augmentation of the Sediment Supply to Marshes and Mudflats, San Francisco Bay, USA. PIANC (World Association for Waterborne Transport Infrastructure) World Congress, San Francisco, June 2014.

Placement regions in the far South Bay were much more effective at supplying sediment to mudflats and marshes than locations in San Pablo Bay, and supplied less sediment to federal navigation channels than the San Pablo Bay placement regions. Further evaluation of the effectiveness of this strategy would be a pilot project of in-Bay sediment placement and measurements of erosion and deposition to validate and refine the model.

Phased Implementation, Monitoring, and Adaptive Management to Address Uncertainty in Sea Level Rise

As the 2007 Final EIS/R explained, the SBSP Restoration Project "…would use phased implementation, monitoring and adaptive management to plan for and accommodate a range of potential future sea level rise. Updated sea level rise estimates would be used as future phases were designed and implemented. Monitoring and adaptive management would provide updated assessments of future sea level rise, inform planning for future phases, and adjust previously implemented phases as needed."

The Adaptive Management Plan and Section 2.3 of the 2007 Final EIS/R explain these actions and provide examples. Specific actions included monitoring sea-level rise in the South Bay, modeling and monitoring sediment dynamics in the South Bay, and using the coupled hydrodynamic and sediment transport model of the South Bay to develop better plans for phasing future implementation actions. Other examples include adjusting the phasing to better match the sediment supply; maintaining levees along the bayfront edge to shelter restored tidal areas from wave energy and encourage marsh formation; restoring natural shorelines such as shell breaches, wrack lines, and Bay-edge pans; using imported fill to raise pond beds to elevations conducive to vegetation establishment; and prioritizing restoration of less subsided ponds and/or ponds close to sediment supplies within the project area. The Phase 2 actions in particular have attempted to prioritize the restoration of less subsided ponds while there is still time to do so before sea-level rise become too rapid and extreme.

Sea Level Rise and Flood Protection / Maintaining Levees and Managed Salt Ponds in the Face of Future Sea-Level Rise

Several comments raised concerns regarding the long-term management of former salt-production ponds levees (which are not engineered levees and are more like berms) and other unimproved features, particularly in the face of sea-level rise and associated risks of failure. The risks of levee failure and the various management and levee maintenance actions are considered and addressed as needed, according to CDFW's ELER management. Such operations and maintenance are performed as needed as part of the overall ELER property management, whether or not a Phase 2 action were to be implemented at a given pond or area within ELER. Some of these risks and potential impacts are actually somewhat greater in the no action alternative than in the tidal restoration alternatives because the latter generally allow ponds to be breached. Other ponds will remain protected in place with adequate elevation and slopes to protect from wind wave or other coastal erosion (and deposition) functions over time. Tidal marsh restoration and retained managed ponds will be designed and implemented such that those actions protect existing habitats and built environments instead of allowing unplanned levee failures that might cause flooding or habitat degradation under a No Action Alternative.

The SBSP Restoration Project is committed to maintaining or improving, rather than reducing the existing levels of flood risk. Phase 2 actions seek to improve current and future flood risk where practicable. Options may include building a levee with a wider base to more easily accommodate future increases needed in levee height. These levee maintenance and/or improvement approaches could also be used for ponds retained and managed for pond-dependent wildlife species.

Sea Level Rise and Habitat Restoration Planning

Given the expected rates of sea-level rise discussed above, the SBSP Restoration Project team believes that it is important to do as much tidal restoration as is safe and feasible as soon as possible, so that the marsh can become established before sea-level rise greatly increases. In support of this idea, the Baylands Ecosystem Habitat Goals Project 2015 Science Update prioritizes maximizing tidal marsh restoration in areas like the South Bay by 2030.

The 2007 Final EIS/R presented lengthy details about how sea-level rise would be incorporated into the program-level planning and in project-level design and planning. It noted that higher than anticipated sea-level rise rates that result in delayed or arrested marsh establishment could affect the progression between the 50:50 and 90:10 alternatives presented in the 2007 Final EIS/R. Tidal habitat restoration may be closer to the 50:50 end point of the SBSP Restoration Project which may maximize the sediment supply available to those ponds that are tidally restored. In other words, at Project completion, the final habitat restoration target may be closer to 50 percent of the ponds being tidally restored in order to most effectively utilize available tidal sediment supply. Adaptive management efforts would be used to encourage marsh establishment in the tidal ponds. Restoration actions contain features to accommodate accelerated sea level rise, such as constructing a gradually sloping habitat transition zone surface that provides an elevation gradient over which tidal marsh could shift upslope as sea level rises. Additional actions could include initiating marsh vegetation plantings to maximize sediment-trapping efficiencies and enhance the accumulation of organic matter in the developing marsh sediments.

Further, Appendix I of the 2007 Final EIS/R was a habitat evolution assessment that, among other findings, presented research by Watson (2004) showing that the high sediment availability in the far South Bay sustained marshes at a time when subsidence was very high. It concluded that, if sea-level rise rates match the lower to mid-range of the predictions and sediment availability remains high, tidal marshes in the South Bay should keep pace with changing conditions as they have done historically. If higher rates of sea level rise prevail, the timeframe for marsh development may be delayed, and tidally-restored areas within the SBSP Restoration Project Area may persist as intertidal unvegetated mudflats or shallow open water habitat for prolonged periods. However, research by Jaffe and others (2006) showed that the South Bay, and in particular the far South Bay, have historically been sediment-laden depositional environments. Thus, tidally-restored ponds were expected to accrete sediment and vegetation is expected to establish in the face of accelerated sea level rise.

More recent research has shown that the Bay's sediment-rich recent history may have been linked to elevated sediment loading from legacy mining activities in the Sierra foothills during the Gold Rush era. This research has indicated the SF Bay may be entering an erosional period, rather than depositional. Recognizing the importance of sediment availability in future restoration with or without sea-level rise, the SBSP Restoration Project Management Team continues to monitor and study sediment dynamics in San Francisco Bay as a whole and in the South Bay in particular. Results from these studies will continue to shape the decisions of where and how to undertake different types of habitat restoration. Beneficial reuse of dredged sediment which meets standards for use in wetland restoration is being considered by the Project as discussed further below. Beneficial reuse has been supported by many other San Francisco Bay regulatory agencies, local municipalities and organizations. Existing approved beneficial reuse sites have been shown to be effective in rapid establishment of vegetated tidal marsh, including within former pond E8A as part of Phase 1.

To guard against the risk of sediment accretion not keeping pace with sea-level rise and inhibiting marsh formation, the Preferred Alternative for Phase 2 at Eden Landing includes the beneficial reuse of dredge material (more details on that are in MCR 4, in Chapter 2, Alternatives, as well as Appendix E, which presents the preliminary designs for that component of the Phase 2 designs). That material would be used to raise the pond bottom elevations prior to breaching the levees and thus "jump-start" marsh formation by reducing the time needed to accrete sediment up to marsh plain elevation. Suitable dredge material could also be used to construct habitat transition zones, which would also reduce the time needed to truck in material from upland excavation projects as well as associated impacts from traffic, noise, and air quality emissions.

The SBSP Restoration Project Management Team continues to work with proponents of the Long-Term Management Strategy, the regulatory agencies around San Francisco Bay, private dredgers, and other stakeholders to develop regulatory, technical, and economic frameworks and mechanisms to make it easier and more efficient to deliver dredged material to the South Bay salt ponds where it can be beneficially reused. The SBSP Restoration Project Management Team is also collaborating with dirt brokers, construction companies, developers, foundations, and local governments to develop sources and supply chains for the continued delivery of excavated dirt from upland projects.

In summary, the SBSP Restoration Project team continues to monitor ongoing research and modeling about climate change and sea-level rise and will continue to plan, design, and manage for higher rates of sea-level rise than initially projected. However, it is important to note that the project, on its own, will largely be limited to maintaining the level of flood risk management already in place. The SBSP Restoration Project will continue to work with willing local project partners to improve the level of flood risk reduction to the extent practicable, while designing and implementing restoration features that will be successful in the presence of future sea-level rise. The SBSP Restoration Project Management Team would seek to accommodate accelerated sea level rise, as feasible and appropriate (e.g., by incorporating beneficial reuse), in order to maximize achievement of the project objectives. This approach depends on the concepts described and used throughout the project, including phased implementation, monitoring, and adaptive management, as described in the EIR and many planning documents.

2.1.4 MCR 4: Beneficial Reuse of Dredge Material, Including Placement Locations, Purpose, Timing, and Impacts

Several comment letters strongly advocated for the inclusion of beneficial reuse of dredge material in the Preferred Alternative, citing the long-standing efforts of many regulatory agencies and other groups to establish a regulatory context for such use as well as the ecological benefits of turning what would otherwise be a waste product into a valuable resource to conduct tidal marsh restoration in the face of sea-level rise. Many of those same commenters made similar points during the scoping portion of the NEPA and CEQA processes.

As noted in MCR 1 and explained in detail in Chapter 6, Preferred Alternative, of the Final EIR, the Preferred Alternative for Phase 2 at Eden Landing includes the potential beneficial reuse of dredge material to raise pond bottom elevations and to build habitat transition zones in several ponds. Dredge material would be placed in the Bay Ponds (E1, E2, E4, and E7) and may be used to raise portions of

Ponds E5 and E6, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of those ponds to tidal marsh.

Appendix E contains the design information for construction as well as operation and maintenance of the offloader and slurry pipe system to deliver dredge material to southern Eden Landing and then to place it in various locations there. Chapter 2 of the EIR explains how the material would be used in different ponds. The environmental impacts of the placement itself as well as the installation of the offloader and the slurry pipe and pump system are addressed throughout the resource sections in Chapter 3.

Some of the comments pointed out the different regulatory standards for cleanliness of material for use in foundations of features such as habitat transition zones versus its use as ecologically active cover material. Raising pond bottoms would occur ‘in the wet’ prior to larger connections with the Bay and surrounding waters and there may be an opportunity to apply foundation material in deeper regions of the ponds prior to application of cover material, depending on future permit requirements. The SBSP Restoration Project proponents are committed to complying with all regulatory standards regarding beneficial reuse of dredge material, including not only the quality requirements for cover or foundation material but also for impacts on the aquatic environment from offloader placement and operation, slurry pipe placement, and other details.

The SBSP Restoration Project proponents do note, however, that the construction of an offloader is expected to be by an external third party and that entity may be responsible for the permits and other regulatory clearances associated with its anchoring in the Bay. These permits may cover aspects such as noise, vibrations, air pollutant and greenhouse emissions, effects on Essential Fish Habitat under the Magnuson-Stevens Fisheries Conservation and Management Act, and others. A lease from the California State Lands Commission is also expected to be necessary. The SBSP Restoration Project proponents intend to be an active participant and partner in those regulatory processes, but the applicant for those permits may more appropriately be the owner/operator of the offloader.

Finally, the SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material. The project would benefit from the incorporation of dredge material but does not depend on it. The inclusion of beneficial reuse of dredge material in the Phase 2 Preferred Alternative at Eden Landing should not be interpreted as a commitment to wait indefinitely for that material to be supplied to the project site.

2.1.5 MCR 5: Fish Habitat Restoration

Many comment letters included a strong preference for restoration actions that would provide multiple connections between the ACFCC and the southern Eden Landing ponds to make that area suitable habitat for migrating salmonids and other native fish. More specifically, many commenters expressed a preference for the type of full tidal marsh restoration described as Alternative Eden B in the Draft EIS/R, while others voiced a similar preference but acknowledged that phased tidal restoration, such as that described in Alternative Eden D, would also bring advantages to salmonids and other native fish. In addition to stating this overall preference, some of the comment letters included recommendations for detailed design that would specifically increase the habitat value of the restoration area. These recommendations included placing large woody debris near pilot channels, constructing deeper pool areas, and adding multiple breach locations to improve habitat complexity, add refuge areas, and reduce efficiency of predation on native fish.

This MCR is intended to provide a broad explanation of the types of fish habitat restoration and enhancements intended for implementation as part of the Phase 2 Project at Eden Landing. Specific comments are addressed in the individual responses that follow, and MCR 2 addresses the different stages of design relative to the current level of design detail, as some of the suggestions may be more appropriately considered at a later design stage.

As explained in MCR 1, the Preferred Alternative includes elements that, from a fish habitat perspective, are much like those in Alternatives Eden B and D. The Bay Ponds would be opened to tidal flows from several breaches on the northern border with Old Alameda Creek (OAC) and to tidal flows from at least two large locations along the southern border with the ACFCC. There would be many interior breaches to connect the four Bay Ponds to each other, and several deeper channels would be excavated to allow for more complete drainage with the tides.

To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes the maximum number of connections outlined in the Draft: two connections to the Bay Ponds and one to the Southern Ponds. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. This breach however, would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail. The other two connections would be through culverts, as described in the Draft EIR.

As shown in Alternatives Eden B and D, the Southern Ponds would be opened to muted tidal flows through a culvert system, making them accessible to salmonids as well. Some of the comments did not support this action, however, because a single connection can be associated with higher predation rates than multiple connections. The SBSP Restoration Project team acknowledges this risk and intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If it does, those ponds could be operated more as true managed ponds and not left open to constant muted tidal flows. This is a shift that could also happen if ongoing monitoring shows that more managed ponds are needed for bird habitat. This is part of the adaptive management approach to the phased restoration of the Southern Ponds, as described for Alternative Eden D and in the Preferred Alternative.

Tidal restoration of the Bay Ponds would provide a large area of increased habitat value for salmonids and other native fish, whether as tidal lagoons in the early years or as marsh once it establishes. Either of these habitats are good nursery and forage habitat for juvenile fish, and this approach would satisfy most of the recommendations in the comments that concerned fish habitat restoration.

The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals unless monitoring and implementation of the Adaptive Management Plan provide a basis for determining that tidal restoration of Ponds E6 and E5 is most beneficial. Similarly, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory bird species during the spring and fall migration periods.

The Project cannot provide multiple unarmored breaches into the ACFCC as requested by many comments. First, because it is a federal flood control levee and uncontrolled openings would require a lengthy and difficult decertification of that levee under Section 408 of the Clean Water Act, which requires an Act of Congress to approve. A bridge structure over the levee would also be required to retain the segment of the Alameda Creek Regional Trail west of the breach, and armoring the levee breach would be required for the bridge.

As noted, however, multiple breaches (as well as extensive areas of levee lowering) are planned for the ponds' northern connection with the OAC. Those, combined with the internal levee breaches and breaches to the ACFCC, will provide ample connectivity to allow multiple points of egress from ponds and decrease potential predation. Some of the other ideas or suggestions (such as large woody debris and excavating deep pools in the pond interiors) will be considered during detailed design.

2.1.6 MCR 6: Public Access Bridge over the Alameda Creek Flood Control Channel

Many of the comments expressed support for a public access (pedestrian and bicycle) bridge over the ACFCC. This MCR is intended to provide additional context to the decision to include the bridge over the ACFCC in the Preferred Alternative. Although this component was included in only one of the action alternatives presented in the Draft EIS/R, the text of the Project Description in Chapter 2 notes that such a bridge is a modular component that could be included into any configuration of a Preferred Alternative or an eventually implemented project.

Note first that providing the Bay Trail spine through Eden Landing is one of the Project's goals, and it is included in the Phase 2 Preferred Alternative. In contrast, the bridge over the ACFCC was initially included in the 2007 Final EIS/R as a possible mitigation measure for one or more breaches through the northern levee of the ACFCC and the resultant loss of existing Alameda Creek Regional Trail to the west of that or those breaches. As currently envisioned, any openings in the ACFCC levee would be armored and bridged or through culverts that would allow continuation of the Alameda Creek Regional Trail, which removes the necessity to provide a public access bridge over the ACFCC as a mitigation measure. The bridge and culvert crossings are elements of the Project that contribute to the regional public access network.

As MCR 1 explains, that bridge over the ACFCC has been included in the Preferred Alternative. Completing the Final EIR processes would thus provide CEQA coverage for that component. However, it is important to acknowledge a few limits on what that inclusion means. First, neither the CDFW nor any of the other SBSP Restoration Project primary entities (the USFWS or the State Coastal Conservancy) owns the land on either side of the ACFCC. The Project therefore holds no unique ability or influence to obtain the necessary funding, permits, or property rights to actually build it. The construction of such a bridge, as with the completion of a portion of the proposed trail through southern Eden Landing, would require property acquisition at fair market value or a permanent public access easement. Therefore, the SBSP Restoration Project proponents/CDFW are unlikely to be the sole implementer of a public access bridge over the ACFCC on their own. As noted, building that bridge will require a substantial effort to acquire funding for and perform design, permitting, and construction, and to obtain necessary easements or property acquisition. This is very likely to need cooperation between a number of partner agencies to successfully implement. The SBSP Restoration Project has already begun contributing to that effort by providing CEQA coverage for a bridge over the ACFCC.

2.1.7 MCR 7: Public Access Trails (Routes, Elevations, and Parking)

One of the Project aspects most frequently commented on in the Draft EIS/R were the public access features in the Phase 2 alternatives. This topic included opinions on and questions about the three trail routes for the Bay Trail spine, trail connections to the Alameda Creek Regional Trail and others, the “community connection” trail segment to link with the neighboring communities in Union City, the lack of added parking facilities, and consistency with external regional plans such as the Bay Trail system’s plans. Many of these comments cannot be fully addressed by a MCR and are addressed in full in the individual responses below. However, this MCR (along with MCR 6, which is specific to the public access bridge over the ACFCC – no further discussion of that particular element is in this MCR) is intended to address several common aspects which those comments share and thereby provide a context for a more detailed answer.

Trail Route in the Preferred Alternative

Despite the misconception in some of the comment letters, all of the action alternatives in the Draft EIS/R included three different routes to complete the Bay Trail spine through all or most of southern Eden Landing, depending on property ownership or easement acquisition. Some of the details (such as elevation) would have differed depending on the alternative chosen, but the routes were in every alternative, as were one or more bridges over internal channels, a new viewing platform, and a commitment to maintaining existing access long the Alameda Creek Regional Trail, regardless of the approach taken to connecting the ponds to the ACFCC.

In the Preferred Alternative, Trail Route 1 was chosen as the alignment of the Bay Trail spine through southern Eden Landing. That was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Note that several public access advocates expressed a strong preference for Trail Route 1. In addition, Trail Route 1 would need permission from the Alameda County Flood Control and Water Conservation District (ACFCWCD) only for small portions of trails and bridge abutments that would cross over its property.

In contrast, Trail Route 2 would likely have needed acquisition of Cargill Pond 3C and its surrounding levees because a permanent easement for public access would not be obtained from Cargill because of their standing policy not to allow public access on their property owned in fee title. Neither acquisition or an easement is reasonably foreseeable at the present time, and so Trail Route 2 was dropped from the Preferred Alternative. Related to that, CDFW and the other agencies on the SBSP Restoration Project’s management team agree that spur trails to Turk Island and/or Cal Hill would be excellent public access features. Efforts continue to be made to acquire the parcel from Cargill. However, the Project cannot commit to providing the Bay Trail spine on a route that it does not currently have a likelihood of successfully acquiring in the near future. This is a major reason that Trail Route 2 was also not included in the Preferred Alternative. The selection of Trail Route 1 does not preclude access to Turk Island/Cal Hill in the future if that parcel is acquired at some point in the future.

Trail Route 3 and the associated "community connector" trail to Union City Boulevard were also removed from the Preferred Alternative because of the strong negative response to it in the comment letters. The original intentions of that route included providing more access for local residents and to provide a "fallback option" for the Bay Trail spine alignment if permission to build Trail Routes 1 or 2 were not able to be obtained from the ACFCWCD or Cargill, respectively. However, the comments received indicated that advocates of the Bay Trail spine and other public access agencies did not value that added option, which was almost unanimously viewed as unsatisfactory. Also, there were concerns from several commenters (including the City of Union City and the East Bay Regional Park District) that creating this community connector would draw more outside trail users to the area and encourage them to park on the existing streets because no new added parking facility was included in the Phase 2 alternatives. Since providing additional parking is not currently feasible (see more on that below), this community connector will not be included, though a community connector will be provided at the Veasy Street entrance.

Several comment letters expressed displeasure at the lack of a new trail all the way to San Francisco Bay (i.e., the lack of a "blue water experience") along OAC. Note that the existing Alameda Creek Regional Trail already provides that experience along Eden Landing's southern border. That trail will be retained in Phase 2 at some expense and difficulty to the restoration effort. A similar experience is available in northern Eden Landing along the spur trail built as part of Phase 1 of the Project. Because the outer, bay-facing levees along Pond E1 and E2 would be improved and because only controlled openings into southern Eden Landing are possible on its southern boundary with the ACFCC, much of the necessary tidal exchange into the project site would come from the north, through multiple breaches into OAC. This makes it infeasible to place a trail to the Bay along that alignment.

A shorter trail along OAC to the former site of the Alvarado Salt Works (with or without the bridge over the OAC to northern Eden Landing) was removed from the Preferred Alternative for similar reasons. Management flexibility would be retained for Ponds E5 and E6 and the northern levee on Pond E6 may be breached as part of the adaptive management approach to the phased restoration of those Ponds.

Levee-top Trail Elevations

In the Preferred Alternative, levee elevations would be increased to 12 feet, North American Vertical Datum of 1988 (NAVD88), along most levee sections improved that would support the public access trail. That design would provide full adaptive management capability while also addressing concerns that either (a) the levees would not be high enough to comply with agency guidance on sea-level rise or with design guidelines for the Bay Trail spine, or (b) permitting of a future elevation increase would be prohibitively difficult due to concerns regarding endangered species habitat. In the short- and medium-term, the Bay Trail spine levees would not necessarily need to be raised to elevation 12 feet because the mid-complex levee would be raised to keep fully tidal flows from the Bay Ponds away from those levees. But raising the levees as part of the Phase 2 action would preserve the adaptive management flexibility to adjust the way two of the Inland Ponds (E5 and E6) and the Southern Ponds (E1C, E2C, E4C, and E5C) are configured in the future. Those levees would also be built with wider bases to allow future increases in elevations without adding more fill in waters of the U.S. and State of California or otherwise affecting endangered species habitat.

Long-term maintenance of the trails and the levees under them are discussed in MCR 8.

Parking

A few letters in particular mentioned the lack of additional parking as part of the Phase 2 action. Note first that CDFW owns no suitable land on which to build a parking lot. As in other MCRs, however, both CDFW and the larger SBSP Restoration Project team would be willing to collaborate with other local agencies and provide assistance in adding parking in one of the surrounding areas.

Second, with the removal of the community connector along Westport Way and Trail Route 3 out to Union City Boulevard (see MCR 1), there is only one community connector trail, at Veasy Street and no new "trailhead" as part of Phase 2, and thus a reduced need for a new parking area. Instead, a Preferred Alternative that completes the Bay Trail spine through southern Eden Landing (per the plan summarized in MCR 1 and detailed in Chapter 6) would make this portion of the Bay Trail more of a through-trail used for longer hikes or bicycle rides to or from existing trailheads. Those existing trailheads with parking are to the north (the Phase 1 parking area at northern Eden Landing) and to the south (the Alameda Creek Regional Trail parking lot along the ACFCC). The elimination of Trail Route 3 unless added parking is feasible (as per City of Union City preference) leaves only one new community connector trail at Veasy Street. The resulting Phase 2 public access features would provide excellent connectivity to the existing regional trail network.

As part of ongoing operational activities at northern Eden Landing, CDFW could expand the parking area built in Phase 1 of the project to accommodate any additional demand by opening and improving the overflow parking area as appropriate. Currently the lot occasionally fills only for brief periods on certain weekend days, particularly during special events, and it is inefficient to build a parking lot to accommodate the peak demand instead of the typical demand. Weekend/peak demand will continue to be monitored at that site by CDFW, and the overflow area could be opened if significant new demand is supported.

2.1.8 MCR 8: Maintenance Responsibilities

Many of the comment letters on the Draft EIS/R contained questions about the ongoing maintenance of existing features at the ELER in general or of specific features of the SBSP Restoration Project Phase 2 action itself. These comments addressed the operations and maintenance of existing levees, proposed levee modifications, proposed trails and bridges, invasive species control, nuisance wildlife species control, and so on. Several commenters inquired about whether and how the SBSP Restoration Project team would be able to adequately maintain (or fund the maintenance of) levees and the public access trails on their crests in the face of the expected sea-level rise. The responses to the individual comments and the specific topics or points made in them are addressed in the individual responses that follow. However, there are some general points that should be made here to provide some additional context and background for those individual responses.

Note first that NEPA and CEQA are intended to inform the public about a proposed project and the potential adverse impacts on the environment from its implementation and operation. Project proponents are required to analyze and disclose these impacts on the environment from the project being proposed. However, NEPA and CEQA generally do not require demonstration of sufficient long-term funding. As with all publicly provided facilities, services, and potential experiences, agency funding levels can vary widely over time. No public agency can "guarantee" long-term funding (as was requested in several comment letters), as it does not unilaterally control its own budget or the levels of supplemental funding that may be obtained through grants or cost-sharing arrangements with outside partners.

CDFW is the landowner and manager of the ELER and is responsible for maintaining the levees, water control structures, and other features of the lands and waters at the site as needed for habitat purposes. CDFW performs or coordinates other maintenance activities such as removal of invasive plant species, performing bird counts or other biological surveys, and patrolling to see that public access features are being used in accordance with Reserve rules (e.g., that people stay on trails, respect rules about dogs, etc.). These types of management actions are things that CDFW would need to do regardless of the details of the Preferred Alternative or whether there was an SBSP Restoration Project at all.

The Project and CDFW are committed to the management of invasive vegetation species (including invasive Spartina and its hybrids, phragmites, and other species), controlling nuisance wildlife species, and maintaining appropriate human uses of the Reserve trails and public access features. They will do so through the continued support and collaboration with the Invasive Spartina Project and other efforts to control invasive species. As stated above, costs of this control are an important part of management, and both the Project and CDFW management will ensure that costs and funding are appropriately considered, estimated, and aggressively sought through various federal, state, regional and local funding sources.

Finally, regarding maintenance of public access features, the SBSP Restoration Project proponents and the managers of CDFW's ELER are committed to participating in the ongoing provision of wildlife-compatible public access. The SBSP Restoration Project's approach to doing that at ELER has been for the Project to design, plan, permit, and build the public access features using the funding it has assembled from various sources. Then, one or more local project partners would be actively sought to participate in funding and performing the long-term maintenance of trails, bridges, viewing platforms (including signage, benches, etc.), with CDFW's involvement. This approach was successfully implemented in Phase 1 of the Project in northern Eden Landing during, in which the Project team and CDFW provided several new trails, viewing platforms, a kayak launch, and a public access parking area for Americans with Disabilities Act (ADA) compliance. The East Bay Regional Park District provides ongoing operation of the Eden Landing Bay Trail spine and Staging Area, while CDFW provides maintenance of those newer Phase 1 features.

Other aspects of trails, and/or maintenance thereof, are discussed in these MCRs:

- MCR 1 describes the Preferred Alternative for Phase 2 at Eden Landing, which includes the Bay Trail through the southern half of Eden Landing (on a route that minimizes the amount of land acquisition or easement agreements necessary from outside parties necessary to complete it), reduces potential adverse impacts on sensitive wildlife species from use of public access features, and addresses as many of the goals or visions of plans such as the Association of Bay Area Governments' Bay Trail Plan as feasible to do while still maintaining existing levels of flood risk management while implementing Phase 2 tidal marsh restoration and retained or enhanced managed ponds.

- MCR 3 describes the plans for levee maintenance (and thus the maintenance of levee-top trails) in light of sea-level rise.

- MCR 6 describes the Project's intentions as they relate to the public access bridge over the ACFCC.

MCR 7 describes the trail alignment included in the Preferred Alternative (as well as the rationale and explanation for that choice), notes a change in the levee-top elevations of those trails, and also addresses some of the other details and limitations of the trail system through southern Eden Landing, as it is based on acquiring some other lands or easements/permissions.

2.2 Individual Comments and Responses

2.2.1 Federal and State Agencies

Comments from federal and state agencies and the responses to those comments are presented in this section.

Environmental Protection Agency (F-EPA)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

May 17, 2018

Brenda Buxton
Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, California 94612

Subject: Draft Environmental Impact Statement/Report (DEIS/EIR), South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve, Alameda County, California (EIS No. 20180053)

Dear Ms. Buxton:

F-EPA-1

The U.S. Environmental Protection Agency (EPA) has reviewed the above-referenced document pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and our NEPA review authority under Section 309 of the Clean Air Act. The Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) is tiered from the 2007 Programmatic EIS/EIR for the South Bay Salt Pond Restoration Project. EPA provided scoping comments for the DEIS to the U.S. Fish and Wildlife Service on July 19, 2016.

EPA fully supports the proposed restoration of salt ponds in the southern half of the Eden Landing Ecological Reserve. In addition to restoring habitat, the proposed project is expected to provide flood risk management and wildlife-oriented public access and recreation. Based on our review of the DEIS, we have rated the action alternatives as *Lack of Objections* (LO).

F-EPA-2

As recommended in EPA's scoping comments, the DEIS/EIR evaluates beneficial reuse of dredged material and includes such reuse in the design of Eden Landing Phase 2. According to DEIS/EIR, dredged material placement would account for a majority of the project's air emissions, which, although estimated to be below federal General Conformity de minimis thresholds, would exceed local significance thresholds for oxides of nitrogen (NOx). The DEIS/EIR states that mitigation for construction equipment requires the use of Tier 4 engines, which offer the highest emissions reductions, while the proposed mitigation for harborcraft is to meet, at a minimum, EPA Tier 2 marine engine emission standards. Because the air basin is in nonattainment for the ozone National Ambient Air Quality Standard (NAAQS), we suggest that the lead agencies encourage the use of marine vessels that meet the latest EPA exhaust emissions standards for marine compression-ignition engines (i.e., Tier 4 for Category 1 & 2 vessels, and Tier 3 for Category 3 vessels), if available, to further reduce air emissions.

F-EPA-3 EPA appreciates the opportunity to review this DEIS/EIR. When the Final EIS/EIR is released for public review, please send one electronic copy to the address above (mail code: ENF-4-2). If you have any questions, please contact me at (415) 972-3521, or contact Karen Vitulano, the lead reviewer for this project, at 415-947-4178 or vitulano.karen@epa.gov.

Sincerely,

Kathleen Martyn Goforth, Manager
Environmental Review Section

Enclosure: Summary of EPA Rating Definitions

cc: Jared Underwood, Refuge Manager, Don Edwards S.F. Bay National Wildlife Refuge
Gregg Erickson, CA Dept. of Fish and Wildlife Regional Manager, Bay Delta Region

2

Response to Environmental Protection Agency (F-EPA)

F-EPA-1

The project proponents appreciate your support of the project.

F-EPA-2

Project-level Mitigation Measure AQ-B has been updated in the Final EIR to encourage the use of marine vessels that meet the latest EPA exhaust emissions standards for marine compression-ignition engines (i.e., Tier 4 for Category 1 & 2 vessels, and Tier 3 for Category 3 vessels), unless such engines are unavailable.

F-EPA-3

Copies of the Final EIR will be provided as requested.

NOAA Fisheries (F-NMFS)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404-4731

June 4, 2018

Brenda Buxton
Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612

Re: Comments on Draft Environmental Impact Statement/Report for Phase 2 of the South Bay Salt Ponds Project at Eden Landing

Dear Ms. Buxton:

F-NMFS-1

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) comments on the California Department of Fish and Wildlife's (CDFW) and the U.S. Department of Fish and Wildlife Service's (FWS) Draft Environmental Impact Statement/Report (DEIS/R) for Phase 2 of the South Bay Salt Ponds (SBSP) Restoration Project at the Eden Landing Ecological Reserve. NMFS is submitting these comments for CDFW and FWS' consideration in the selection of the final Phase 2 Action Alternative for Eden Landing.

The Eden Landing Phase 2 project area is comprised of 11 ponds within the southern portion of the Eden Landing Ecological Reserve in the vicinity of the confluence of Alameda Creek and South San Francisco Bay, Alameda County, California. CDFW and FWS are considering the SBSP at Eden Landing as a means to restore and/or enhance 2,270 acres of tidal wetland habitat and managed ponds in the South San Francisco Bay, while simultaneously providing flood risk management and wildlife-oriented public access and recreation. The DEIS/R contains the No Action Alternative and three Action Alternatives. All three Action Alternatives aim to restore the existing ponds to either entirely tidal marsh or a mixture of tidal marsh and enhanced managed ponds. To date, a Preferred Alternative has not yet been selected for this proposed project, which will likely contain a combination of landscape and habitat features currently included in the Action Alternatives B, C, and D.

F-NMFS-2

Federally threatened Central California Coast (CCC) Distinct Population Segment (DPS) steelhead (*Oncorhynchus mykiss*) and threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*) occur in South San Francisco Bay and the Eden Landing Phase 2 project area. Additionally, designated critical habitat for both of these listed species occurs within the project area. The project area is also designated as Essential Fish Habitat (EFH) for various life stages of fish managed under the Pacific Coast Groundfish Fishery Management Plan (FMP), Coastal Pelagic Species FMP, and the Pacific Coast Salmon FMP, pursuant to section 305(b) of the Magnuson-Stevens Fisheries Conservation and Management Act (MSA).

Tidal marsh and channel habitat in the South Bay provide important habitat for CCC steelhead and sDPS green sturgeon. For steelhead, tidal marshes and sloughs provide rich foraging opportunities for juvenile steelhead prior to ocean entry, areas for acclimation of smolts to seawater, and serve as migration corridors to several South Bay steelhead spawning streams.

2

F-NMFS-2 (cont.)

Juvenile sDPS green sturgeon spend their first few years in the Delta and San Francisco Bay before entering the marine environment as subadults. Within tidal marshes and sloughs in the Bay, juvenile sturgeon are thought to be primarily opportunistic benthic foragers and feed on benthic crustaceans, particularly amphipods, shrimps, clams, annelid worms, crabs, and small fishes. For these listed species and EFH, the restoration of tidal marsh at Eden Landing is expected to increase aquatic productivity in adjacent tidal sloughs and channels and significantly enhance foraging opportunities in South San Francisco Bay.

Alternative Eden B proposes to restore the project area to tidal marsh in one stage by major levee alterations and improvements. Through the utilization of levee breaches, levee lowering, and pilot channel techniques, this alternative would maximize connectivity of tidal habitats with Alameda Creek and provide new foraging opportunities during high tide in developing tidal channel networks within the restored marshes. Increases in productivity are expected to expand the prey base available to native fish species including CCC steelhead, sDPS green sturgeon, and species managed under the Groundfish, Coastal Pelagic, and Salmon FMPs. The proposed addition of rootwads, habitat islands and mounds, and habitat transition zones are also expected to increase foraging and refuge opportunities for numerous fish species in the project area.

F-NMFS-3

Under Alternatives Eden C and D, the creation and continued operation of managed ponds in the project area has the potential to adversely affect native fish in South San Francisco Bay including steelhead, green sturgeon, and EFH for groundfish, coastal pelagics, and salmon. The effects of artificial tidal restriction through implementation of water control structures on ecosystem structure and function have been documented worldwide (Roman *et al.* 1984; Burdick *et al.* 1996; Roman *et al.* 2002; Raposa and Talley 2012). Impacts include loss of biodiversity and abundance of fish and invertebrates, proliferation of invasive non-native species, and prolonged periods of hypoxia or anoxia (Portnoy 1991; Daehler and Strong 1996; Zedler *et al.* 2001; Raposa and Roman 2003; Gedan *et al.* 2009). Water quality factors and shallow pond depths combine to affect aquatic systems by changing primary and secondary productivity, altering benthic and pelagic communities or harming or killing aquatic prey organisms, and changing biomass, and nutrient dynamics (Hall *et al.* 1978). Fish in the project area may be entrained from the South Bay, Alameda Creek and tidal sloughs into managed ponds where they will be exposed to degraded water quality conditions, increased risk of predation, and non-native species and reduction of prey resources, as observed in the Alviso Pond Complex (Hobbs *et al.* 2013; Lewis *et al.* 2016; Hobbs 2017). Hobbs *et al.* (2013) reports the managed ponds within the Alviso Complex exhibit disproportionately high numbers of non-native fish species and reduced prey resources for fish compared to tidal marsh habitat.

F-NMFS-4

For the above reasons, NMFS recommends CDFW and FWS select a final action alternative that maximizes the restoration of tidal marsh habitat and incorporates enhancement features such as habitat islands, large wood, and habitat transition zones. Detrital input from restored marshes is expected to increase benthic and pelagic productivity, potentially increasing the density of the invertebrate prey base available to various fish species in the South Bay. Important rearing and nursery areas for fish will be expanded and enhanced as tidal channel networks develop within restored marshes and increase the amount of foraging opportunities during high tide. Marsh restoration is also expected to benefit productivity on adjacent South Bay mudflat habitat. Crustaceans, polychaete worms, gastropod and bivalve mollusks, and other invertebrates live on

F-NMFS-4 (cont.)

or just below the surface of the mud (Harvey *et al.* 1977). Fish that move over the mudflats to feed on these invertebrates will benefit from the increased productivity.

F-NMFS-5

NMFS appreciates the opportunity to comment on the DEIS/R for Phase 2 Eden Landing and we look forward to working with CDFW and FWS as the project proceeds through environmental review and permitting. Please contact Brian Meux at (707) 575-1253, or brian.meux@noaa.gov, if you have questions regarding these comments.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

cc: Gregg Erickson, California Department of Fish and Wildlife, Napa, CA
Anne Morkill, U.S. Fish and Wildlife Service, Fremont, CA
John Bourgeois, California Coastal Conservancy, Oakland, CA
Copy to ARN File #151422WCR2018SR00116
Copy to Chron

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Response to NOAA Fisheries (F-NMFS)

F-NMFS-1

Your comments have been reviewed and considered during the formation of the Preferred Alternative and in preparation of the Final EIR.

F-NMFS-2

The project proponents agree that restoration of tidal marsh habitat and the inclusion of enhancement features such as rootwads, habitat islands and mounds, and habitat transition zones can benefit a wide range of aquatic species. As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 5, Fish Habitat Restoration, the Preferred Alternative includes many of the same elements as Alternative Eden B intended to maximize connectivity, provide new foraging opportunities, and increase productivity.

F-NMFS-3

Section 3.5.3 of the EIR acknowledges that managed ponds can provide adverse conditions for aquatic species due to poor productivity, low dissolved oxygen levels, and/or increased predation pressure, and with Alternatives Eden C and D, the Inland and Southern Ponds would continue to be operated as seasonal or managed ponds for some duration. Note that Alternatives Eden C and D would not create managed ponds in areas that currently have tidal habitat, but instead would restore some ponds (the Bay Ponds) to tidal habitat which would provide a large area of increased habitat value for salmonids and other native fish, improve conditions in southern Eden Landing, and provide good nursery and forage habitat for juvenile fish. Therefore, each of the action alternatives is expected to benefit, but not necessarily provide the same degree of benefits to, aquatic species.

F-NMFS-4

The Preferred Alternative is intended to maximize tidal marsh restoration while still balancing multiple restoration goals. As such, the Bay Ponds would be converted to tidal marsh in the initial phase of restoration under the Preferred Alternative. Several connections are planned for the ACFCC, with one of the connections between the Bay Ponds and the ACFCC no longer through large culverts, as initially described, but instead through a full breach. This breach would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail. The Southern Ponds would be opened to muted tidal flows through a culvert system, making them accessible to salmonids. However, because a single connection to the Southern Ponds could be associated with higher predation rates, this water control structure would be carefully monitored in the early years to evaluate the need for operational changes, consistent with an adaptive management approach.

As described in MCR 1, Selection of the Preferred Alternative, and MCR 5, Fish Habitat Restoration, the Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals unless monitoring and implementation of the Adaptive Management Plan provide a basis for determining that tidal restoration of Ponds E6 and E5 is most beneficial. Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods.

As noted, however, multiple breaches (as well as extensive areas of levee lowering) are planned for the Bay Ponds' northern connection with the OAC. Those, combined with the internal levee breaches and breaches to the ACFCC, will provide ample connectivity to allow multiple points of egress from these ponds and decrease potential predation. Enhancement features such as habitat islands and habitat transition zones are also included in the Preferred Alternative.

F-NMFS-5

Thank you for your comment letter.

California State Lands Commission (S-CSLC)

STATE OF CALIFORNIA EDMUND G. BROWN JR., *Governor*

CALIFORNIA STATE LANDS COMMISSION
100 Howe Avenue, Suite 100-South
Sacramento, CA 95825-8202

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Established in 1938

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June 5, 2018

File Ref: SCH #2016052051

Gregg Erickson
California Department of Fish and Wildlife, Region 3
7329 Silverado Trail
Napa, CA 94558

Brenda Buxton
Deputy Program Manager
California State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612

VIA REGULAR & ELECTRONIC MAIL (phase2comments@southbayrestoration.org)

Subject: Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve, Alameda County

Dear Mr. Erickson and Ms. Buxton:

S-CSLC-1

The California State Lands Commission (Commission) staff has reviewed the subject EIS/EIR for the South Bay Salt Pond (SBSP) Restoration Project (Project), Phase 2 at the Eden Landing Ecological Reserve (Reserve), which is being prepared by the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW), in coordination with the California State Coastal Conservancy (SCC). The CDFW, as the public agency who owns and manages the Eden Landing Ecological Reserve (proposed Project area), is the lead agency under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.), and the USFWS is the lead agency under the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et seq.). The Commission is a trustee agency for projects that could directly or indirectly affect State sovereign land and their accompanying Public Trust resources or uses. Additionally, since the Project involves work on State sovereign land, the Commission will act as a responsible agency.

Commission Jurisdiction and Public Trust Lands

S-CSLC-1 (cont.)

The Commission has jurisdiction and management authority over all ungranted tidelands, submerged lands, and the beds of navigable lakes and waterways. The Commission also has certain residual and review authority for tidelands and submerged lands legislatively granted in trust to local jurisdictions (Pub. Resources Code, §§ 6009, subd. (c); 6009.1; 6301; 6306). All tidelands and submerged lands, granted or ungranted, as well as navigable lakes and waterways, are subject to the protections of the common law Public Trust Doctrine.

As general background, the State of California acquired sovereign ownership of all tidelands and submerged lands and beds of navigable lakes and waterways upon its admission to the United States in 1850. The state holds these lands for the benefit of all people of the state for statewide Public Trust purposes, which include but are not limited to waterborne commerce, navigation, fisheries, water-related recreation, habitat preservation, and open space. On tidal waterways, the State's sovereign fee ownership extends landward to the mean high tide line (MHTL), except for areas of fill or artificial accretion or where the boundary has been fixed by agreement or a court. On navigable non-tidal waterways, including lakes, the state holds fee ownership of the bed of the waterway landward to the ordinary low-water mark and a Public Trust easement landward to the ordinary high-water mark, except where the boundary has been fixed by agreement or a court. Such boundaries may not be readily apparent from present day site inspections.

Based upon the information contained in the Draft EIS/EIR and a review of in-house records, Commission staff has determined that portions of the proposed Project will extend onto State owned sovereign land under the jurisdiction of the Commission. Figure ES-2 of the Draft EIS/EIR shows the Project area encompassing Old Alameda Creek (OAC) and extending into Alameda Creek Flood Control Channel (ACFCC)[1] and San Francisco Bay (Bay) waterward of the MHTL. These waterbodies are State owned sovereign land, as the Draft EIS/EIR correctly notes at page 1-20. The Draft EIS/EIR also notes that a lease from the Commission will be required for the bayward dredge material infrastructure and for pilot channel dredging. Other project improvements on State owned sovereign land will require a lease or other authorization from the Commission. Commission staff requests that the lead agencies contact George Asimakopoulos (see contact information below) to determine which Project components will require a lease and formal authorization from the Commission for the use of State sovereign land.

In addition, active Public Agency leases cover State sovereign land adjacent to or within the Project area. On April 23, 2014, the Commission authorized the issuance of Lease No. PRC 2380.9, General Lease – Public Agency Use to the Alameda County Flood Control and Water Conservation District, for the continued use, maintenance, and operation of flood control channels, ditches, waterway, conduits, channels, storm dikes,

[1] Commission staff name these water courses differently. What the Draft EIS/EIR calls "Old Alameda Creek," our maps and leases call "Alameda Creek Flood Control Channel." What the Draft EIS/EIR calls "Alameda Creek Flood Control Channel," our maps and leases call "Coyote Hills Slough." We note this in hopes of preventing confusion, and in this letter, we use the names from the Draft EIS/EIR.

Greg Erickson and Brenda Buxton Page 3 June 5, 2018

S-CSLC-1 (cont.)

embankments, and protective works in Old Alameda Creek. Lease No. PRC 5520, dated June 1, 1978, authorizes Alameda County to control a tidal flow gate near the far northeast corner of the Project area. These leases, though non-exclusive, may prohibit certain uses of the land.

These comments are made without prejudice to any future assertion of State ownership or public rights, should circumstances change, or should additional information come to our attention. In addition, these comments are not intended, nor should they be construed as, a waiver or limitation of any right, title, or interest of the State of California in any lands under its jurisdiction.

S-CSLC-2

Project Description

The objectives of the Project as explained in the Draft EIS/EIR are to restore or enhance 2,270 acres of tidal wetlands and managed pond habitats, while providing flood management and wildlife-oriented public access, in the South Bay of Alameda County. The Project is the second phase of the SBSP Restoration Project, which was analyzed in a 2007 Final Programmatic EIS/EIR. This Draft EIS/EIR provides a project-level analysis of Phase 2 and evaluates the potential environmental impacts of four Action Alternatives, including a No Action Alternative. From the Project Description, Commission staff understands that the Project would include the following proposed actions that have the potential to affect State sovereign land:

- Levee Lowering and Breaching in OAC. Portions of levees would be lowered and breached to introduce tidal flows to Bay Ponds. These levees would be lowered to mean higher high water to provide more frequent levee overtopping, help provide an equal/improved level of flood risk management relative to existing conditions and increase the hydraulic connectivity between channels and marshes.
- Water Control Structure Installation and Pilot Channel Excavation in OAC and the ACFCC and Fish Habitat/Passage Enhancements. Water control structures would be installed to manage tidal exchange and flows between the Project area and its connection points to OAC and ACFCC.
- Pilot Channel Excavation in OAC and the ACFCC. Pilot channels would be excavated to connect the levee breaches and lowering to the rest of the Bay Ponds and Inland Ponds.
- Fish Habitat Enhancements in the ACFCC. One pilot channel, paired with a water control structure, would be excavated to provide enhanced fish habitat. The channel would be sized, placed, and oriented to allow passage of anadromous steelhead and other native fish from the ACFCC into the large Bay Ponds, which are expected to be beneficial nursery habitat for anadromous and estuarine fish as restored tidal marsh.
- Pedestrian Bridge Construction Across the ACFCC. This bridge would be constructed over the ACFCC at Cal Hill. Construction methods may include cofferdams, foundation piles, cast-in-place concrete abutments, and placement of riprap scour protection.

- Placement of Root Wads and Logs in the Bay. Root wads and logs would be placed on the Bay side of Pond E2 to help trap sediment and form beach-like areas while providing some erosion protection.
- Temporary Construction of an Offloading Facility in the Bay. This facility would be less than 30,000-square-feet and located approximately 3 miles offshore in the deep-water channel of the Bay. The offloading facility would comprise a hydraulic offloader, landing barges, temporary mooring piles (30 piles, 18 to 36 inches in diameter), delivery vessels, a feed water system, and slurry pipeline.

S-CSLC-2 (cont.)

These components are included in various combinations in each Action Alternative and are intended to improve habitat complexity and allow for the appropriate management of the Reserve. As described in the Draft EIS/EIR, the lead agencies will identify an Environmentally Superior Alternative during the preparation of the Final EIS/EIR with consideration of public and agency comments on the Draft EIS/EIR.

Environmental Review

Commission staff requests that the USFWS and CDFW consider the following comments on the EIS/EIR to ensure that impacts to State sovereign land are adequately analyzed for the Commission's use of the certified EIS/EIR to support future lease approvals for the Project.

S-CSLC-3

General Comments

1. Mitigation Measures, Biological Opinion Conservation Measures/Conditions, Best Management Practices (BMPs), Project Features, and Deferred Mitigation: In the Draft EIS/EIR, there are references to mitigation measures adapted from the 2007 Final EIS/EIR, conservation measures/conditions from the Programmatic Biological Opinion (BO) or future BO, and BMPs to reduce Project-related impacts.

   In the Biological Resources section of the Draft EIS/EIR, for example, the analysis section discusses potentially significant impacts to biological resources. While Project activities may significantly affect these resources, the analysis concludes that impacts are Less Than Significant after mitigation measures required by BMPs or the BO. It is unclear whether these measures are required by the Programmatic BO or a future BO. The Draft EIS/EIR incorporates all program-level mitigation measures into the Project as Project features rather than mitigation measures. For Biological Resources, however, no program-level mitigation measures were implemented; instead all potential impacts were found to be Less Than Significant. This finding was based partly on Project features, such as seasonal work windows, surveys, and biological monitoring, which could be characterized as mitigation measures. Thus, it is unclear whether impacts are Less Than Significant or Less Than Significant with Mitigation and referring back to the Programmatic EIS/EIR does not clarify the analysis in all cases.

S-CSLC-4

   Please provide a table of all mitigation measures, project design features, BO measures/conditions, and BMPs and describe how each will be implemented, the

S-CSLC-4 (cont.)

specific impacts they apply to, and the document from which each measure originates (e.g., 2007 Programmatic EIS/EIR, Draft EIS/EIR, Programmatic BO). This table will help responsible agencies and stakeholders to identify this information for activities occurring within the Project area and respective jurisdictions. In order to avoid the improper deferral of mitigation, these measures should either be presented as a range of specific, feasible, enforceable obligations that may be required or as specific "performance standards which would mitigate the significant effect of the project and which may be accomplished in more than one specified way" (State CEQA Guidelines, §15126.4, subd. (a)).

S-CSLC-5

2. Alternative B – Root Wads and Logs: Alternative B includes the placement of root wads and logs on the Bay side of Pond E2 to help trap sediment and form beach-like areas, while providing some erosion protection. However, the Draft EIS/EIR does not describe how the root wads and logs would be anchored/integrated into the Bay side of Pond E2, or the potential ecological effects of trapping sediment and changing the Bay coastline. This information should be detailed in the EIS/EIR, with the potential environmental effects fully analyzed and disclosed in the appropriate environmental resource sections.

Biological Resources

S-CSLC-6

3. Underwater Noise Impacts: Impact 3.5-14 (pages 3.5-93 to -97) discusses the potential for Project-related impacts to estuarine fish inhabiting the Project area. While the Draft EIS/EIR states that underwater noise generated during Project construction may affect movement, foraging, and cause temporary threshold shifts in hearing ability, no underwater noise analysis is provided. Instead, the Draft EIS/EIR defers this analysis until project permitting. This also appears to be the case for Impact 3.5-17 (page 3.5-104 to -106), which identifies that underwater noise generated during Project construction may expose harbor seals to underwater noise above the National Marine Fisheries Service's established thresholds. Commission staff requests that an underwater noise analysis be conducted and included in the EIS/EIR, especially for pile driving activities, to provide responsible agencies and stakeholders with information regarding the potential for injurious and behavioral effects to estuarine fish and harbor seals, and whether the measures or proposed BMPs reduce impacts to Less Than Significant. Additionally, please include these measures or BMPs in a table, as described in Comment 1, above.

S-CSLC-7

4. Dewatering Impacts to Fish: The Biological Resources section does not specifically consider impacts from dewatering activities to steelhead and estuarine fish for the installation of water control structures. Commission staff recommends that the USFWS and CDFW analyze these impacts in the Draft EIS/EIR. In particular, please assess whether stranding may occur during dewatering, and determine if stranding would result in significant impacts. If dewatering activities create significant impacts, please provide mitigation that would avoid or reduce the impacts to the extent feasible. If impacts from dewatering are found to be significant, Commission staff recommends that the USFWS and CDFW consider expanding the discussion of fish rescue activities and use fish rescue and relocation as a mitigation measure.

S-CSLC-8

Recreation

5. Water-Based Recreation: Although water-based recreation is discussed in Section 3.6.1 of the Draft EIS/EIR, the analysis does not consider whether construction activities, including levee breaching, water control structure construction, and bridge construction, would impact water-based recreation in the Project area. Please analyze whether construction activities would create significant impacts to water-based recreation. If impacts are found to be significant, provide mitigation measures that would avoid or reduce impacts. Mitigation measures could include public notices at nearby boat launches regarding the construction schedule and public access impacts, and alternative areas for public access and recreation.

S-CSLC-9

Cultural Resources

6. Area of Potential Effects (APE): In Section 3.7, Cultural Resources, it is unclear if the APE includes areas of the Bay which would be utilized by the Project, especially considering the ground-disturbing work that would occur during pile driving to secure the offloading facility. Commission staff recommends that the offloading facility be included in the APE and for USFWS and CDFW to conduct a cultural resources search for the offshore Project area to determine whether cultural resources are present. If cultural resources are present, it should be determined whether the mitigation measures proposed would avoid potentially significant impacts, or if the offloading facility can be relocated to an area where such resources are not present.

S-CSLC-10

7. Submerged Resources: The EIS/EIR should evaluate potential impacts to submerged cultural resources in the Project area. The Commission maintains a shipwrecks database that can assist with this analysis. Commission staff requests that the USFWS and CDFW contact Staff Attorney Jamie Garrett (see contact information below) to obtain shipwrecks data from the database and Commission records for the Project site. The database includes known and potential vessels located on the state's tide and submerged lands; however, the locations of many shipwrecks remain unknown. Please note that any submerged archaeological site or submerged historic resource that has remained in state waters for more than 50 years is presumed to be significant. Due to this possibility, please add the following mitigation measure: "In the event cultural resources are discovered during any construction activities, Project personnel shall halt all activities in the immediate area and notify a qualified archaeologist to determine the appropriate course of action."

S-CSLC-11

8. Title to Resources: The EIS/EIR should also identify that the title to all abandoned shipwrecks, archaeological sites, and historic or cultural resources on or in the tide and submerged lands of California is vested in the state and under the jurisdiction of the Commission (Pub. Resources Code, § 6313). Commission staff requests that the USFWS and CDFW consult Staff Attorney Jamie Garrett should any cultural resources on state lands be discovered during construction of the proposed Project. In addition, Commission staff requests that the following statement be included in the EIS/EIR's Mitigation and Monitoring Program (MMP): "The final disposition of archaeological, historical, and paleontological resources recovered on state lands under the

S-CSLC-11 (cont.)

jurisdiction of the California State Lands Commission must be approved by the Commission."

Tribal Cultural Resources

S-CSLC-12

9. Tribal Engagement and Consideration of Tribal Cultural Resources: The Draft EIS/EIR lacks an analysis of Project impacts to Tribal cultural resources, in conformance with State CEQA Guidelines (see http://www.opr.ca.gov/ceqa/updates/ab-52/) and Assembly Bill (AB) 52 (Gatto; Stats. 2014, ch. 532). AB 52 provides procedural and substantive requirements for lead agency consultation with California Native American Tribes, consideration of effects on Tribal cultural resources (as defined in Pub. Resources Code, § 21074), and examples of mitigation measures to avoid or minimize impacts to these resources. Even if no Tribe has submitted a consultation notification request for the Project area, the USFWS and CDFW should:

   - Contact the Native American Heritage Commission to obtain a general list of interested Tribes for the Project area
   - Include the results of this inquiry within the EIS/EIR
   - Disclose and analyze potentially significant effects to Tribal Cultural Resources; and avoid impacts when feasible

   Since the Draft EIS/EIR does not disclose if notification or outreach to interested Tribes has occurred and does not document their response, Commission staff recommends that the USFWS and CDFW include this information in the EIS/EIR to maintain a clear record of their efforts to comply with AB 52.

Climate Change

S-CSLC-13

10. Sea-Level Rise: The State of California released the final "Safeguarding California: Reducing Climate Risk, an Update to the 2009 California Climate Adaptation Strategy" (Safeguarding Plan) on July 31, 2014, to provide policy guidance for state decision-makers as part of continuing efforts to prepare for climate risks. The Safeguarding Plan sets forth "actions needed" to safeguard ocean and coastal ecosystems and resources as part of its policy recommendations for state decision-makers.

    Commission staff believes the goals of the Project are consistent with the guidance and recommendations presented in the Safeguarding Plan, and that the restored habitat and creation of habitat transition zones will enhance the resilience of wetland habitat and local communities to sea-level rise; however, Commission staff suggests that additional detail be provided in the EIS/EIR that describes the sea-level rise projections used to inform the Project design, including the height of the levees and pedestrian bridges. It is not clear in the Project Description or subsequent resource analyses which projections are being used to ensure protection from and resilience to the effects of climate change and future sea-level rise. Please note that when

S-CSLC-14

    considering a lease application for the Project, Commission staff will:

Greg Erickson and Brenda Buxton Page 8 June 5, 2018

S-CSLC-14 (cont.)

- Request information from applicants concerning the potential effects of sea-level rise on their proposed projects
- If applicable, require applicants to indicate how they plan to address sea-level rise and what adaptation strategies are planned during the projected life of their projects
- Where appropriate, recommend project modifications that would eliminate or reduce potentially adverse impacts from sea-level rise, including adverse impacts on public access

S-CSLC-15

Additionally, the USFWS and CDFW should also consider developing a long-term monitoring program to track shoreline changes and monitor other climate change-related impacts (e.g., storms, high tides) on the improved levee system. The information gathered from such monitoring efforts could help identify triggers that might lead to future modifications of the levee system or additional adaptation efforts.

S-CSLC-16

Thank you for the opportunity to comment on the Draft EIS/EIR for the Project. As a responsible and trustee agency, the Commission will need to rely on the certified EIS/EIR for the issuance of any amended/new lease as specified above. Therefore, we request that you consider our comments prior to certification of the EIS/EIR.

Please send copies of future Project-related documents, including electronic copies of the certified EIS/EIR, MMP, Notice of Determination, CEQA Findings, and if applicable, Statement of Overriding Considerations when they become available. Please refer questions concerning environmental review to Kelly Keen, Environmental Scientist, at (916) 574-1938 or via email at kelly.keen@slc.ca.gov. For questions concerning archaeological or historic resources under Commission jurisdiction, please contact Staff Attorney Jamie Garrett, at (916) 574-0398 or via email at jamie.garrett@slc.ca.gov. For questions concerning Commission leasing jurisdiction, please contact George Asimakopoulos, Public Land Management Specialist, at (916) 574-0990 or via email at george.asimakopoulos@slc.ca.gov.

Sincerely,

Cy R. Oggins, Chief
Division of Environmental Planning
and Management

cc: Office of Planning and Research
K. Keen, Commission
J. Garrett, Commission
G. Asimakopoulos, Commission

Response to California State Lands Commission (S-CSLC)

S-CSLC-1

The project proponents appreciate the clear statement that a lease or other authorization from the CSLC will be needed for the project and the provision of the appropriate person (and contact information) with which to proceed with that process.

S-CSLC-2

This comment is a summary of portions of the project description. No response is required.

S-CSLC-3

The Final EIR includes a Mitigation Monitoring and Reporting Program (MMRP) table that summarizes environmental commitment for the project. As discussed in Chapter 2 of the EIR, program-level avoidance and minimization measures outlined in Section 2.3 of the EIR and the conservation measures outlined in the USFWS programmatic Biological Opinion for the SBSP Restoration Project are incorporated into the Phase 2 project design and would be implemented as part of the action alternatives. The environmental commitments specified in Chapter 2, Alternatives, are incorporated into the project design and as such are not project-level mitigation measures. In addition, ongoing monitoring specified in the Adaptive Management Plan is a program-level activity that would be implemented even in the absence of Phase 2 actions. (And as a point of clarification, there were no biological resource program-level mitigation measures in the 2007 Final EIS/R.) The MMRP table includes sections describing each of these types of environmental commitments. The significance determination in the resource chapters is based on the need for project-specific mitigation in addition to the environmental commitments described above.

Clarifying text is included in the Final EIR to indicate that the biological opinion referenced in Section 3.5 was the Programmatic biological opinion and not a future biological opinion specific to the Phase 2 project at Eden Landing. Additional clarifying details were also included regarding BMPs required during pile driving. The inclusion of this additional clarifying information in the Final EIR does not change the analysis or conclusions of the Draft EIS/R (since the information clarifies and amplifies the information provided in the Draft EIS/R).

S-CSLC-4

Much of the information requested above is provided in the MMRP table for the Final EIR. As discussed in the response to comment S-CSLC-3, the MMRP table includes project-level mitigation measures and additional sections describing each type of environmental commitment. Additional information regarding application to specific impacts is discussed in the resource chapters.

S-CSLC-5

Additional clarifying details are included in Chapter 2, Alternatives, regarding the rootwads and logs and associated environmental enhancement features included on Pond E2's bay-facing levee. Although there are range of potential options for how the rootwads and logs could be anchored (such as cabling to new boulders placed adjacent to the bay-facing levee), specific details regarding the anchoring is not available at the current level of design. Construction effects and potential long-term effects of the enhancement features have been considered in the environmental resource sections; specific reference to these features as rootwads are now included (e.g., in Section 3.5).

S-CSLC-6

The input parameters for an underwater noise analysis are dependent on the specific number and size of temporary mooring piles that would be driven to secure the offloading facility. An approximate range for the size of the offloading facility, the number of temporary mooring piles, and the diameter of the piles are provided in Section 2.2 of the EIR; however, underwater noise analysis would require a level of specificity that has yet to be developed. As discussed in MCR 2, Details of Designs, the project is based on a preliminary design, which is consistent with the level of design detail required for both CEQA and NEPA. Permitting and other regulatory processes generally require more detailed design with more refined estimates of (in this case) size, number, and composition of mooring piles, which would typically require designs ranging between 30 and 60 percent. As the designs proceed, the specific information will become available. With respect to a discussion of BMPs, please see response to comment S-CSLC-3.

S-CSLC-7

Additional clarifying details have been added to Section 3.5 to address this concern. That additional text indicates that temporary cofferdams would be used during installation of new water control structures. As previously indicated in the impact analysis for steelhead and estuarine fish, if fish rescue and/or relocation would be required during construction, these activities would be completed under an agency-approved plan to limit impacts. Stranding during dewatering activities would be avoided because fish would be removed or flushed out of the cofferdams prior to dewatering wherever such activities would occur.

S-CSLC-8

Clarifying text has been added in Section 3.6 of the Final EIR to indicate that, similar to the temporary closures of some parking areas or trails during construction, there would be brief restrictions on water-based recreation in some areas during some portions of construction (e.g., during the breach events themselves). These restrictions would be temporary and regular recreational use of waterways that allow these uses would resume shortly thereafter.

S-CSLC-9

As discussed in Section 3.7.3 of the EIR, cultural resources have not been identified in the deepwater channel of the Bay near the proposed location for the offloading facility. While there is a very low potential for encountering archaeological material within Bay mud, some isolated burials have been found in other areas of the Bay. If the pile driving activity is deep enough to extend below the Bay mud, then there is also some potential for encountering archaeological resources in the deeper strata (although no such sites have been found to date). The exact location for the offloading facility will be identified as the design proceeds. Geotechnical borings could provide information about the presence of cultural resources prior to pile driving and if those areas were found to have cultural resources, additional protection measures would be implemented as indicated in SBSP Mitigation Measure 3.8-1.

S-CSLC-10

As detailed in Section 2.3.2, SBSP Mitigation Measure 3.8-1 includes provisions for unanticipated finds, including but not limited to halting operations in the vicinity of the find and following appropriate contact procedures. Work would not resume in the vicinity of the find until a qualified professional archaeologist has had the opportunity to examine the find. Additional clarifying information has been included in Section 3.7.3 regarding the specific case of encountering shipwrecks.

S-CSLC-11

The SBSP Restoration Project will coordinate with the listed CSLC personnel as requested if cultural resources are discovered on state lands. Clarifying text has also been included in Section 3.7.2 of the Final EIR indicating that the title to abandoned shipwrecks, archaeological sites, and historic or cultural resources on or in the tide and submerged lands of California is vested in the State of California.

S-CSLC-12

Consistent with AB52 requirements, CDFW sent a request on April 10, 2017 to the Native American Heritage Commission (NAHC) for a sacred lands file search and a list of tribes that are culturally or traditionally affiliated with the geographic area associated with the SBSP Phase 2 project at ELER. CDFW received a list of Native American contacts from the NACH on April 11, 2017. Letters were then sent to the tribes identified on the list on April 21, 2017 along with background information, maps and contact information to determine if they wanted to consult on the project. No requests for consultation followed.

S-CSLC-13

MCR 3, Sea-Level Rise, provides a discussion of future sea-level rise projections that have been considered including the Ocean Protection Council's *State of California Sea-Level Rise Guidance 2018 Update*. Consistent with project goals and objectives, the intent of the project is to maintain or improve existing levels of flood risk management at adjacent and nearby properties. This project goal is one of the primary design objectives and will continue to be incorporated into the design as the project proceeds.

S-CSLC-14

This comment provides information regarding CSLC's review of a lease application. There are no specific comments therein.

S-CSLC-15

As per the Adaptive Management Plan, transects are evaluated in breached ponds and bathymetry and LiDAR (or Iconos satellite data and/or aerial photography and ground truthing) are performed periodically over a larger area of the South Bay to evaluate sediment dynamics and changes to subtidal shallows, channels, and mudflats. Monitoring triggers and potential management actions are identified and linked to these monitoring efforts.

S-CSLC-16

Copies of future SBSP Restoration Project-related documents will be provided to the individuals listed in the comment letter, as requested the CSLC.

2.2.2 Regional and Local Agencies

Comments from regional and local agencies and the responses to those comments are presented in this section.

Alameda County Flood Control and Water Conservation District (L-AFCD1)

Flood Control & Water Conservation DISTRICT

Daniel Woldesenbet, Ph.D., P.E., General Manager

399 Elmhurst Street • Hayward, CA 94544 • (510) 670-5480 • www.acgov.org/pwa

May 21, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612
Via email: phase2comments@southbayrestoration.org

Subject: Alameda County Flood Control & Water Conservation District, Review Comments on *Draft Environmental Impact Statement/Report, Phase 2, Eden Landing Ecological Reserve, April 2018*

Dear Ms. Buxton:

L-AFCD1-1

The Alameda County Flood Control & Water Conservation District (District) appreciates our longstanding and positive collaboration with the South Bay Salt Pond Restoration Project to develop a vibrant, healthy, accessible, and sustainable tidal marsh habitat, while maintaining or improving flood risk management. Several major District flood control facilities – including the Alameda Creek Flood Control Channel, Old Alameda Creek, and the J Ponds (Lines J-2, J-3, and associated pump stations) – are located within the Phase 2 Eden Landing Ecological Reserve footprint. These facilities provide flood risk management to people, neighborhoods, businesses, and infrastructure in the Cities of Hayward, Union City, and Fremont.

We congratulate you and the State Coastal Conservancy staff on this important milestone of publishing the *Draft Environmental Impact Statement/Report, Phase 2, Eden Landing Ecological Reserve*. In general, the District is fully supportive of the project goals and the project, provided that the inland community's flood risk is not negatively impacted and the District's flood control system in not compromised. To this end, the District respectfully submits the following comments on the alternatives outlined in the EIS/R.

L-AFCD1-2

1. The District has concerns over the terms flood risk and flood risk management as used in the document. Please provide further explanation of these terms and difference between the two terms, particularly as they pertain to the level of flood protection provided and maintained by the project.

1

L-AFCD1-3

2. Historic salt pond operation in the Eden Landing project area has resulted in the creation of a network of ponds and earthen berms which were used to control flow of water though the site. Although the main intent of these existing ponds, dikes, berm, and levees was not to provide inland flood protection, the overall nature and operation of this system did provide a baseline level of flood protection to inland properties, as evidenced by many years of observations supported by hydrologic modeling and analyses performed by the District. The planned restoration concept at Eden Landing involves modification of the existing system of berms and opening of the system to tidal inflow. Although the District does not expect the project to provide the level of flood protection ultimately required by FEMA, the project should, at a minimum, maintain the level of flood protection and associated flood risk that existed at the time of land acquisition by the State of California.

L-AFCD1-4

3. Section 1.2.4, Flood Risk Management states "*Recognizing that the changing hydrology in these areas requires the expertise and funding available from local flood protection agencies, the SBSP restoration Project's management team invited these agencies to join the planning team early in the process. The approach to managing flood risks with tidal restoration projects was to locate the projects in areas where they would not increase the existing flood risk; in addition, existing levees were to be improved to provide increased, if still limited, protection or to raise existing high-ground areas with fill. In areas where this approach was not sufficient, the project sought to work with local flood protection agencies to implement the appropriate measures to protect adjacent areas and allow for tidal and other habitat restoration.*"

The District appreciates SBSP Restoration Project's management team's ongoing efforts to collaborate with District staff to ensure that equivalent or greater flood protection to adjacent and nearby properties. Future collaboration will be necessary to ensure that the District can continue to fulfill its mission: "to support the public safety, health, and welfare of the residents and businesses of Alameda County by developing and maintaining functional and appropriate flood control systems." While the District appreciates the opportunity to be a partner in this important restoration project, the District does not have funding available to support improvements to the existing flood protection system necessitated by any impacts from increased flood risk caused by the project. This should be clearly stated in the document.

L-AFCD1-5

4. The District acknowledges that fully developed and healthy tidal marsh habitat can provide robust shoreline flood mitigation function and is generally preferred over the existing system of earthen berms and ponds which require ongoing management and maintenance. With this goal in mind, the District stresses the importance of ensuring that the baseline level of flood protection is maintained, at a minimum, during the interim period before full development of marsh features occurs and project completion. Acceptable interim flood protection measures need to be developed by the Project and agreed upon by the District and affected cities.

2

L-AFCD1-5 (cont.)

5. Alternative A offers a valuable baseline if existing conditions against which the performance of other alternatives can be measured. Regardless of which final alternative is selected, the de facto levels of coastal flood risk management provided to the adjacent inland communities must be maintained or improved upon.

L-AFCD1-6

6. Regarding Section 2.2.3, Paragraph 1, Sentence 4, "Outboard levees would be expected to be maintained as necessary (or repaired on failure)": the outboard levees are a vital – and perhaps the most important – flood risk management feature in the Eden Landing complex. The District requests that Sentence 3 be revised to state, "The outboard levees, outboard dikes, and levees around the ponds are high-priority levees to be maintained …", and that Sentence 4 be deleted.

L-AFCD1-7

7. Restoration is intended to be performed in a single stage of construction in Alternative B. The District is concerned that all system redundancies would be removed at once, thereby relying solely on the backside levee for flood risk management. The District does not consider this configuration as providing the de facto levels of coastal flood risk management.

L-AFCD1-8

8. The District's J Ponds are currently isolated from tidal action and serve as vital drainage detention facilities for District Lines J-2 (Patterson Creek) and J-3 and the associated J-2 and J-3 pump stations. The District strongly opposes any measures that open the J Ponds to tidal action that would increase flood risk due to a loss of storage capacity. The presence of a permanent mid-complex levee (as shown in Alternative C) would be an acceptable solution to keep the J Ponds isolated from downstream (west) tidal action. However, additional levee strengthening on the upstream (east) levees around the J Ponds would be needed to protect against damage caused by tidal action from Pond E6C.

L-AFCD1-9

9. The EIR includes a suggestion that portions of the outer levees around the Bay Ponds be lowered to MHHW (7 ft NAVC88) to provide more frequent levee overtopping and increase hydraulic connectivity between channels and marshes. The District has two comments on this feature: (1) Lowering the segments to MHHW will allow daily tidal water to enter the ponds only infrequently, and thereby may not satisfy the goals of tidal restoration. (2) The District is concerned that lowering the levees will eliminate maintenance vehicle access to the outboard levees and dikes along the Bay shoreline. Regardless of which alternative is selected and implemented, the outboard levees are a vital – and perhaps the most important – flood risk management feature in the Eden Landing complex. The outboard levees are subject to significant erosive wave action and will require long-term maintenance to protect the marshes, wetlands, and inland communities behind them. If portions of the existing outer levees are lowered, alternative vehicle access will be needed to ensure that the outboard levees can be adequately maintained.

L-AFCD1-10

10. The District opposes a "root wad" based outboard levee configuration, as shown in Alternative B, or any other configuration that is not designed to sustain long term exposure to wind and wave action and extreme tidal events. For adequate flood risk management, the outboard levee should be either maintained indefinitely or designed with cross-sectional width adequate to sustain and resist erosion, land subsidence, seismic ground shaking, and other potential damage.

L-AFCD1-11

11. The District may support the concept of breaching the ACFCC north levee to allow flow and connectivity between Alameda Creek and Ponds E2 and/or E4. There are many details to consider during design; the District has the following several conceptual comments at this stage: (1) Breaching the ACFCC channels would necessitate installation of a much stronger mid-complex levee to provide adequate flood risk management, rather than a temporary mid-complex levee, as shown in Alternative D. (2) Breaching the ACFCC levee would introduce large fluvial flows into Ponds E2, E4, E1, and E7. Potential flooding in Old Alameda Creek will need to be considered from this additional source of water. (3) The sizing of the breach opening will need to be optimized to allow adequate flow in and out, while allowing beneficial sediment flow and offering favorable fish passage habitat. (4) A bridge would need to be built across the breach to allow maintenance access to the outboard levee.

L-AFCD1-12

12. Breaching Old Alameda Creek (as shown in Alternatives B, C, and D) will allow both tidal and fluvial flooding into the adjacent ponds (Ponds E1, E7, and E6). Depending on the timing of surface water flow in combination with tidal action, the water levels in Ponds E5 and E6 may be higher than elevation 12 (the height of the proposed backside levee).

L-AFCD1-13

13. Any modifications to the drainage into and out of Old Alameda Creek from the pond modifications, from an ACFCC breach, and directly from the Bay should consider the timing of tidal flows (high tide) combined with fluvial high-water drainage scenarios to ensure that the creek does not flood at Eden Landing or upstream. A continuous simulation analyses, based on a reasonable record of data (10-year minimum) should be performed, rather than an assumed design discharge condition.

L-AFCD1-14

14. The District feels that the analyses of wave action on the outboard levee may have resulted in an underestimate of the erosive power and damage that could be caused by wind-driven waves. For example, the outboard levee at the Hayward Marsh, just north of Eden Landing, failed and a large portion of the marsh has been inundated. The suggestion (as shown in Alternative C and D) that the outboard levee serves only for "habitat separation and enhancement" is a moot point. As stated previously, the outboard levee must be designed for long term sustainability and flood protection, regardless of other beneficial uses.

L-AFCD1-14 (cont.)

Nevertheless, the District favors the improved outboard levee presented in Alternative D, which includes a habitat transition zone. This configuration most resembles the District's proposed "landmass" concept, which has been discussed and accepted by the District.

L-AFCD1-15

15. The temporary mid-complex levee, as shown in Alternative D, is directly adjacent to the Pond E5 and E6 pilot channel, and may be subject to higher erosive action than other levees. The District suggests that, if a temporary mid-complex levee is included in the final alternative, two conditions be met: (1) the temporary levee be engineered and constructed with enough integrity to withstand this erosion over the projected lifespan of the structure, and (2) the outboard levee continue to be maintained even after the Bay Ponds become established as a tidal marsh, to protect the restored wetlands from damage and thereby ensure adequate flood risk management.

L-AFCD1-16

16. All scenarios should be evaluated for current conditions and for reasonable projections of sea level rise in the San Francisco Bay. The District recommends that the project not rush to implement the "lowered levee" features, as the Eden Landing Pond complex may need to rely on higher levees as sea level rises.

The District plans to provide additional technical comments by the state's deadline (June 5, 2018). Please feel free to contact me (510-670-5553 or hank@acpwa.org) if you have any questions or need further clarification on our comments. We look forward to continuing to work together on this important project.

Sincerely,
Alameda County Flood Control & Water Conservation District

Hank Ackerman, PE
Flood Control Program Manager

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Response to Alameda County Flood Control and Water Conservation District (L-AFCD1)

L-AFCD1-1

The project proponents appreciate your support of the project.

L-AFCD1-2

As discussed in Section 1.2.4 of the EIR, the terminology used by the SBSP Restoration Project has changed from “flood protection” to “flood risk management” when describing forward-looking statements and actions that would be taken in the future to distinguish improvements to existing salt pond levees from improvements needed for FEMA-accredited levees designed specifically for flood protection. The term “flood risk” is used in a similar manner as in the 2007 Final EIS/R.

L-AFCD1-3

As discussed in Chapter 2 of the EIR, each of the action alternatives were developed to maintain or improve existing levels of flood risk management at adjacent and nearby properties as compared to existing conditions. Since land acquisitions in 1996 and 2003, CDFW has inspected their levees, identifying areas with potential erosion, and performed routine levee maintenance on an as needed basis. Such repairs have included re-armoring levee in Pond E10 and E2 in 2008 with large rock, rebuilding Pond E2’s water control structure in 2010 to address erosion beneath the structure within the headwalls, and re-armoring Pond E2’s levees in 2017 at four locations. As the landowner and manager of the ELER, CDFW would continue to maintain the levees, water control structures, and other features of the lands and waters at the site as needed for habitat purposes while maintaining (or improving) the level of flood protection and associated flood risk that existed at the time of land acquisition by the State.

L-AFCD1-4

There are no impacts from increased flood risk expected to be caused by the project. Consistent with project goals and objectives, the intent of the project is to maintain or improve existing levels of flood risk management at adjacent and nearby properties. This project goal is one of the primary design objectives and will continue to be incorporated into the design as the project proceeds. Water control structures, levee breaches, and other features described in the EIR are considered project elements, which would be funded in a similar manner as other project actions. The ACFCWCD’s request to include in the document a discussion of the ACFCWCD’s funding status is noted, and the inclusion of this comment in this appendix to the Final EIR satisfies that request.

L-AFCD1-5

As described in response to comment L-AFCD1-3, each of the action alternatives were developed to maintain or improve existing levels of flood risk management at adjacent and nearby properties. Preliminary hydrodynamic modeling provided in Appendix D of the EIR indicates that this objective would be met with proposed project improvements and existing pond bathymetry. As discussed in MCR 1, the Preferred Alternative also incorporates multiple levee improvements and habitat transition zones, providing redundancy in flood risk management.

L-AFCD1-6

The third sentence in this section was changed as requested but the fourth sentence was retained which indicates that the outboard levees would be maintained, as needed. As a further point of clarification, the existing outboard levees were not built as flood risk management features, but they do provide some measure of de facto flood risk management.

L-AFCD1-7

Each of the action alternatives, including Alternative Eden B, was developed to maintain or improve existing levels of flood risk management at adjacent and nearby properties. Levee improvements were proposed to ensure that the extent of landward flooding during the 100-year design event was no greater than existing conditions. As described in MCR 1, the Preferred Alternative incorporates levee improvements and habitat transitions zones at multiple locations (e.g., outboard, mid-complex, and backside levees), providing redundancy in the flood risk management. The Preferred Alternative is also phased, and second phase of construction would incorporate “lessons learned” from the initial phase of construction.

L-AFCD1-8

As discussed in MCR 1, the Preferred Alternative includes a mid-complex levee on the west of the J-ponds and improvements to the levee on the northern side of Ponds E1C, E5C, and E4C. Pond E6C would be a permanent managed pond providing seasonal habitat for western snowy plover; as such, it would not have tidal flows. This configuration would isolate the J-ponds from adjacent areas with tidal action. Furthermore, as shown in the draft alternatives, the Preferred Alternative includes a new water control structure in the southern portion of the J-ponds that would allow the ACFCWCD to passively drain their detention ponds. This water control structure does not exist currently and all J-pond drainage is limited to the existing water control structure upstream and the Alvarado Pump Station. Therefore, the Preferred Alternative and expected project implementation should improve the ACFCWCD’s ability to manage storm water detention.

L-AFCD1-9

Daily tides would enter the Bay Ponds through the levee breaches. Levee lowering will allow increased flow during the higher ranges of the tidal cycle and is intended to increase habitat complexity for fish and wildlife. Under the Preferred Alternative, the outboard levee would be improved and a habitat transition zone would be placed along the eastern edge of the levee, buffering the improved levee and providing additional protection to the restored ponds. Pond E1’s northern levee and Pond E2’s southern levee would be breached, preventing vehicle access along the top of levee beyond those locations. Areas west of unarmored levee breaches would be lowered because those areas would already have restricted access due to the unarmored breaches.

As discussed in response to comment L-AFCD1-3 and L-AFCD1-4, as the landowner and manager of the ELER, CDFW would continue to maintain the levees, water control structures, and other features of the lands and waters at the site as needed for habitat purposes. While land-based access would not be maintained due to breaches on the northern and southern levees to connect with stream channels (not on the outboard levee), marine access would a remain viable means of access for maintenance and occasional repairs, as needed.

L-AFCD1-10

Rootwads and other enhancement features on the bay-facing levee are intended to increase habitat complexity and to encourage formation of fringe wetlands by accelerating accretion near the structure; they are not intended to be a flood risk management feature. Mechanisms to anchor these features would be developed during detailed design, but would not use existing features, such as the surface rip-rap, in a manner that would damage the levee. As discussed in MCR 1, the Preferred Alternative incorporates levee improvements and a habitat transitions zone at the outboard levee at Pond E1 and E2.

L-AFCD1-11

MCR 1, Selection of the Preferred Alternative, identifies the components selected for the Preferred Alternative. Due to this input, the Preferred Alternative includes an improved mid-complex levee and an armored and bridged breach at the ACFCC. A bridge would not be needed across the breach to allow maintenance access to the outboard levee. While land-based access would not be maintained due to breaches on the northern and southern levees to connect with stream channels (not on the outboard levee), marine access would a remain viable means of access for maintenance, as needed.

L-AFCD1-12

Although there may be a combination of tide and creek flow that results in a water level in the ponds greater than 12 feet (for example, a 500-year tide is 12 feet; *San Francisco Bay Tidal Datums and Extreme Tides Study, 2016*), as discussed in the preliminary design hydrodynamic modeling report (Appendix D, Attachment 1), the design criteria of providing at a minimum the same level of tidal and fluvial flood protection as exists under current conditions was applied to flood scenarios with a combination of 10- and 100-year riverine and tidal events: the 100-year tide with 10-year riverine discharge from the OAC and ACFCC (coinciding tide and discharge peaks), and 10-year tide with 100-year riverine discharge from the OAC and ACFCC (coinciding tide and discharge peaks). These flood scenarios were chosen because at the time of the modeling these scenarios were recommended by the ACFCWCD. Also note that this approach is more conservative than recommended in the Alameda County Hydrology and Hydraulics Manual (2003) where for primary facilities the highest of the following scenarios is to be used:

- The FEMA 100-year water surface elevation; or
- The 5-year recurrence peak discharge combined with a 100-year tide elevation in the Bay; or
- The 15-year recurrence peak discharge with a MHHW elevation in the Bay.

As seen by the modeling results for the flood scenarios, water surface elevations on the Inland Ponds landside levee were found to be at 10 feet NAVD88 or less in each of the modeled scenarios.

L-AFCD1-13

See response to comment L-AFCD1-12 regarding the flood scenarios modeled for the preliminary design. Although a continuous simulation analysis would provide results for a wide variety of fluvial and tidal conditions that could be used to evaluate the performance of a flood control basin, it is highly unlikely to provide a combination of extreme events (such as the 100-year fluvial and 10-year tidal) which has been used here to model a conservative scenario for inland flooding.

L-AFCD1-14

As discussed in MCR 1, the Preferred Alternative includes three habitat transition zones in the project area: one located on the inside of the outboard levee, one on the west side of the mid-complex levee, and one on the west side of the backside levee. The habitat transition zone at the outboard levee would buffer the improved levee and provide additional protection to the restored ponds. See also response to comment L-AFCD1-4 regarding levee design. It should also be noted that the outboard levee at Cogswell Marsh on the Hayward Regional Shoreline did not fail; it was designed with the bayfront levee breached. Although a large portion of the marsh has been inundated and eroded, this was due to a potential design flaw, not a levee failure. At Eden Landing, no bayfront breach is proposed.

L-AFCD1-15

As discussed in MCR 1, the Preferred Alternative includes an improved mid-complex levee and a pilot channel connecting a control structure at the ACFCC and a levee breach at Pond E4. The potential for erosion from the pilot channel is being considered in the detailed design of the levee. The Preferred Alternative also includes an improved outboard levee with an adjacent habitat transition zone. The habitat transition zone would be placed along the eastern edge of Pond E2's outboard levee, providing de facto flood risk management. Maintenance access to the outboard levee would be limited, as trucks and other vehicles would not be able to access the outboard levee after breaching Pond E1's northern levee and Pond E2's southern levee. However, the outboard levee would be inspected and repaired by marine access as needed to protect habitat in the Bay Ponds from additional damage.

L-AFCD1-16

Appendix D of the EIR describes the hydrodynamic modeling associated with the preliminary design. The flood scenarios modeled are described in response to comment L-AFCD1-12. Results for near-future conditions indicate that flooding during the 100-year design events would be no greater than existing conditions. As discussed in MCR 3, Sea-Level Rise, and MCR 8, Maintenance Responsibilities, CDFW will maintain existing levels of flood risk management with implementation of the Preferred Alternative. Potential future impacts from long-term sea-level rise in San Francisco Bay are not project impacts for evaluation in the NEPA/CEQA document.

Alameda County Flood Control and Water Conservation District (L-AFCD2)

Flood Control & Water Conservation DISTRICT

Daniel Woldesenbet, Ph.D., P.E., General Manager

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June 5, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612
Via email: phase2comments@southbayrestoration.org

Subject: Alameda County Flood Control & Water Conservation District, Review Comments on *Draft Environmental Impact Statement/Report, Phase 2, Eden Landing Ecological Reserve, April 2018*

Dear Ms. Buxton:

L-AFCD2-1

The Alameda County Flood Control & Water Conservation District (District) is pleased to submit additional comments on the *Draft Environmental Impact Statement/Report, Phase 2, Eden Landing Ecological Reserve* in accordance with the California Environmental Quality Act (CEQA) process. In a letter dated May 21, 2018, the District previously provided comments in accordance with the National Environmental Policy Act (NEPA) process. Please consider this letter and our May 21 letter, together, to constitute our full set of comments.

Comments on the Alternatives

In our May 21 letter, the District offered general comments on various aspects or components of the proposed alternatives. The District is herewith providing an alternative-by-alternative summary of comments on each of the four alternatives, along with additional technical comments.

L-AFCD2-2

Alternative A: The EIR/S states that de facto levels of coastal flood risk management provided to the adjacent inland communities will be retained. The District is concerned that long-term coastal subsidence, particularly in Ponds E1 and E2, may jeopardize the current level of flood risk management provided by the existing marshlands. Higher water levels in the San Francisco Bay caused by sea level rise may exacerbate this problem. Therefore, in Alternative A, the future level of flood protection may not be adequate.

L-AFCD2-3

Regarding Section 2.2.3, Paragraph 1, Sentence 4, "*outboard levees would be expected to be maintained as necessary (or repaired on failure)*": the outboard levees are a vital – and perhaps

1

L-AFCD2-3 (cont.)

the most important – flood risk management feature in the Eden Landing complex. The District would prefer a more definitive statement that the outboard levees, which serve as the primary line of defense against wave action and flooding, be rigorously maintained and repaired to current conditions into the future. Therefore, the District requests that Sentence 3 be revised to state, "The outboard levees, outboard dikes, and levees around the ponds are high-priority levees to be maintained …", and that Sentence 4 be deleted.

L-AFCD2-4

Alternative B: Restoration is intended to be performed in a single stage of construction in Alternative B. The District is concerned that all system redundancies (including allowing the outboard levee to deteriorate, flooding all ponds at once, and lowering the levees along Ponds E1 and E1) would be removed at once, thereby relying solely on the backside levee for flood risk management. Although the backside levee would be raised of elevation 12 feet NAVD88, the backside levee itself is a non-engineered structure. Without redundancies, if the inboard levee failed, there would be no means to protect adjacent inland communities. The District, therefore, does not believe Alternative B provides de facto levels of coastal flood risk management, and the District is not in favor of Alternative B.

L-AFCD2-5

The District's J Ponds are currently isolated from tidal action and serve as vital drainage detention facilities for District Lines J-2 (Patterson Creek) and J-3 and the associated J-2 and J-3 pump stations. The District strongly opposes any measures that open the J Ponds to tidal action that would increase inland flood risk due to a loss of storage capacity. In Alternative B, the proposed breach into the south side of Pond E2 would allow tidal San Francisco Bay waters into District's J Ponds, which would adversely impact the District's flood control operations.

L-AFCD2-6

The EIR includes a suggestion that portions of the outer levees around the Bay Ponds (Ponds E1 and E2) be lowered to MHHW (7 ft NAVC88) to provide more frequent levee overtopping and increase hydraulic connectivity between channels and marshes. The District has two comments on this feature: (1) Lowering the segments to MHHW will allow daily tidal water to enter the ponds only infrequently, and thereby may not satisfy the goals of tidal restoration. (2) The District is concerned that lowering the levees will eliminate maintenance vehicle access to the outboard levees and dikes along the Bay shoreline.

Regardless of which alternative is selected and implemented, the outboard levees are a vital – and perhaps the most important – flood risk management feature in the Eden Landing complex. The outboard levees are subject to significant erosive wave action and will require long-term maintenance to protect the marshes, wetlands, and inland communities behind them. If portions of the existing outer levees are lowered, alternative vehicle access will be needed to ensure that the outboard levees can be adequately maintained.

L-AFCD2-7

The District opposes a "root wad" based outboard levee configuration, as shown in Alternative B, or any other configuration that is not engineered. For adequate flood risk management, the outboard levee must be a fully engineered structure, designed and maintained to resist erosion, land subsidence, earthquake shaking, and other potential damage.

L-AFCD2-8

Breaching Old Alameda Creek, as shown in Alternative B, will allow both tidal and fluvial flooding into the adjacent ponds (Ponds E1, E7, and E6). Depending on the timing of surface

2

L-AFCD2-8 (cont.)

water flow in combination with tidal action, the water levels in Ponds E5 and E6 may be higher than elevation 12 (the height of the proposed backside levee). The District would like the opportunity to review future hydraulic and hydrologic modeling and analyses.

L-AFCD2-9

Any modifications to the drainage into and out of Old Alameda Creek from the pond modifications, from an ACFCC breach, and directly from the Bay should consider the timing of tidal flows (high tide) combined with fluvial high-water drainage scenarios to ensure that the creek does not flood at Eden Landing or upstream. A continuous simulation analyses, based on a reasonable record of data (10-year minimum) should be performed, rather than an assumed design discharge condition.

L-AFCD2-10

The District supports the concept of breaching the ACFCC north levee to allow flow and connectivity between Alameda Creek and Ponds E2 and/or E4. There are many details to consider during design; the District has the following several conceptual comments at this stage: (1) Breaching the ACFCC channels would necessitate installation of a permanent mid-complex levee to provide adequate flood risk management, rather than a temporary mid-complex levee, as shown in Alternative D. (2) Breaching the ACFCC levee would introduce large fluvial flows into Ponds E2, E4, E1, and E7. Potential flooding in Old Alameda Creek will need to be considered from this additional source of water. (3) The sizing of the breach opening will need to be optimized to allow adequate flow in and out, while allowing beneficial sediment flow and offering favorable fish passage habitat. The water control structure shown and described in Alternative B (6-foot x 6-foot box culvert) will likely be too small. (4) A bridge would need to be built across the breach to allow maintenance access to the outboard levee.

L-AFCD2-11

Alternative C: The District feels that the EIR/S analyses of wave action on the outboard levee may have resulted in an underestimate of the erosive power and damage that could be caused by wind-driven waves. For example, the outboard levee at the Hayward Marsh, just north of Eden Landing, failed and a large portion of the marsh has been inundated. The suggestion (as stated in Alternative C) that the outboard levee serves only for "*habitat separation and enhancement*" and "*not necessarily for flood risk management*" is not acceptable to the District. A levee with the primary purpose of "*prevent[ing] scour and erosion of the restoring marsh in the Bay ponds behind it*" is not equivalent to the levee currently in-place; damage to the outboard levee would endanger the newly formed habitat and inland coastal communities. The outboard levee must be designed and maintained as fully engineered structure, regardless of function, to prevent damage to the levee itself and to the inland marshland and communities.

The mid-complex habitat transition zone shown in Alternative C may partially compensate for the increased flood risk to inland communities due to future sea level rise and tidal extremes; however, from a flood risk management perspective, Ponds E1 and E2 may still be at risk of future inundation if the outboard levee fails.

L-AFCD2-12

The District's J Ponds are currently isolated from tidal action and serve as vital drainage detention facilities for District Lines J-2 (Patterson Creek) and J-3 and the associated J-2 and J-3 pump stations. The District strongly opposes any measures that open the J Ponds to tidal action that would increase flood risk due to a loss of storage capacity. The presence of a permanent

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L-AFCD2-12 (cont.)

mid-complex levee (as shown in Alternative C) would be an acceptable solution to keep the J Ponds isolated from downstream (west) tidal action. Additional levee strengthening on the upstream (east) levees around the J Ponds would be needed to protect against damage caused by tidal action from Pond E6C. However, it appears that a breach is proposed between Pond E4 and the J Ponds, allowing tidal San Francisco Bay waters from Pond E4 into District's J Ponds, which would adversely impact the District's flood control operations.

L-AFCD2-13

Breaching Old Alameda Creek (as shown in Alternative C) will allow both tidal and fluvial flooding into the adjacent ponds (Ponds E1, E7, and E6). Depending on the timing of surface water flow in combination with tidal action, the water levels in Ponds E5 and E6 may be higher than elevation 12 (the height of the proposed backside levee). The District would like the opportunity to review future hydraulic and hydrologic modeling and analyses.

L-AFCD2-14

Any modifications to the drainage into and out of Old Alameda Creek from the pond modifications, from an ACFCC breach, and directly from the Bay should consider the timing of tidal flows (high tide) combined with fluvial high-water drainage scenarios to ensure that the creek does not flood at Eden Landing or upstream. A continuous simulation analyses, based on a reasonable record of data (10-year minimum) should be performed, rather than an assumed design discharge condition.

L-AFCD2-15

Alternative D: The District prefers Alternative D, as it appears to be the most plausible from a flood protection perspective. The District favors the improved outboard levee presented in Alternative D, which includes a habitat transition zone. This configuration most resembles the District's engineered "landmass" concept, which has been approved for other similar projects by FEMA for flood risk management purposes. However, the suggestion (as stated in Alternative D) that the outboard levee serves only for "*creating upland and transitional habitat, not flood risk management purposes*" is not acceptable to the District. The outboard levee must be designed and maintained as fully engineered structure, regardless of function, to prevent damage to the levee itself and to the inland marshland and communities.

L-AFCD2-16

The EIR includes a suggestion that portions of the outer levees around the Bay Ponds (Ponds E1 and E2) be lowered to MHHW (7 ft NAVC88) to provide more frequent levee overtopping and increase hydraulic connectivity between channels and marshes. The District has two comments on this feature: (1) Lowering the segments to MHHW will allow daily tidal water to enter the ponds only infrequently, and thereby may not satisfy the goals of tidal restoration. (2) The District is concerned that lowering the levees will eliminate maintenance vehicle access to the outboard levees and dikes along the Bay shoreline.

The outboard levees are a vital flood risk management feature in the Eden Landing complex. The outboard levees are subject to significant erosive wave action and will require long-term maintenance to protect the marshes, wetlands, and inland communities behind them. If portions of the existing Bay Pond levees are lowered, alternative vehicle access will be needed to ensure that the outboard levees can be adequately maintained.

L-AFCD2-17

Breaching Old Alameda Creek (as shown in Alternative D) will allow both tidal and fluvial flooding into the adjacent ponds (Ponds E1, E7, and E6). Depending on the timing of surface

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L-AFCD2-17 (cont.)

water flow in combination with tidal action, the water levels in Ponds E5 and E6 may be higher than elevation 12 (the height of the proposed backside levee). The District would like the opportunity to review future hydraulic and hydrologic modeling and analyses.

L-AFCD2-18

Any modifications to the drainage into and out of Old Alameda Creek from the pond modifications and directly from the Bay should consider the timing of tidal flows (high tide) combined with fluvial high-water drainage scenarios to ensure that the creek does not flood at Eden Landing or upstream. A continuous simulation analyses, based on a reasonable record of data (10-year minimum) should be performed, rather than an assumed design discharge condition.

L-AFCD2-19

The temporary mid-complex levee, as shown in Alternative D, is directly adjacent to the Pond E5 and E6 pilot channel, and may be subject to higher erosive action than other levees. The District suggests that, if a temporary mid-complex levee is included in the final alternative, two conditions be met: (1) the temporary levee be engineered and constructed with enough integrity to withstand this erosion over the projected lifespan of the structure, and (2) the outboard levee continue to be maintained even after the Bay Ponds become established as a tidal marsh, to protect the restored wetlands from damage and thereby ensure adequate flood risk management.

L-AFCD2-20

Technical Comments

1. The District does not agree with the representation of water levels and resulting flood impacts under the existing condition, which effectively establishes the baseline for which Project alternatives are compared relative to the ultimate level of flood protection provided. Because the range of tidal events that could affect Project impacts to existing flood control facilities has not yet been fully evaluated for the existing condition, comparisons to impacts of the proposed alternatives are also considered invalid.

2. In determining Project impacts to flood control, modeling and evaluation of extreme events only (i.e. 10-yr, 100-yr tidal and fluvial combinations) can effectively obscure Project impacts to newly tidally exposed areas from more frequent events, such as King Tides, that need to be mitigated. The Project must evaluate the impact of restoration alternatives under a wider range of tidal scenarios with no fluvial impacts to more fully understand Project impacts to flood control due to tides. This range of scenarios must include more frequent tidal events such as King Tides that occur several times annually and are not necessarily coincident with significant fluvial events.

L-AFCD2-21

3. The fluvial hydrographs for Old Alameda Creek (OAC) and Alameda Creek Flood Control Channel (ACFCC) should be consistent with District hydrology model results. For ACFCC, the design flood hydrograph used for evaluation of flood impacts must be consistent with the historic record for critical extreme flow events indicated by the gauge at Niles. The District does not believe that a single peak hydrograph such as that presented in Appendix D, Attachment 1, Figure 2.7 is representative of the critical flood hydrograph for Project evaluations of fluvial flood impacts.

L-AFCD2-22

4. As discussed in Appendix D, Attachment 1, Section 2.8, the design dimensions of restoration tidal channel and levee breach width sizes is based, in part, on empirical hydraulic geometries of historic marshes in San Francisco Bay, as published in *PWA et al. 2004*. We understand that *PWA, et. al., 2004* is based on historic tidal marsh geometry data from the entire San Francisco Bay. Results of this study are used to inform design dimensions for tidal channels and levee breaches. Project design of tidal channel dimensions and appropriate levee breach widths should be based on a more refined evaluation of historic tidal marsh conditions which reflect the south San Francisco Bay, including the Eden Landing site vicinity. Results of such a refined evaluation should be considered in recommended design dimensions for tidal channels and levee breach widths.

L-AFCD2-23

5. To have a more comprehensive understanding of potential Project impacts to flood control and to support establishment of appropriate design criteria for protective levee systems, the evaluation of each alternative should include consideration of the fully restored condition. At this time, the EIR only includes pre- and (immediate) post-project conditions and not the intended "fully restored condition." Furthermore, all scenarios should be evaluated for current conditions and for reasonable projections of sea level rise in the San Francisco Bay. The District recommends that the project not rush to implement the "lowered levee" features, as the Eden Landing Pond complex may need to rely on higher levees as sea level rises.

L-AFCD2-24

The District, as a Project partner and landowner that will be affected by the project, desires to work with SBSPRP in establishing realistic and acceptable baseline conditions for the level of flood protection provided by the existing system of ponds and associated berms and water control structures. Additionally, the District requests an opportunity to review and approve project design criteria, basis of design, and design plans and construction specifications related to flood control and flood risk management. This includes, but is not limited to, hydraulics and hydrology, seismicity and seismic hazards, civil and geotechnical design, and operation and maintenance and emergency action and repair plans.

Please feel free to contact me (510-670-5553 or hank@acpwa.org) if you have any questions or need further clarification on our comments. We look forward to continuing to work together on this important project.

Sincerely,
Alameda County Flood Control & Water Conservation District

Hank Ackerman, PE
Flood Control Program Manager

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Response to Alameda County Flood Control and Water Conservation District (L-AFCD2)

L-AFCD2-1

See the response to comments L-AFCD1-1 through L-AFCD1-16 for responses to the previously submitted comments.

L-AFCD2-2

Section 3.2.3 of the EIR evaluates the increased risk of flooding that would occur as a result of maintaining the ponds at southern Eden Landing in accordance with existing Reserve management documents and practices. Activities such as maintaining levees or operating seasonal ponds would not cause coastal subsidence or sea-level rise to be worse. MCR 3, Sea-Level Rise, and MCR 8, Maintenance Responsibilities, discuss the limits of CDFW's flood management responsibilities. For the No Action Alternative (Alternative Eden A), the existing level of flood risk management when acquired by the State would be maintained. We acknowledge that existing conditions may not be adequate for future conditions.

L-AFCD2-3

See response to comment L-AFCD1-6. The third sentence in this section was changed as requested but the fourth sentence was retained as this sentence also indicates that the outboard levees would be maintained as needed. As a further point of clarification, the existing outboard levees were not built as flood risk management features, but they do provide some measure of de facto flood risk management.

L-AFCD2-4

See response to comment L-AFCD1-7. Alternative Eden B also includes a habitat transition zone that would be placed along the western edge of the backside levee, which would buffer the improved levee and reduce the potential for levee failure. The backside levee in Alternative Eden B would be an engineered structure (improvements as per stamped engineering design drawings), but it would not be a FEMA-accredited levee designed specifically for flood protection.

L-AFCD2-5

See response to comment L-AFCD1-8. As discussed in the preliminary design hydrodynamic modeling report (Appendix D, Attachment 1), the modeled flood scenarios indicate that water from the ACFCC (in the 10-year tide and 100-year fluvial discharge scenario) or from the Bay (in the 100-year tide and 10-year fluvial discharge scenario) is expected to flow into the J-ponds under existing conditions. This indicates that it is not the breach that allows tidal flow into the J-ponds, but instead this is due to the extreme tides or fluvial discharge and the low topography. In Alternative Eden B, some of the water from the ACFCC (in the 10-year tide and 100-year fluvial discharge scenario) would instead flow through the breach in Pond E2 and out towards OAC via the lowered levees on Pond E1. Water surface elevations in the J-ponds in Alternative Eden B are expected to be equal to or less than existing conditions for these modeled flood scenarios.

L-AFCD2-6

See response to comment L-AFCD1-9.

L-AFCD2-7

See response to comment L-AFCD1-10 and L-AFCD1-5.

L-AFCD2-8

See response to comment L-AFCD1-11 and L-AFCD1-12. The SBSP Restoration Project proponents will continue to coordinate with the ACFCWCD during later stages of modeling and design.

L-AFCD2-9

See response to comment L-AFCD1-12 and L-AFCD1-13.

L-AFCD2-10

See response to comment L-AFCD1-11.

L-AFCD2-11

See response to comment L-AFCD1-14. Note that the levees improved for habitat separation and the levees improved for flood risk management in Alternative Eden C would be raised to the same minimum elevation and management and repair of those levees would be similar. In the Preferred Alternative, the outboard levee, the mid-complex levee, and the backside levee would all be improved, and with the inclusion of the habitat transition zones, each of these levees would serve multiple purposes including flood risk management and habitat enhancement. See also MCR 3, Sea-Level Rise, and MCR 8, Maintenance Responsibilities, regarding sea-level rise.

L-AFCD2-12

See response to comments L-AFCD1-8 and L-AFCD2-5. In Alternative Eden C, the breach at Pond E4 levee that connects the pilot channel to pond is located west of the mid-complex levee. It is not a breach through the mid-complex levee connecting Pond E4 to the J-ponds.

L-AFCD2-13

In Alternative Eden C, a water control structure would connect OAC to Pond E6 and another water control structure would connect Pond E7 to Pond E5. In addition, the Inland Ponds would be permanent managed ponds. See response to comment L-AFCD1-12 and L-AFCD2-5 for a discussion of the modeled flood scenarios. Water levels in Ponds E5 and E6 under Alternative Eden C are expected to remain relatively low due to the mid-complex levee.

L-AFCD2-14

See response to comment L-AFCD1-12 and L-AFCD1-13.

L-AFCD2-15

See response to comments L-AFCD1-14 and L-AFCD2-11.

L-AFCD2-16

See response to comment L-AFCD1-9.

L-AFCD2-17

In Alternative Eden D, a water control structure would connect OAC to Pond E6. See response to comment L-AFCD1-12 and L-AFCD2-5 for a discussion of the modeled flood scenarios. Water levels in Ponds E5 and E6 under Alternative Eden C are expected to remain relatively low during interim conditions due to the mid-complex levee and continue to be at or below 10 feet NAVD88 when breached. As was the case during the development of the preliminary design, the ACFCWCD would be given the opportunity to review future hydraulic and hydrologic modeling and analyses, if conducted to support implementation of the Preferred Alternative.

L-AFCD2-18

See response to comment L-AFCD1-12 and L-AFCD1-13.

L-AFCD2-19

See response to comment L-AFCD1-15.

L-AFCD2-20

See response to comment L-AFCD1-12 for a description of the flood scenarios evaluated in the preliminary design and why those particular scenarios were selected. A typical tide was also evaluated during the preliminary design to confirm that the restoration features would create adequate filling and draining of the ponds during tidal cycles. No flood impacts were found under the typical tide scenario. The flood and tide modeling scenarios provide a range of events that "bookend" the potential combinations of fluvial and tidal flows that would be experienced under existing conditions and with the action alternatives. Although other modeling scenarios can be investigated, this range of potential outcomes provided the necessary information needed to evaluate the extent of inland flooding at nearby communities in the EIR.

As discussed in response to comment L-AFCD2-5, the modeled flood scenarios indicate that water from the ACFCC or from the Bay can flow into the J-ponds under existing conditions reducing the amount of flood storage that can be provided by the J-ponds. As discussed in MCR 1 and response to comment L-AFCD1-8, the Preferred Alternative includes a mid-complex levee on the west of the J-ponds and improvements to the levee on the northern side of Ponds E1C, E5C, and E4C to isolate the J-ponds from adjacent areas with tidal action.

Hydrodynamic modeling will be used as needed to support later stages of design and the SBSP Restoration Project proponents will coordinate with the ACFCWCD during this process. Specific topics evaluated during detailed design would include issues such as potential scour from the pilot channel located west of the mid-complex levee, which may necessitate additional bank protection at the mid-complex levee toe.

L-AFCD2-21

As discussed in the preliminary design hydrodynamic modeling report (Appendix D, Attachment 1), the hydrographs for the 10- and 100-year discharge events from OAC and ACFCC were selected to be consistent with contemporary modeling efforts for the ACFCC that were being performed for the ACFCWCD. Hydrodynamic modeling will be used to support later stages of design as needed and the SBSP Restoration Project proponents will coordinate with the ACFCWCD during this process.

Also note that a single peak hydrograph is consistent with the 24-hour design storm in the 2018 Alameda County Hydrology and Hydraulics manual.

L-AFCD2-22

The suggested refinement will be considered during detailed design.

L-AFCD2-23

With the exception of Alternative Eden D, which includes a temporary mid-complex levee, the levees included in the action alternative would remain in place during the fully restored condition. In addition and as acknowledged by the ACFCWCD in comment L-AFCD1-5, a fully developed and healthy tidal marsh habitat is expected to provide a robust shoreline flood mitigation function. As such, the de facto flood risk management provided by the project is expected to be maintained or improve rather than decrease in the fully restored condition assuming existing tidal elevations and fluvial flows. MCR 3, Sea-Level Rise, and MCR 8, Maintenance Responsibilities, discuss the limits of CDFW's flood management responsibilities. Potential future impacts from long-term sea-level rise in San Francisco Bay are not project impacts for evaluation in a NEPA/CEQA document.

L-AFCD2-24

The SBSP Restoration Project proponents will continue to coordinate with the ACFCWCD during later stages of design.

Alameda County Flood Control and Water Conservation District (L-AFCD3)

From: Attiogbe, Kwablah
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Comments Phase 2 Eden Landing Draft Environmental Impact Statement/Report
Date: Tuesday, June 05, 2018 5:26:08 PM

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612

L-AFCD3-1

The Alameda County Flood Control and Water Conservation District (District) reviewed portions of the Phase 2 Eden Landing Draft Environmental Impact Statement/Report and have the following comments. The review period is inadequate to allow thorough examination of the document. The review period should be extended several more weeks.

L-AFCD3-2

- There is inadequate discussion on the impacts of the project on several Flood Control District properties, including the J Ponds and the portions identified on Figure 2-6 as Alameda County Marsh. The District requests the Restoration Project to coordinate with the District prior to any work that would adversely affect it properties.

L-AFCD3-3

- The landfill identified as County owned on page 2-9 is an error. This is a private property.

L-AFCD3-4

- The County of Alameda and the Alameda County Flood Control District are two different entities. The Alameda County Flood Control District owns all the properties identified as Alameda County's. Please correct this error.

Thank you for the opportunity to comment

Kwablah Attiogbe
Alameda County Public Works Agency
Alameda County Flood Control & Water Conservation District
399 Elmhurst St
Hayward Ca 94544
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You received this message because you are subscribed to the Google Groups "Phase 2 Comments" group.
To unsubscribe from this group and stop receiving emails from it, send an email to phase2comments+unsubscribe@southbayrestoration.org.

Response to Alameda County Flood Control and Water Conservation District (L-AFCD3)

L-AFCD3-1

A 45 to 60 day public review period for the Draft EIS/R is consistent with NEPA and CEQA guidelines.

L-AFCD3-2

The SBSP Restoration Project proponents will continue to coordinate with the ACFCWCD during later stages of design and construction. See response to comment L-AFCD2-5 (and Appendix D, Attachment 1) regarding the hydrodynamic modeling results and the potential effects of the opening in the ACFCC, the pilot channel, and the levee breach in Pond E2 on the nearby high marsh and J-ponds. See also response to comment L-AFCD1-8 for a discussion of Preferred Alternative and its improvements at and near the J-ponds. Implementation of the Preferred Alternative is not expected to adversely affect ACFCWCD properties and may improve stormwater management.

L-AFCD3-3

Figure 2-9 indicates that the landfill is on a private parcel.

L-AFCD3-4

Figure 2-9 was revised in the Final EIR to indicate that the ACFCC, OAC, and the J-ponds are owned by the ACFCWCD, and not the County.

Alameda County Mosquito Abatement District (L-ACMAD)

23187 Connecticut Street
Hayward, CA 94545

T: (510) 783-7744
F: (510) 783-3903

acmad@mosquitoes.org

June 5, 2018

Brenda Buxton
Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612-1401

Subject: Comments regarding Phase 2, Eden Landing Ecological Reserve Draft EIS & EIR

Dear Ms. Buxton:

L-ACMAD-1

The Alameda County Mosquito Abatement District appreciates the opportunity to comment on the Phase 2, Eden Landing Ecological Reserve Draft Environmental Impact Report. As a public health organization responsible for protecting the residents of Alameda County from mosquitoes, we encourage the reduction of any mosquito breeding habitat. Please see the comments below organized by the sections in which they are found.

Section 2.2.2 Overview of Eden Landing Phase 2 Project Alternatives, Alternative Eden D (p. 2-16) – This section states Eden D would have a temporary mid-complex levee that would eventually be used for habitat enhancement, including transition zones. Once this is turned into a transition zone there needs to be access for mosquito inspections and treatments.

L-ACMAD-2

Section 2.2.4 Alternative Eden B, Habitat Transition Zones (p. 2-18) – Habitat transition zones are defined as having a slope as shallow as 30:1 (h:v), but they could be designed and built to be steeper... Steeper slopes are recommended to minimize they potential for standing water which can collect in depressions as the transition zone settles.

L-ACMAD-3

Section 2.2.4 Alternative Eden B, Habitat Transition Zones (p. 2-19) – This section clearly states that the maintenance of the habitat transition zones is generally limited to removal of invasive plants and mosquito abatement activities, as discussed in Section 2.2.10, Operation and Maintenance, however there is no mention of mosquito abatement activities in Section 2.2.10.

L-ACMAD-4

Section 2.2.6 Alternative Eden D, Habitat Transition Zones (p. 2-33) – In this alternative, the habitat transition zone is located on the east (internal) side of the westernmost Bay-facing levee of Pond E2. There are no land access options to the habitat transition zone for mosquito inspections and treatments. Therefore, Alternative Eden D is the least preferred alternative as it has the potential to have a significantly impact on public health and vector management.

www.mosquitoes.org Alameda County Mosquito Abatement District @AlamedaMosquito
An Independent Special District Protecting Public Health Since 1930

ACMAD
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L-ACMAD-5 **Section 2.2.7 Construction Methods, Individual Components, Levee improvements, Habitat transition zones (p. 2-43)** – Once again it states the habitat transition zones would be constructed by placing material at roughly 30:1 (h:v) side slopes. Steeper slopes are recommended to minimize they potential for standing water which can collect in depressions as the transition zone settles.

L-ACMAD-6 **Section 2.2.10 Operations and Maintenance (p. 2-55)** – In the fifth paragraph we recommend including mosquito abatement in the list of maintenance activities for habitat transition zones like stated in section 2.2.4, p. 2-18.

L-ACMAD-7 **Section 2.2.10 Operations and Maintenance (p. 2-55)** – In the seventh paragraph it states that ponds open to full tidal flows need little to know operations or maintenance beyond the control of invasive plants. We recommend expanding the maintenance activities to include minor regrading and the creation of minor ditches in areas where tidal waters settle and do not fully flush in and out.

L-ACMAD-8 **Section 3.9.1 Physical Setting, Project Setting (p. 3.9-2)** – In the second paragraph, the last word, mosquitoes is misspelled.

Table 3.9.1 Mosquito Species Found in the SBSP Restoration Project Eden Landing Phase 2 Area (p. 3.9-2) – Remove *Aedes melanimon* and *Aedes taeniorhynchus* from this table.

Section 3.9.2 Regulatory Setting (p. 3.9-4) – In the last paragraph of this section change California Department of Health Services to California Department of Public Health.

L-ACMAD-9 **Section 3.9.3 Environmental Impacts and Mitigation Measures, Project-Level Evaluation, *Phase2 Impact 3.9-1:* Potential increase in mosquito populations. *Alternative Eden D* (p. 3.9-6 and p. 3.9-7)** – In the Alternative Eden D, upland areas (e.g., habitat transition zones) would be constructed on the east (internal) side of the westernmost Bay-facing levee of Pond E2. Upland areas have the potential to increase the amount of mosquito-breeding habitat if they are not designed, constructed, and maintained so that water does not pool in them. The location of this habitat transition zone does not allow for land access for mosquito inspection and control. Also, Eden D would have a temporary mid-complex levee that would eventually be used for habitat enhancement, including transition zones. Once this is turned into a transition zone there needs to be access for mosquito inspections and treatments. Inaccessible habitat transition zones have the potential to increase mosquito populations and the need for mosquito management activities. This makes the impact from this alternative potentially significant.

L-ACMAD-10 **General Comments:**
Access – Access to all areas holding water needs to have a route with all-weather paths that will accommodate vehicle travel.

L-ACMAD-11 **Fully Tidal Salt Marsh, Muted Tidal Marsh, –** These habitats support a variety of mosquito species which are aggressive day-biting mosquitoes that disperse long distances. Access needs to be provided to these areas for mosquito inspection and treatments. Permission for off-road vehicle use (Argos, ATVs) is needed for inspections and treatments in large areas. Minimizing areas that hold water and the amount of time that they hold water will reduce the need for mosquito control. Regrading and the creation of minor ditches which tie into the pilot ditches may be needed.

2

ACMAD
Page 3 of 3

L-ACMAD-12 **Habitat Transition Zones –** These habitats support a variety of mosquito species including *Culex tarsalis*, one of the primary vectors of West Nile virus. Access needs to be provided to these areas for mosquito inspection and treatments. Minimizing areas that hold water and the amount of time that they hold water will reduce the need for mosquito control.

L-ACMAD-13 **Coordination –** The Alameda County Mosquito Abatement District requests to remain in consultation regarding the creation of wetland areas and access to and throughout the areas.

Thank you again for the opportunity to provide comments on the Phase 2, Eden Landing Ecological Reserve Draft Environmental Impact Report. Should you have any questions about these comments or the work done by the Alameda County Mosquito Abatement District, please contact me at (510) 783-7744 or via email at erika@mosquitoes.org.

Sincerely,

Erika Castillo
Regulatory & Public Affairs Director
Alameda County Mosquito Abatement District

3

Response to Alameda County Mosquito Abatement District (L-ACMAD)

L-ACMAD-1

As discussed in MCR 1, the Preferred Alternative includes three habitat transition zones in the project area: one located on the inside of the outboard or bayward levee, one on the west side of the mid-complex levee, and one on the west side of the backside or landward levee. Access conditions vary for each of these habitat transition zones. The backside levee would remain accessible by maintenance truck. The mid-complex levee would be accessible by truck during the initial phase of restoration. However, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of Ponds E5 and E6, the mid-complex levee and the northern levee of Pond E6 could be breached which would limit truck access to some areas. Vehicular access to the bayward habitat transition zone would also be limited, as both the northern levee on E1 and the southern levee on E2 would be breached and have sections where the levee is lowered. Off-road vehicles (Argos, ATVs) could be used in areas with sufficient elevation where conditions are safe (e.g., on the upper section of the transition zones and in areas with high marsh elevations). Traversing areas near levee breaches would likely be limited due to safety hazards, precluding land access.

L-ACMAD-2

Several issues will be considered during detailed design of the transition zones including settlement, compaction, the availability of soil/sediment of sufficient quality to meet surface/cover criteria, and the frequency and duration of standing water and the corresponding need for mosquito abatement. Note that the lower portion of the habitat transition zone would be inundated on a frequent (twice daily) basis, while the upper portion of the transition zone that ties into the levee would be rarely flushed/inundated. Only a small section of the transition zone would be inundated with the highest tide and not flushed the same day or the next day. Although there is a potential for differential settlement which allows small pockets of standing water to form within a narrow band on the transition zone and hold water for several days, these pools are expected to be small. The size and the depth of these depressions would generally be limited by the height of the lower lip of the pool and the lip itself would be subject to tidal inundation. Additional text is included in Section 3.9.3 of the EIR to clarify. Also note that long-term operation of ponds and the habitat transition zones are subject to adaptive management actions for vector control, as described below in response to comment L-ACMAD-4.

L-ACMAD-3

Clarifying text is included in the beginning of Section 2.2.10 which indicates that mosquito abatement activities could occur at levees, habitat transition zones, or in other areas of the ponds.

L-ACMAD-4

See response to comment L-ACMAD-1 and L-ACMAD-2. Also note that the project alternatives include implementation of adaptive management actions that are designed to avoid a substantial increase in the need for vector management activities. These actions include adjusting the design to enhance drainage or tidal flushing, controlling vegetation in ponded areas, and/or facilitating access to marsh ponds. Although vehicular access to outboard levees would be precluded under Alternative Eden D and the Preferred Alternative, other adaptive management measures would be implemented to decrease mosquito-breeding habitat in that area.

L-ACMAD-5

See response to comment L-ACMAD-2.

L-ACMAD-6

Clarifying text is included in the beginning of Section 2.2.10 which indicates that mosquito abatement activities could occur at levees, habitat transition zones, or in other areas of the ponds.

L-ACMAD-7

Clarifying text is included in this paragraph, as suggested.

L-ACMAD-8

Text was revised as suggested.

L-ACMAD-9

As discussed in response to comment L-ACMAD-1, L-ACMAD-2, and L-ACMAD-4, the habitat transition zones would be designed for enhanced drainage and/or tidal flushing, constructed with a fairly uniform slope, and maintained per the Adaptive Management Plan. Although vehicular access to outboard levees would be precluded under Alternative Eden D and the Preferred Alternative, other adaptive management measures would be implemented to decrease mosquito-breeding habitat in that area. These actions would likely include controlling vegetation in ponded areas and/or minor regrading and the creation of minor ditches (as recommended above) when adaptive management triggers are exceeded. The detection of mosquitoes at levels exceeding management triggers would be addressed through implementation of the above Adaptive Management Plan actions. As such, the potential impact would be reduced to a less-than-significant level with implementation of the Adaptive Management Plan.

L-ACMAD-10

See response to comment L-ACMAD-1.

L-ACMAD-11

See response to comments L-ACMAD-1, L-ACMAD-4, and L-ACMAD-9.

L-ACMAD-12

See response to comments L-ACMAD-1, L-ACMAD-4, and L-ACMAD-9.

L-ACMAD-13

The project proponents would continue to coordinate with the Alameda County Mosquito Abatement District regarding wetland areas as per the Adaptive Management Plan.

Alameda County Water District (L-ACWD)

ACWD
ALAMEDA COUNTY WATER DISTRICT

43885 SOUTH GRIMMER BOULEVARD • FREMONT, CALIFORNIA 94538
(510) 668-4200 • FAX (510) 770-1793 • www.acwd.org

June 5, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612

Dear Ms. Buxton:

Subject: Draft Environmental Impact Statement/Environmental Impact Report, for the South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve

L-ACWD-1

Thank you for the opportunity to comment on the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for the South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve (Project). The Alameda County Water District's (ACWD) geographic area encompasses approximately 105 square miles. ACWD's groundwater statutory service area includes the Cities of Fremont, Newark, Union City, and the southern portion of the City of Hayward. ACWD primarily provides retail water service to a population of 356,000 within the Cities of Fremont, Newark, and Union City. ACWD manages the Niles Cone Subbasin 2-09.01 (Niles Cone) that underlies the Project area and operates water supply infrastructure on Alameda Creek to benefit native fish species. As a result, ACWD is committed to stewardship of the natural resources within our community and therefore supports the multi-agency effort to restore tidal marsh habitat to the South San Francisco Bay region, which has significant benefits for the Alameda Creek watershed.

Alameda Creek and Fish Restoration Projects

ACWD has a strong interest in protecting and preserving water quality and water supply in Alameda Creek and the Alameda Creek watershed and views the Project proposal as a critical project that will restore habitat within the Alameda Creek corridor and foster ecological resilience against climate change. ACWD is one of the founding members of the Alameda Creek Fisheries Restoration Workgroup and has collaborated with multiple stakeholders since 1999 on efforts to benefit Central Coast Steelhead, a federally-listed, threatened species. Over the last two decades, ACWD has committed millions of dollars to construct a variety of enhancements for salmonids migrating on Alameda Creek, including the removal of a rubber dam, the installation of three fishways (one built and two others currently in progress), and full fish screening of all off-stream diversion points. Come the year 2022, with the completion of the final fish ladder, steelhead will have full access to the Alameda Creek watershed for the first time in 50 years.

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L-ACWD-1 (cont.)

The goals of the proposed Project align directly with ACWD's broader efforts to restore steelhead to Alameda Creek. Specifically, the Project would maximize habitat potential for anadromous fish in the Alameda Creek corridor through expansion of habitat transition zones and improvements in habitat connectivity, allowing for more growth during a critical stage in the lifecycle. The importance of such habitat enhancement cannot be understated. Fishery science has shown that the survival rate of migratory steelhead is highly dependent on smolt size. With only limited opportunities to enhance steelhead habitat within the urbanized Alameda Creek watershed, restoration of the tidal marshes in the Eden Landing Ecological Reserve could provide a crucial opportunity for migratory steelhead passing through ACWD's fish ladders to gain an early advantage before journeying out to sea. Implementation of the Project may therefore represent a major step to re-establishing a healthy steelhead run in the Alameda Creek watershed.

L-ACWD-2

Comments for the DEIS/EIR

ACWD has reviewed the DEIS/EIR for the South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve and would appreciate your consideration of the following comments:

1. <u>Section 2.2.4 Alternative Eden B (pages 2-16 through 2-25)</u>:

   In Alternative Eden B, the DEIS/EIR discusses the potential of utilizing two ACWD Aquifer Reclamation Program (ARP) wells as an alternative water supply for the habitat transition zone. ACWD is interested in the concept of exploring partnership opportunities to leverage ACWD's ARP wells to deliver brackish groundwater to habitat transition zones in the Inland and Southern Ponds. Such collaboration could help sustain the target salinity gradient for the transitional ponds while furthering ACWD's long-term effort to remove excess salinity from the underlying Niles Cone.

   The DEIS/EIR states that these two ARP wells are used to removed "trapped" saline water (page 2-23). Please note that the objective of these two wells is mainly to improve overall groundwater quality. Because they are screened in the Newark Aquifer, they do not remove brackish water "trapped" in the deeper aquifers of the Niles Cone. In addition, the wells are currently non-operational and will require supplementary evaluation before the wells can be utilized and the volume of groundwater pumped from the wells will need to be measured and is subject to a Replenishment Assessment fee.

L-ACWD-3

2. <u>Section 2.3.1 Surface Water, Sediment, and Groundwater Quality (pages 2-57 & 2-58)</u>:

   a. ACWD appreciates the inclusion of SBSP Mitigation Measure 3.4-6 (page 2-57) which provides coordination with ACWD regarding the proper destruction of abandoned wells within the Project area. Historical records indicate the existence of three remaining abandoned wells within this portion of the overall South Bay Salt Pond Restoration project area. Project proponents should also coordinate with ACWD prior to any construction activities (e.g., levee improvement, levee breaches,

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L-ACWD-3 (cont.)

channel excavation, dredging) in areas where ACWD has already identified abandoned water wells that have not been destroyed, so that ACWD can assist in their location and identification. Although not specifically within the Project area, project proponents should be aware that ACWD has also identified two abandoned water wells in pond CP3C. ACWD is currently working on updating its well location map of the Project area and will send a copy to the State Coastal Conservancy at a later date.

L-ACWD-4

b. ACWD owns several groundwater monitoring wells within the Project area and near the perimeter. Groundwater sampling and monitoring of these wells is imperative to ACWD's management of the Niles Cone. Therefore, ACWD requests that the DEIS/EIR address maintaining access to all ACWD monitoring wells and the protection of these wells against being potentially damaged or lost (e.g., buried) during construction activities.

L-ACWD-5

3. Section 3.2.3 Environmental Impacts and Mitigation Measures (pages 3.2-16 through 3.2-27):

For Alternatives Eden B, C, and D, the DEIS/EIR states that two new bridges would be constructed between the inland and southern ponds to extend the Bay Trail through Eden Landing. This is to allow Alameda County equipment access under the bridge, if necessary. The construction will require bridge abutments on the channel banks and support pier in the water channels. Please note that support piers must be constructed in a manner that will prevent the creation of: 1) a preferential pathway that could allow runoff to rapidly infiltrate the subsurface and bypass soils which have the capacity to remove pollutants and protect the groundwater supply, or 2) an interconnection of aquifers or water-bearing zones. In order to protect the groundwater basin, ACWD requests the DEIS/EIR include the provision that project proponents coordinate and consult with ACWD prior to the design and construction of the piers or piles.

L-ACWD-6

4. Section 3.3.1 Physical Setting (pages 3.3-1 through 3.3-14):

The DEIS/EIR states: "The relatively thin Holocene Bay muds at the margins of the Bay do not currently isolate the shallow Newark Aquifer between the current outboard and inboard salt pond levees. However, Bay mud and fine-gained alluvial deposits do generally create differences in hydraulic head that are evidenced of hydraulic separation" (page 3.3-11). This statement is correct with respect to the Bay mud (marine deposition) which appears to thin out as it approaches the original Bay margins. Field identification of the Bay muds is typically identified by a darker colored fine grained material in the blue-gray range, and the terrestrial source (alluvial deposition) is typically identified by a lighter olive gray-olive-brown color range. A review of data from ACWD's drilled borings in the area indicate minor amounts of blue-gray silts and clays with a majority of the identified silts and clays being within the lighter color olive-gray to olive-brown color range. Although the Bay muds are not isolating surface infiltration from the Newark Aquiclude, the 25 to 50 feet of alluvial silts and clays appear to be.

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L-ACWD-6 (cont.)

In addition, areas west of I-880 may have a perched shallow water-bearing zone that is located within the Newark Aquiclude that overlies the Newark Aquifer. This shallow water-bearing zone should not be confused with the Newark Aquifer itself. To the extent that groundwater may be interacting with the ponds in the project area, such groundwater may be from this shallow water-bearing zone and not the Newark Aquifer.

L-ACWD-7

5. Section 3.3.3 Environmental Impacts and Mitigation Measures (pages 3.3-24 through 3.3-49):

   a. The DEIS/EIR states: "None of the SBSP Restoration Project alternatives use groundwater, so the project would not interfere with groundwater recharge or deplete groundwater supplies through groundwater extraction" (page 3.3-24). However, Alternative Eden B identifies a potential for groundwater use by referencing ACWD's ARP wells as an alternative water supply for the habitat transition zone. As previously mentioned, ACWD is interested in the concept of exploring partnership opportunities to leverage ACWD's ARP wells to deliver brackish groundwater to habitat transition zones. However, if Project proponents decide to move forward with utilizing groundwater, a subsequent or supplemental CEQA document will likely be required.

L-ACWD-8

   b. The DEIS/EIR states: "The threshold for an impact to groundwater quality is a substantial increase in the potential for salinity intrusion from the Bay into deep potable aquifers. This increase would be indicated by a project-related increase in salinity or total dissolved solids (TDS) at monitoring wells protecting water supplies that exceeds the narrative objective for salinity or the numeric objective for TDS or violates the state's antidegradation policy by unreasonably degrading the quality of high-quality water" (page 3.3-28). The DEIS/EIR should clarify which monitoring wells are being referenced in this section and if the monitoring of these wells is included in the Adaptive Management Plan. Since the TDS concentration in the Newark Aquifer at the Project area currently exceeds 500 milligrams per liter (mg/L), the threshold for impact from saltwater intrusion should be determined by observed spikes or increasing trends in TDS and chloride concentrations near the Project area.

L-ACWD-9

   c. The DEIS/EIR states: "Because surface water and groundwater are in at least partial hydraulic communication, shallow groundwater could seep into the ponds or restored tidal habitat or the surrounding sloughs and Bay. Fuel and solvent spills affect the shallow aquifers in industrialized areas of the South Bay, and the resulting plumes migrate in the groundwater flow direction" (page 3.3-45 & 46). As previously discussed, areas west of I-880 may have a perched shallow water-bearing zone that is located within the Newark Aquiclude that overlies the Newark Aquifer. Based on ACWD's review of nearby cleanup sites (unless there is compelling alternative information), "shallow groundwater" as referenced

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L-ACWD-9 (cont.)

above, should be clarified in the DEIS/EIR as being from the shallow water-bearing zone.

L-ACWD-10

ACWD will continue to engage with our environmental, regulatory, and community partners to maintain a fish-friendly waterway in Alameda Creek and restore native habitat to the region. Successful completion of the South Bay Salt Pond Restoration Project, Phase 2, Eden Landing Ecological Reserve will contribute to this ongoing mission.

Sincerely,

Steven D. Inn

Steven D. Inn
Manager of Water Resources

ks/cs
By email

Response to Alameda County Water District (L-ACWD)

L-ACWD-1

The project proponents appreciate your support of the project. As noted by the commenter, one the Project's intended ecological goals is fish habitat restoration and enhancement. As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 5, Fish Habitat Restoration, the Preferred Alternative includes restoration elements intended to maximize habitat connectivity, provide new foraging opportunities, and increase productivity.

L-ACWD-2

Text was revised to indicate that the primary use of the two Aquifer Reclamation Program (ARP) wells near southern Eden Landing is to improve water quality in the Newark Aquifer.

L-ACWD-3

The project proponents will coordinate with interested parties during construction and will continue to coordinate with ACWD regarding abandoned wells per SBSP Mitigation Measure 3.4-6. As discussed in Section 3.3.3 of the EIR, all known well locations in the Reserve were closed as part of Phase Out Agreement with Cargill and the Initial Stewardship Plan and therefore there are no known wells in the ELER. The project proponents appreciate any updated information provided regarding abandoned wells in the project area and vicinity.

L-ACWD-4

Section 3.3.1 of the EIR indicates that there are several ACWD monitoring wells located near the eastern edge of the salt ponds. According to figures from the ACWD's 2017 groundwater monitoring report, these wells are primarily located east of the ELER within the city boundaries of the City of Union City, but a few wells are located along OAC near Ponds E6A and E8. The project proponents will coordinate access during construction to infrastructure located within the ELER that is owned by others, and coordinate access near work areas and staging areas. During construction, these features would be marked, protected or fenced, and avoided by the construction contractor.

L-ACWD-5

Issues raised by the ACWD regarding the potential for bridge piers and abutments that may create a preferred pathway between surface water and groundwater and the potential for bridge piers, and abutments to create an interconnection between groundwater aquifers and other water bearing zones would be considered during detailed design of the project. Note that the project proponents will continue to coordinate with interested parties during the design process and during project construction. More formal consultation would occur with agencies that issue project permits.

L-ACWD-6

Clarifying text is included in the paragraph, as suggested.

L-ACWD-7

As noted by the commenter, Section 3.3.3 of the Draft EIS/R describes the potential use of brackish water from ARP wells in Alternative Eden B. The conflicting information identified by the commenter was deleted in the Final EIR.

L-ACWD-8

Clarifying text is included in the EIR to indicate that the referenced wells are regional groundwater wells. Focused monitoring efforts for the Adaptive Management Plan have been concentrated on ponds and regional surface waters, not on groundwater. As discussed in Section 3.3.3 of the EIR, tidal inundation of prior circulation or batch ponds are not expected to result in a significant change in groundwater hydrology or quality because groundwater currently has positive flow into the Bay.

Consequently, regional groundwater quality data would be reviewed, but the installation of new groundwater monitoring wells would not be required to implement the Adaptive Management Plan. Observed spikes or increasing trends in TDS and chloride concentrations near the Project area would be evaluated against management triggers and potential management actions.

L-ACWD-9

Clarifying text is included in the Final EIR to indicate that it is perched groundwater from the shallow waterbearing zone that could be in partial hydraulic communication with the restored ponds.

L-ACWD-10

The project proponents will coordinate with interested parties during design and construction of SBSP Restoration Project, Phase 2 at the ELER.

City of Union City (L-CUC)

UNION CITY
california

May 21, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, California 94612

Dear Ms. Buxton:

L-CUC-1

On behalf of the City of Union City, I am writing to submit comments on the Draft EIS/EIR for the Eden Landing Ecological Reserve Phase 2 Project, also known as the South Bay Salt Ponds (SBSP) Restoration Project. The City's comments are focused on the needed improvements to protect the community from sea level rise and the need for the planned Bay Trail to provide long-term community benefits that link Northern Eden Landing to Coyote Hills Regional Park through the bay lands.

1) Sea Level Rise Mitigation of Project

a) We appreciate the attention to the discussion of sea level rise throughout the document and support incorporating sea level rise mitigations.

b) We strongly support the Bay Trail guidelines that state the Bay Trail should be elevated to accommodate sea level rise. The Bay Trail levee improvements should be designed so as funding is available for the SBSP Restoration Project, the improvements can be made in tandem. These necessary improvements should be strategically planned, considered, and anticipated so there are not unexpected impacts to the Project in the future. As a matter of 'fact,' sea level rise must be incorporated into the improvements. Increasing the base width and height of a levee could be very disruptive to the ecology of the SBSP Restoration Project in the future. As such, we believe that critical, backbone infrastructure to protect against sea level rise should be constructed as part of the first phase of the Project.

c) The Bay Trail should not be located on levees that will be lost to deterioration or sea level rise. This would be a poor use of public funds and would not provide a long-term benefit to the public.

d) We strongly support that the Project sponsors continue their partnership with Alameda County Flood Control and Water Conservation District to determine a final Bay Trail alternative that also mitigates the community impacts of sea level rise.

L-CUC-2

2) Bay Trail Access from Union City Boulevard - The City supports additional public access from Union City Boulevard to the Bay Trail. However, please consider the following:

a) Trailheads with public access and parking lots should be provided in the Horner/Veasy Street area in Union City and at the East Bay Regional Park Land District property adjacent to Alameda Creek. Other access points should be secondary and solely for pedestrian and bicycle access.

economic & community development

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california

L-CUC-3

b) The preferred trail alignments on Alternatives B, C, and D are the Proposed Trail, Proposed Trail: Route 1, and Proposed Trail: Route 2. The Existing Trail and Proposed Trail: Route 3 rely on Union City Boulevard as a Bay Trail connector. Union City Boulevard is a busy, heavily trafficked street that does not fulfill the need or the vision of a Bay Trail. Additionally, on the south side of the closed Turk Island Landfill, both the Existing Trail and the Proposed Trail: Route 3 alignments require the trail to traverse through a single-family residential neighborhood along Westport Way. The neighborhood does not have adequate public parking and is already impacted by sports activities at Sea Breeze Park. Parking from the park activities often overflows into the neighborhood. Adding additional traffic and parking to the neighborhood that would result from a new trailhead/community connector is not appropriate.

c. Alternative bicycle and pedestrian links along existing levee roadways from Union City Boulevard may be appropriate points of connection other than Westport Way.

d. Union City staff request that meetings be held with the neighborhood for their input should the Project sponsor determine that Westport Way is the preferred community connector alignment for the Bay Trail.

L-CUC-4

3) Linking the Bay Trail to Coyote Hills Regional Park – The Bay Trail should complete the link between Eden Landing Phase 1 and Coyote Hills Regional Park on an alignment that is located west of Union City Boulevard in the bay lands. The Project should also include the bridge across Alameda Creek in order to complete the link to Coyote Hills Regional Park. This has been a long-term goal of the region, the City and the Bay Trail plan.

L-CUC-5

Thank you for the opportunity to comment. The SBSP Restoration Project will be an open space amenity for the region as it restores habitat for native plants and animals across the 15,100 acres. However, with such a large investment of public funds, the project should plan for and incorporate the improvements that are needed to protect against sea level rise. Further, the Project should include recreational opportunities for public access that are provided for by a Bay Trail alignment that is fully incorporated into the Restoration Project and links to Eden Landing Phase 1 and Coyote Hills Regional Park.

Sincerely,

Joan Malloy

JOAN MALLOY
Economic and Community Development Director, City of Union City
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economic & community development

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Response to City of Union City (L-CUC)

L-CUC-1

As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 7, Public Access Trails (Routes, Elevations, and Parking), the Preferred Alternative includes a trail alignment through southern Eden Landing that would be located upon levees raised to a minimum elevation of 12 feet NAVD88, which is the same height as the proposed mid-complex levee. Because this trail alignment is intended to extend the Bay Trail spine through southern Eden Landing, the design of the levees would follow Bay Trail design guidelines with respect to trail width and surfacing, as practicable. Bridges would be passable by pedestrians and bicycles and depending on bridge length and location may also be passable by maintenance or emergency vehicles.

As discussed in MCR 3, Sea-Level Rise, although there is considerable uncertainty to the rate of sea level rise, particularly after about 2050 due to uncertainties in global carbon emission rates, there is a general consensus among scientists that sea levels near San Francisco are likely to increase by 4 to 6 inches by 2030, 7 to 13 inches by 2050, and 12 to 41 inches by 2100, relative to levels in 2000 (OPC 2018). Although improved levees may be subject to wave run-up, overtopping, and ponding at some point in the future, trails located on levees improved to 12 feet NAVD88 would generally be protected from coastal inundation from high tides during interim future conditions. Building the levees with wider bases to allow for future increases in elevations without adding more fill in waters of the U.S. and State of California or otherwise affecting endangered species habitat will also be considered during detailed design where feasible and reasonable.

L-CUC-2

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), both CDFW and the larger SBSP Restoration Project team would be willing to collaborate with other local agencies and provide assistance in adding parking in one of the surrounding areas (such as seeking supplemental funding through grants).

Also note that the Preferred Alternative includes one community connector at Veasy Street and no new "trailheads" with Phase 2, which makes this connection to the existing Bay Trail more of a through-trail used for longer hikes or bicycle rides to or from existing trailheads, and consequently there is a reduced need for a new parking area. Existing trailheads with parking are to the north (the Phase 1 parking area at northern Eden Landing) and to the south (the Alameda Creek Regional Trail parking lot along the ACFCC). As part of ongoing operational activities at northern Eden Landing, CDFW could expand the parking area built in Phase 1 of the project to accommodate any additional demand by opening and improving the overflow parking area as appropriate. Currently the lot occasionally fills only for brief periods on certain weekend days, particularly during special events, and it is inefficient to build a parking lot to accommodate the peak demand instead of the typical demand. Weekend/peak demand will continue to be monitored at that site by CDFW, and the overflow area could be opened if significant new demand is supported.

L-CUC-3

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the preferred trail alignment through southern Eden Landing is Trail Route 1. Trail Routes 2 and 3 and the community connector at Westport Way were not included in the Preferred Alternative. Trail Route 1 was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Trail Route 3 and the associated “community connector” trail to Union City Boulevard was not included in the Preferred Alternative because of a strong negative response to it by stakeholders (including the City of Union City) and because of the concern that the community connector would draw more outside trail users to the area and encourage them to park on existing streets. Bicycle and pedestrian links would still connect to the south via the Alameda Creek Regional Trail.

L-CUC-4

As discussed in MCR 1, the Preferred Alternative includes the trail alignment at Trail Route 1, which is the westernmost of the three route options considered, and the public access bridge over the ACFCC. However, it is important to acknowledge a few limits on what that inclusion means. First, neither the CDFW nor any of the other SBSP Restoration Project primary entities (the USFWS or the State Coastal Conservancy) owns the land on either side of the ACFCC. The Project therefore holds no unique ability or influence to obtain the necessary funding, permits, or property rights to actually build it. The construction of such a bridge, as with the completion of a portion of the proposed trail through southern Eden Landing, would require property acquisition at fair market value or a permanent public access easement. Therefore, the SBSP Restoration Project proponents/CDFW are unlikely to be the sole implementer of a public access bridge over the ACFCC on their own. As noted, building that bridge will require a substantial effort to acquire funding for and perform design, permitting, and construction, and to obtain necessary easements or property acquisition. This is very likely to need cooperation between a number of partner agencies to successfully implement.

L-CUC-5

See response to comment L-CUC-1 regarding sea-level rise and response to comment L-CUC-4 regarding public access links to Coyote Hills Regional Park via a public access bridge over the ACFCC.

East Bay Regional Park District (L-EBRP)

East Bay Regional Park District

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May 21, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612-1401

RE: Eden Landing Ecological Reserve Phase 2 Draft EIS/EIR

Dear Ms. Buxton:

L-EBRP-1 Thank you for the opportunity to comment on the Eden Landing Ecological Reserve (ELER) Phase 2 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR). The East Bay Regional Park District owns and manages 122,000 acres of open space and active transportation trails in both Contra Costa and Alameda Counties. Specifically, we operate Hayward Regional Shoreline, Coyote Hills Regional Park, Quarry Lakes Regional Park, and the Alameda Creek Regional Trail as well as provide maintenance of the 7 miles of ELER Phase 1 trails.

Park District staff understands that the South Bay Salt Pond Restoration Project (SBSP) is a multiple agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood risk management, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds. One of the project objectives also is to "[p]rovide public access and recreational opportunities compatible with wildlife and habitat goals".

Public land along the Bay shoreline is rare, and ELER Phase 2 represents a unique opportunity to provide much-needed and mandated public access. Some of the proposed alternatives, however, include no public access. Instead, there should be more public access to the "blue water" experience of the San Francisco Bay, especially considering the vast acreage and mileage of shoreline. Additionally, once endangered species habitat is established, this opportunity will be lost in perpetuity as well as the ability to repair levees and provide coastal protection to the communities that ELER buffers.

L-EBRP-2 For all alternatives, only one trail leads to ELER with minor spurs with little to no connectivity to the south. These trails are located on levees that are 8 or 9 feet high, and they will probably need to be 13.5 feet high to address sea level rise projections over the next 80 years. If a trail were to be flooded in the next 20 years for endangered species, the levees could not be raised. At a minimum, there must be a wide enough "bench" for the levee trail so that in the future fill can be added without negatively impacting endangered species' habitat.

L-EBRP-3 We appreciate that this restoration project is a major investment in improving habitat and ecological function of the baylands. Regardless, the value of this investment is diminished if the public who are funding it do not have access to it. Furthermore, the proposed project is in a State-designated disadvantaged community, and this proposed plan essentially keeps the people who most need access to recreational resources out.

L-EBRP-4

Preferred Alternative

Parallel to the environmental planning of this phase of the SBSP, SBSP staff has been engaged with other key stakeholders such as the San Francisco Bay Trail, Alameda County Flood Control District, and Park District staff in the Resilient by Design challenge that seeks to create a blueprint for coastal resilience and social equity in the San Francisco Bay Area. The Public Sediment proposal for Alameda Creek includes the Alameda Creek Trail, Quarry Lakes Regional Park, Coyote Hills Regional Park, and the South Bay Salt Ponds. The team has proposed a plan that will reconnect sediment flow to the marshes and mudflats at the Bay edge, create protective ecological infrastructure that adapts to sea level rise, mitigates flood risk, and provides adequate public access.

On May 5, 2018, key stakeholders, including SBSP staff, actively engaged in a conference call to specifically discuss public access and completion of the Bay Trail spine with a "blue water" experience at ELER Phase 2. We all agreed that the Draft EIS/EIR Alternative Eden C Trail Route 2 with a bridge across Alameda Creek would most closely align with the Resilient by Design proposal and should be the preferred alternative. To be consistent with regional goals of completing the Bay Trail alignment, ELER Phase 2 should implement the entire Bay Trail spine that connects ELER Phase 1 to Coyote Hills Regional Park, including the 600-foot long bridge crossing the Alameda Flood Control Channel shown in Alternative Eden C. ELER Phase 2 is a unique opportunity and possibly the last chance to implement this critical segment of Bay Trail along the Alvarado Wetlands properties. This preferred alternative would also require the acquisition of a couple of parcels of private land from a willing seller at fair market value.

L-EBRP-5 We support the beneficial reuse of dredged material and/or upland fill material as well as increasing wildlife-oriented public access and extension of the Bay Trail. L-EBRP-6 Since the Park District currently provides maintenance of ELER Phase I trails, the breach bridge should be drivable by a heavy-duty truck for these purposes.

Following are specific comments related to section 3.6 Recreation Resources and section 3.11 Traffic of the Draft EIS/EIR.

Recreation Resources

L-EBRP-7 As stated in section 3.6.2 Regulatory Setting, the San Francisco Bay Conservation and Development Commission (BCDC), among other responsibilities, regulates shoreline public access, and the *San Francisco Bay Plan* specifies that the ELER provides excellent wildlife compatible recreation opportunities. Furthermore, BCDC considers the Bay Trail Plan in making determinations as to whether a project is consistent with their policies on public access.

In terms of Phase 2 Impact 3.6-3, this impact should be revised to potentially significant for all alternatives except Alternative Eden A, because they do not propose staging nor parking areas. The analysis refers to the trailhead parking areas such as the Alameda Creek Regional Trail and ELER Bay Trail staging areas. These staging areas currently serve their respective trails – the Park District's Alameda Creek Trail and the Bay Trail associated with ELER Phase 1. Additionally, the analysis should include the number of acres of public open space, number of parking spaces, and number of miles of trail to demonstrate the amount of public access that would or would not be provided. The analysis acknowledges that the use of the new trail and public access facilities would increase use and demand for existing trailhead facilities. With the addition of Phase 2, adequate parking that provides service to the new trail and public access facilities should be included and analyzed. The

L-EBRP-7 (cont.)

lack of parking would cause stress on nearby Park District staging areas by substantially increasing recreation use and cause substantial physical deterioration of these adjacent recreational facilities, which would result in a potentially significant impact. This impact should be mitigated by providing additional parking, and the statement should be revised to reflect this impact. This issue is further discussed in the traffic section below.

L-EBRP-8

Traffic

Section 3.11 Traffic states that the current ELER Bay Trail connection only provides 24 parking spaces. The existing 24-space ELER parking lot serves Phase 1 and would not adequately provide parking for both Phase 1 and 2. Phase 2 Impact 3.11-3 says that the estimated increase in recreational use from Phase 2 implementation is up to 150 additional recreational users per day, increasing demand by up to 56 vehicles per day. As the impact statement also states, the landowner shall design recreational facilities with sufficient parking spaces to accommodate the projected increase in vehicles that access the site. Relying on potential off-site parking to provide additional parking is not sufficient, as it would increase demand for parking and public access at nearby Park District parks. Since the lack of adequate parking in all the alternatives except for Alternative Eden A would increase demand for parking, the proposed project would result in a potentially significant impact that should be mitigated.

L-EBRP-9

We appreciate the opportunity to provide comments and applaud this major effort at restoring habitat and ecological function of the baylands. The proposed project, however, should balance habitat restoration with public access to the Bay, as stated in the project objectives. The Resilient by Design challenge is an opportunity for all the key stakeholders to collaborate on a vision that achieves those objectives and should be used as the preferred alternative. Furthermore, to be consistent with regional goals of completing the Bay Trail spine, ELER Phase 2 should implement the entire Bay Trail spine that connects ELER Phase 1 to Coyote Hills Regional Park including the bridge across Alameda Creek. ELER Phase 2 is a unique opportunity and possibly the last chance to implement this critical segment of Bay trail along the Alvarado Wetlands. Please feel free to contact us if you have any questions or would like additional information.

Sincerely,

Sandra Hamlat

Sandra Hamlat
Senior Planner

cc: Brian Holt, Chief of Planning/GIS
Chris Barton, Environmental Program Manager
Sean Dougan, Trails Program Manager
Mark Taylor, Park Supervisor
Lee Huo, Bay Trail Planner

Response to East Bay Regional Park District (L-EBRP)

L-EBRP-1

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), all of the action alternatives in the Draft EIS/R included three different routes to complete the Bay Trail spine through all or most of southern Eden Landing, depending on property ownership or easement acquisition. Some of the details (such as elevation) would have differed depending on the alternative chosen, but the routes were in every alternative, as were one or more bridges over internal channels, a new viewing platform, and a commitment to maintaining existing access long the Alameda Creek Regional Trail, regardless of the approach taken to connecting the ponds to the ACFCC. In the Preferred Alternative, Trail Route 1 was chosen as the alignment of the Bay Trail spine through southern Eden Landing. It was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Additional explanations of the trails that were selected for inclusion in the Preferred Alternative are in MCR 7, Public Access Trails (Routes, Elevations, and Parking).

In addition to providing public access, each of the action alternatives (and the Preferred Alternative) includes features to address coastal flooding that would maintain or improve existing levels of flood risk management at adjacent and nearby properties. Note that CDFW is the landowner and manager of the ELER and is responsible for maintaining the levees, water control structures, and other features of the lands and waters at the site as needed for habitat purposes. CDFW performs or coordinates other maintenance activities such as removal of invasive plant species, performing bird counts or other biological surveys, and patrolling to see that public access features are being used in accordance with Reserve rules (e.g., that people stay on trails, respect rules about dogs, etc.) These types of management actions are activities that CDFW would continue to conduct regardless of the details of the Preferred Alternative or whether there was an SBSP Restoration Project at all.

L-EBRP-2

Refer to response to comment L-EBRP-1 and MCR 7, Public Access Trails (Routes, Elevations, and Parking), regarding public access for the action alternatives. Also note that the Preferred Alternative includes a trail alignment through southern Eden Landing that would be located upon levees raised to a minimum elevation of 12 feet NAVD88, which is the same height as the proposed mid-complex levee.

As discussed in MCR 3, Sea-Level Rise, although there is considerable uncertainty to the rate of sea level rise, particularly after about 2050 due to uncertainties in global carbon emission rates, there is a general consensus among scientists that sea levels near San Francisco are likely to increase by 4 to 6 inches by 2030, 7 to 13 inches by 2050, and 12 to 41 inches by 2100, relative to levels in 2000 (OPC 2018). Although improved levees may be subject to wave run-up, overtopping, and ponding at some point in the future, trails located on levees improved to 12 feet NAVD88 would generally be protected from coastal inundation from high tides during interim future conditions. Building the levees with wider bases to allow for future increases in elevations without adding more fill in waters of the U.S. and State of California or otherwise affecting endangered species habitat will also be considered during detailed design where feasible and reasonable.

L-EBRP-3

As discussed above in response to comment L-EBRP-1 and MCR 7, Public Access Trails (Routes, Elevations, and Parking), the trail routes in the action alternatives would increase public access and complete the Bay Trail spine through southern Eden Landing, thereby providing people in the nearby community a new public access opportunity.

L-EBRP-4

As discussed in MCR 1, the Preferred Alternative includes Trail Route 1 and the public access bridge over the ACFCC. Trail Route 1 was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Although the public access bridge over the ACFCC was included in only one of the action alternatives presented in the Draft EIS/R, the text of the Project Description in Chapter 2 notes that such a bridge is a modular component that could be included into any configuration of a Preferred Alternative or an eventually implemented project.

However, it is important to acknowledge a few limits on what that inclusion means. First, neither the CDFW nor any of the other SBSP Restoration Project primary entities (the USFWS or the State Coastal Conservancy) owns the land on either side of the ACFCC. The Project therefore holds no unique ability or influence to obtain the necessary funding, permits, or property rights to actually build it. The construction of such a bridge, as with the completion of a portion of the proposed trail through southern Eden Landing, would require property acquisition at fair market value or a permanent public access easement. Therefore, the SBSP Restoration Project proponents/CDFW are unlikely to be the sole implementer of a public access bridge over the ACFCC on their own. As noted, building that bridge will require a substantial effort to acquire funding for and perform design, permitting, and construction, and to obtain necessary easements or property acquisition. This is very likely to need cooperation between a number of partner agencies to successfully implement. The SBSP Restoration Project has already begun contributing to that effort by providing NEPA and CEQA coverage for a bridge over the ACFCC.

L-EBRP-5

Each of those components are included in the Preferred Alternative.

L-EBRP-6

To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes a connection between the Bay Ponds and the ACFCC that will no longer be through large culverts, as initially described, but instead through a full breach. This breach however, would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail. This breach bridge is intended to be drivable by heavy duty truck for maintenance purposes.

As a point of clarification, although East Bay Regional Park District operates and maintains the Bay Trail spine on the original Baumberg Tract at the northern boundary of Eden Landing (which is about 3 miles in length), CDFW currently operates and maintains the 4 miles of new spur trails developed during Phase 1 at ELER.

L-EBRP-7

Section 3.6.4 of the EIR evaluates the potential impact associated with the physical deterioration of neighboring recreational facilities due to increased use in the ELER Phase 2 area. Projected recreational use of the ELER Phase 2 area is estimated to average 100 to 125 users per day with peak periods such as summer weekends within the range of 150 to 250 users per day. These estimates are similar to average daily use for the Hayward Regional Shoreline as measured at Hayward Marsh (150 to 200 users per day), Hayward's Landing (120 to 150 users per day) and the San Lorenzo Trail Bridge (145 to 160 users per day). This is likely a conservative estimate, as the average daily use in the ELER Phase 1 area has historically been lower, with 50 to 125 users per day reported near the Phase 1 parking area at northern Eden Landing and only 10 to 75 users per day at Eden Shores (described in Appendix G). Low trail use in the ELER Phase 1 area was also found by Sokale and Trulio (2013).

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the Preferred Alternative (and the action alternatives), which connects the existing Bay Trail segment at Eden Shores to the Alameda Creek Regional Trail, would be more of a through-trail used for longer hikes or bicycle rides to or from existing trailheads, and consequently there would be a reduced need for a new parking area. However, as part of ongoing operational activities at northern Eden Landing, CDFW could expand the parking area built in Phase 1 of the project to accommodate any additional demand by opening and improving the overflow parking area, as appropriate. Currently the lot occasionally fills only for brief periods on certain weekend days, particularly during special events. Weekend and peak demand will continue to be monitored at that site by CDFW, and the overflow area could be opened if significant new demand is supported.

In addition, both CDFW and the larger SBSP Restoration Project team would be willing to collaborate with other local agencies and provide assistance in adding parking in one of the surrounding areas.

Note that Section 3.6.3 of the EIR describes the proposed recreation and public access facilities in detail, including location, length, and improvements and Section 3.11.1 of the EIR describes the number of parking spaces in the ELER Phase1 area and at the Alameda Creek Regional Trail. Clarifying information is included in Section 3.6.4 of the Final EIR which indicates that the proposed facilities in southern Eden Landing are expected to be used as a through-trail for longer hikes or bicycle rides to or from existing trailheads.

L-EBRP-8

See Response to Comment L-EBRP-7. As part of ongoing operational activities at northern Eden Landing, CDFW could expand the parking area built in Phase 1 of the project to accommodate any additional demand by opening and improving the overflow parking area, as appropriate. Weekend and peak demand will continue to be monitored at that site by CDFW, and the overflow area could be opened if significant new demand is supported. In addition, both CDFW and the larger SBSP Restoration Project team would be willing to collaborate with other local agencies and provide assistance in adding parking in one of the surrounding areas.

L-EBRP-9

See response to comment L-EBRP-1 regarding the proposed public access for the action alternatives and response to comment L-EBRP-4 regarding the public access bridge over the ACFCC.

Port of Redwood City (L-PRC)

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June 5, 2018

Ms. Brenda Buxton, Deputy Program Manager
California State Coastal Conservancy
1515 Clay Street
Oakland, CA 94111

Re: Comments on the South Bay Salt Pond (SBSP) Restoration Project Phase 2 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for Eden Landing Ecological Reserve

Dear Ms. Buxton,

L-PRC-1

The Port of Redwood City (RWC) has been and continues to be a supporting neighbor and property owner to the SBSP Restoration Project. The Port's Redwood City Harbor federal navigation channel (RCH) is adjacent to the Don Edwards South S.F. Bay National Wildlife Refuge. Over 50,000 CY of the dredged material from the channel contributed to restoration of tidal marsh on the Refuge's Bair Island.

The Port has long been actively promoting the restoration of tidal marsh and the vital opportunity this Restoration Project provides for the beneficial use of dredged sediment to achieve the Project's habitat restoration and flood risk management goals in the South Bay.

The Eden Landing Ecological Reserve (ELER) tidal salt marsh restoration alternatives under consideration include construction of a large earthen bayfront feature as well as upland transition zones and/or raised pond bottom elevations. All of these restoration and/or flood protection features could make use of dredged material from nearby port navigation channels, the closest in proximity being the Port of RWC's federal channel. The proposed construction design concept(s) is described in the Draft EIS-EIR's Appendix E, "*Preliminary Design Memorandum of Dredged Material Placement at Southern Eden Landing*".

Another important related project, supported by the Port of RWC, is the California State Coastal Conservancy's non-federal cost-sharing proposal, ***Resilient San Francisco Bay Project***, for consideration as one of the ten selected projects in the beneficial use pilot program established by the U.S. Army Corps of Engineers pursuant to Section 1122 of the Water Resources Development Act of 2016. Eden Landing is one of the four placement sites that, when permitted upon the Final certification of the Draft EIS-EIR. would be eligible for dredged material placement under the new Resilient S.F. Bay Project, (if selected as one of the ten).

PORT OF REDWOOD CITY
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L-PRC-1 (cont.)

The Port of RWC fully endorses the ELER Phase 2 project and accompanying Draft EIS-EIR and Appendix E. The Port looks forward to the Final certified environmental document so that the ELER site permitting can be accomplished as soon thereafter as possible to enable dredged material placement for restoration and shoreline resilience.

Sincerely yours,

Michael J. Giari
Executive Director

Cc: LTC Travis Rayfield, San Francisco District Engineer, U. S. Army Corps of Engineers
Jason Brush, U. S. EPA, Region IX
Larry Goldzband, Executive Director, S.F. Bay Conservation and Development Commission
Bruce Wolfe, Executive Officer, S. F. Bay Regional Water Quality Control Board
John Krause, ELER Manager, CDFW
John Bourgeois, Executive Project Manager, SBS

Response to Port of Redwood City (L-PRC)

L-PRC-1

The project proponents appreciate your support of the project. As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the Preferred Alternative for Phase 2 at Eden Landing includes the potential beneficial reuse of dredge material to raise pond bottom elevations and to build habitat transition zones in several ponds. Dredge material would be placed in the Bay Ponds (Ponds E1, E2, E4, and E7) and may be used to raise portions of Ponds E5 and E6, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of those ponds to tidal marsh.

Also note that, the SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material. The project would benefit from the incorporation of dredge material but does not depend on it. The inclusion of beneficial reuse of dredge material in the Phase 2 Preferred Alternative at Eden Landing should not be interpreted as a commitment to wait indefinitely for that material to be supplied to the project site.

San Francisco Bay Trail Project, Bay Area Metro (L-SFBT)

May 18, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612

Subject: **Comments on the Draft Environmental Impact Statement (EIS) and Environmental Impact Report (EIR) for the Eden Landing Ecological Reserve Phase 2 Project**

Dear Ms. Buxton:

L-SFBT-1

On behalf of the San Francisco Bay Trail Project, I am writing to submit comments on the Draft EIS/EIR for the Eden Landing Ecological Reserve Phase 2 Project (Phase 2 Project). The Bay Trail Project is a nonprofit organization administered by the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) that plans, promotes, and advocates for the implementation of the Bay Trail. The Bay Trail is a planned 500-mile continuous network of multi-use bicycling and hiking paths that, when complete, will encircle San Francisco and San Pablo Bays in their entirety. It will link the shoreline of all nine Bay Area counties, as well as 47 cities. To date, 355 miles of the proposed Bay Trail system has been developed.

The core essence of the Bay Trail is the vision of a continuous shoreline trail that provides a "Bay" experience for bicyclists and pedestrians around San Francisco Bay. As a result, proximity to the Bay waters and environment as well as connectivity are key elements to successfully implementing the vision of the Bay Trail.

Since the realization of the South Bay Salt Pond purchase to return the salt ponds to the public, it has been the goal of the Bay Trail Project to move the Bay Trail alignment off of city streets along Union City Boulevard to an alignment that will provide Bay views and a "Bay" experience consistent with Bay Trail goals at Eden Landing.

After reviewing the draft EIS/EIR for the Phase 2 Project, we have the following comments:

1) We were surprised that the project did not explicitly include the goal of completing the entire Bay Trail alignment between the existing Bay Trail at Eden Landing Phase 1 and Coyote Hills Regional Park. To be consistent with the regional goals of completing the Bay Trail alignment, we believe that the Phase 2 Project should explicitly list the goal of

Ms. Brenda Buxton
May 18, 2018

L-SFBT-1

implementing the entire Bay Trail spine that connects Eden Landing Phase I to Coyote Hills Regional Park including the 600-foot-long bridge crossing the Alameda Flood Control Channel shown in Alternative C.

L-SFBT-2

2) As we stated in the NOP/NOI letter that we submitted for this project, Route 1 is the trail alignment that best meets the Bay Trail goal of providing a "Bay" experience and should be the alignment selected for implementation. The Route 3 trail alignment does not meet the goals of completing the Bay Trail spine or providing a "Bay Experience" and should be eliminated as a project option.

L-SFBT-3

3) The Phase 2 Project proposes to remove the Bay Trail alignment that would provide a "Blue Water" experience along Old Alameda Creek. We were surprised to read that the draft EIS/EIR described the trails provided with Eden Landing Phase 1 as providing a "similar" experience as the Old Alameda Creek Bay Trail alignment. The trails provided in Phase 1 absolutely do not replace the experience that would have been provided at Old Alameda Creek since none of those trails take you out to the shoreline edge of the Bay or provide a "Blue Water" experience. As such, we continue to see the removal of this alignment as a loss in trail and public access experience that must be mitigated.

L-SFBT-4

In addition, the new trails in Phase 1 still have not been officially submitted for inclusion as part of the Bay Trail alignment despite several requests.

L-SFBT-5

4) We were surprised that the draft EIS/EIR did not include a long-term maintenance plan or a specific proposal to ensure that the Bay Trail implemented as part of the project would be maintained for the long term and would be constructed to survive the anticipated sea level rise in the Bay. Other than the trails proposed in Alternative B and Route 2 in Alternative D, none of the trail proposals include improvement of the existing levees to widen them to Bay Trail standards and to ensure that the trails will survive long term including from the impacts of sea level rise. The very concept of the Bay Trail is predicated on creating interconnected permanent facilities. Much of the trail alternatives discussed in the EIS/EIR involve placing the Bay Trail on unimproved levees that will potentially be lost to deterioration, settlement, or sea level rise. This is patently unacceptable. The Phase 2 Project must include a long-term plan to maintain the trails implemented with this project and must build the trails to standards that will have longevity and be able to survive sea level rise.

L-SFBT-6

5) Related to long-term maintenance and creating opportunities to raise the proposed trails if necessary to respond to sea level rise, the Phase 2 project must create a buffer zone around the proposed trails to allow for trail rebuilds and raising the trail to address sea level rise. The Phase 2 Project cannot be proposed in a manner where the trails would not be able to be repaired or raised due to habitat being established right to the edge of trail and creating inherent conflicts between habitat and public access.

L-SFBT-7

6) The draft EIS/EIR often cites costs as reasons to not move forward with a trail alignment or trail design. The development of all Bay Trail alignments require partnerships that work together to secure funding from a multitude of funding sources. We consistently work with our partners to successfully find funding to develop trails as long as we have a clear and compelling vision for the trail. Instead of eliminating trail options and designs

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L-SFBT-7 (cont.)

based on perceived cost issues, we believe the Phase 2 Project should work towards a trail alignment and design that addresses the issues that we outlined above and that fairly balances the goals of flood control, restoration, and public access.

The South Bay Salt Pond Project will be a jewel in the Bay and creating trails and access that allows the public to experience these spaces funded with many of their dollars including Measure AA will help to highlight not only this fantastic project but also support for future work like this. As stated in the EIS/EIR, "[t}he mission of CDFW is to manage California's diverse fish, wildlife, and plant resources, and the habitats on which they depend, for their ecological values and for **their use and enjoyment by the public**."

L-SFBT-8

The Bay Trail Project appreciates the opportunity to provide comments on the draft EIS/EIR for the Phase 2 Project and looks forward to working with the South Bay Salt Pond Restoration Project to identify a safe, usable, connected, and direct Bay Trail alignment consistent with Bay Trail goals. Please do not hesitate to call me at (415) 820-7915 if you have any questions regarding the above comments or the Bay Trail.

Sincerely,

Lee Chien Huo
Bay Trail Planner

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Response to San Francisco Bay Trail Project, Bay Area Metro (L-SFBT)

L-SFBT-1

The goal of Phase 2 of the SBSP Restoration Project at Eden Landing, which was adopted from the 2007 Final EIS/R, is the restoration and enhancement of wetlands in the South Bay while providing for flood risk management and wildlife-oriented public access and recreation. As such, the public access options analyzed in the action alternatives include completing the Bay Trail spine along the eastern edge of southern Eden Landing in several different ways, depending on the Project's ability to acquire external properties or access easements.

As discussed in MCR 1, the Preferred Alternative includes Trail Route 1 and the public access bridge over the ACFCC. Trail Route 1 was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. The public access bridge over the ACFCC is included in the Preferred Alternative; however, it is important to acknowledge a few limits on what that inclusion means. First, neither the CDFW nor any of the other SBSP Restoration Project primary entities (the USFWS or the State Coastal Conservancy) owns the land on either side of the ACFCC. The Project therefore holds no unique ability or influence to obtain the necessary funding, permits, or property rights to actually build it. The construction of such a bridge, as with the completion of a portion of the proposed trail through southern Eden Landing, would require property acquisition at fair market value or a permanent public access easement. Therefore, the SBSP Restoration Project proponents/CDFW are unlikely to be the sole implementer of a public access bridge over the ACFCC on their own. As noted, building that bridge will require a substantial effort to acquire funding for and perform design, permitting, and construction, and to obtain necessary easements or property acquisition. This is very likely to need cooperation between a number of partner agencies to successfully implement. The SBSP Restoration Project has already begun contributing to that effort by providing NEPA and CEQA coverage for a bridge over the ACFCC.

L-SFBT-2

See response to comment L-SFBT-1 regarding the regarding the inclusion of Train Route 1 in the Preferred Alternative.

L-SFBT-3

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the action alternatives did not include a new trail all the way to San Francisco Bay along OAC because much of the necessary tidal exchange into the project site would come from OAC along the north perimeter of southern Eden Landing, through multiple breaches into OAC and levee lowering. Tidal exchange along OAC is required because the outer, bay-facing levee along Pond E1 and E2 would be improved and because only controlled openings into southern Eden Landing are possible on its southern boundary with the ACFCC. This makes it infeasible to place a trail to the Bay along that alignment. Section 3.6.4 of the EIR analyses the permanent removal of existing recreational features (trails) in locations that visitors have been accustomed to using and that would not be replaced in the general vicinity of the removed feature (Phase 2 Impact 3.6-2). A trail along OAC, although in the Bay Trail plan developed in the 1980's, is not an existing recreational feature. Therefore, the lack of this feature in the action alternatives does not represent a loss in trail and public access experience, nor does it require mitigation.

Note that MCR 1 describes the Preferred Alternative for Phase 2 at Eden Landing, which includes the Bay Trail through the southern half of Eden Landing to ACFCC on a route that minimizes the amount of land acquisition or easement agreements required from outside parties to complete it, reduces potential adverse impacts on sensitive wildlife species from use of public access features, and addresses as many of the goals or visions of plans such as the Association of Bay Area Governments' Bay Trail Plan as feasible to do while still maintaining existing levels of flood risk management and implementing Phase 2 tidal marsh restoration and enhanced managed ponds. Also note that the existing Alameda Creek Regional Trail extends to the Bay along Eden Landing's southern border. Although the ACFCC would be breached, that breach would be armored and bridged to retain public access to the Bay.

L-SFBT-4

This comment does not pertain to the adequacy or accuracy of this Phase 2 EIR. The project proponents/CDFW will continue to coordinate with the San Francisco Bay Trail Project regarding Phase 1 recreational features, as needed for formal designation of the Bay Trail spurs, and for the new Phase 2 Bay Trail spine segment.

L-SFBT-5

As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 7, Public Access Trails (Routes, Elevations, and Parking), the Preferred Alternative includes a trail alignment through southern Eden Landing that would be located upon levees raised to a minimum elevation of 12 feet NAVD88, which is the same height as the proposed mid-complex levee. Because this trail alignment is intended to extend the Bay Trail spine through southern Eden Landing, the design of the levees would follow Bay Trail design guidelines with respect to trail width and surfacing, as practicable.

As discussed in MCR 3, Sea-Level Rise, although there is considerable uncertainty to the rate of sea level rise, particularly after about 2050 due to uncertainties in global carbon emission rates, there is a general consensus among scientists that sea levels near San Francisco are likely to increase by 4 to 6 inches by 2030, 7 to 13 inches by 2050, and 12 to 41 inches by 2100, relative to levels in 2000 (OPC 2018). Although improved levees may be subject to wave run-up, overtopping, and ponding at some point in the future, trails located on levees improved to 12 feet NAVD88 would generally be protected from coastal inundation from high tides during interim future conditions. Building the levees with wider bases to allow for future increases in elevations without adding more fill in waters of the U.S. and State of California or otherwise affecting endangered species habitat will also be considered during detailed design where feasible and reasonable.

Consistent with project goals and objectives, the intent of the project is to maintain or improve existing levels of flood risk management at adjacent and nearby properties. This project goal is one of the primary design objectives and will continue to be incorporated into the design as the project proceeds. Potential future impacts from long-term sea-level rise in San Francisco Bay are not project impacts for evaluation in the NEPA/CEQA document. MCR 3, Sea-Level Rise, and MCR 8, Maintenance Responsibilities, discuss the limits of CDFW's flood management responsibilities.

Finally, regarding maintenance of public access features, the SBSP Restoration Project proponents and the managers of CDFW's ELER are committed to participating in the ongoing provision of wildlife-compatible public access. The SBSP Restoration Project's approach to doing that at ELER has been for the Project to design, plan, permit, and build the public access features using the funding it has assembled from various sources. Then, one or more local project partners would be actively sought to participate in funding and performing the long-term maintenance of trails, bridges, viewing platforms (including signage, benches, etc.), with CDFW's involvement. This approach was successfully implemented in Phase 1 of the Project in northern Eden Landing during, in which the Project team and CDFW provided several new trails, viewing platforms, a kayak launch, and a public access parking area for ADA compliance. The East Bay Regional Park District provides ongoing operation of the Eden Landing Bay Trail spine and Staging Area, while CDFW provides maintenance of those newer Phase 1 features.

L-SFBT-6

See response to comment L-SFBT-5 regarding levee heights and widths for the Preferred Alternative.

L-SFBT-7

Section 3.6.3 of the EIR describes the trail route options analyzed in the action alternatives and provides an explanation of how and why Trail Route 3 was modified subsequent to the Phase 2 project scoping. Trail Route 3 was modified due to a range of potential environmental issues and costs including potential wetland/biological impacts, berm/fill geotechnical and structural issues, right of way ownership, and other concerns associated with the creation of either a retaining wall or boardwalk. Project costs were not the sole reason this trail route alignment was modified.

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), Trail Route 1 was selected as the preferred alignment for the Bay Trail spine through southern Eden Landing. It was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. It address many of the goals and visions of regional recreational resource plans, such as the Association of Bay Area Governments' Bay Trail Plan, while still implementing the project's restoration and flood risk management objectives. In addition, the trail variant selected for the Preferred Alternative reduces potential adverse impacts on sensitive wildlife species by avoiding the southern levee at Pond E6C. This trail alignment was not selected due to project costs, nor would it have been the least expensive trail route to implement.

L-SFBT-8

The project proponents will continue to coordinate with the San Francisco Bay Trail Project regarding Phase 2 recreational features at Eden Landing.

2.2.3 Organizations and Businesses

Comments from organizations and businesses and the responses to those comments are presented in this section.

Alameda Creek Alliance (O-ACA)

Alameda Creek Alliance

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April 25, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
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Brenda.Buxton@scc.ca.gov
phase2comments@southbayrestoration.org

Re: Alameda Creek Alliance Comments on Phase 2 Eden Landing DEIR

O-ACA-1

These are the comments of the Alameda Creek Alliance on the draft Environmental Impact Report/Statement for the Phase 2 Eden Landing project.

The Alameda Creek Alliance is a community watershed group with over 2,000 members, dedicated to protecting and restoring the natural ecosystems of the Alameda Creek watershed. Our organization has been working to restore steelhead trout and protect endangered species in the Alameda Creek watershed since 1997. A consortium of local, state and federal agencies has been working since 1999 to restore steelhead trout and salmon to Alameda Creek, which is considered an "anchor watershed" for salmonid restoration in the entire Bay Area.

We generally support project Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage. Restoring the entire project area to tidal marsh would be the most beneficial alternative for steelhead trout in Alameda Creek.

We support multiple points of access to the restored tidal marshes from lower Alameda Creek, the Bay, and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead. We support breaches of existing levees or levee alterations to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

We support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a larger breach of the levee (which we understand has been determined not to increase flooding risk) to improve fish access to and from the restored marsh.

We support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek. We specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement. We support the proposed placement of root wads and logs outside of Pond E2 to help trap sediment and form beach-like areas while providing some erosion protection.

We support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

O-ACA-1 (cont.)

We support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

O-ACA-2

Attached is a memo prepared by expert fish biologists (Tim Caldwell and Scott McBain of McBain Associates, and Natalie Stauffer-Olsen, California staff scientist with Trout Unlimited) regarding Eden Landing restoration plan alternatives, relative to benefits and impacts to anadromous steelhead trout. The McBain Associates memo summarizes relevant literature and expert opinions on how steelhead may use the restored Eden Landing salt ponds and risks to steelhead which may be associated with project alternatives, such as predation risk, connectivity, and water quality. McBain Associates provides recommendations of project elements that could benefit steelhead, as well as monitoring and research that could better inform final design and implementation.

McBain Associates reviewed literature and solicited expert opinion on the use of California coastal estuaries by juvenile steelhead, with the assumption that steelhead may utilize restored ponds similarly to estuarine habitat. While restored salt ponds will not necessarily function the same way that an estuary would, they expect some similarities during certain seasons and hydrological conditions. Their main suggestions involve reducing predation risk, increasing habitat connectivity and providing suitable water quality for steelhead.

McBain Associates note that if juvenile steelhead can access restored salt ponds effectively and with suitable habitat conditions (i.e. dissolved oxygen, salinity, and water temperature) they have the potential to grow at a higher rate. This is significant because juvenile rearing habitat is currently limiting in Alameda Creek and salt pond restoration has the potential to increase the rearing habitat available and increase juvenile fish growth rates, and subsequent survival.

McBain Associates recommend that multiple points of connectivity between the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel with the restored ponds are critical for juvenile steelhead to best utilize the restored marsh habitat when suitable environmental conditions exist. Multiple points of access will increase connectivity between habitats and allow steelhead to move freely and efficiently between potentially fertile nursery areas in restored marshes and freshwater habitats.

McBain Associates recommend identifying potential freshwater sources and inputs to the restored ponds that could dilute salinity and create a brackish system which would likely result in more suitable rearing habitat for juvenile steelhead. Since there is uncertainty about the salinity levels that juvenile steelhead will be able to endure, they recommend water quality modeling or monitoring to determining the suitability for juvenile steelhead rearing in the restored ponds. Steelhead are adapted to thrive in certain temperature and dissolved oxygen ranges, and seek refuge in freshwater when conditions became unfavorable. Water quality monitoring and/or water quality modeling could determine the sub-daily levels of dissolved oxygen and temperatures that would occur in the restored ponds.

McBain Associates note that predation by introduced fish could be high at levee breach and water control structure access points to restored ponds, where predators are likely to congregate. Providing more than one breach, wider breaches or the maximum number of breaches possible along the Alameda Creek Flood Control Channel and on the bay side of the ponds would likely dilute predation pressure. McBain Associates suggest monitoring predator use of breaches, water control structures and restored ponds if a phased approach is taken, to help inform design of phase two.

O-ACA-3

Finally, McBain Associates recommend addition of pools (with cover) with a residual depth of 2–3 feet to provide juvenile steelhead refugia should they become entrained within restored ponds. Structure cover, such as large wood, could also be added to these areas to provide cover to juvenile steelhead to reduce predation risk by birds, mammals, or other fish.

O-ACA-3 (cont.)

Habitat and depth diversity is important for native fish, but very deep, straight channels should be minimalized. Monitoring of the Napa River salt marsh restoration found that only non-native fish species such as striped bass used man-made, deeper channels, while native fishes generally used shallow margins.

O-ACA-4

We also support investigating whether high food production habitat areas can be created in the restored ponds which do not get flushed each tidal cycle, without causing entrainment of fish. Slowing down water movement and allowing water and food to spread out and accumulate in shallows and finger channels is essential to food production and can provide rich foraging opportunities for many native fish species. We note that potential entrainment of salmonids and estuarine fish would likely be higher in managed ponds than in restored tidal marsh.

O-ACA-5

As far as proposed recreational trails, we generally support all proposed recreation and public access where it does not severely impact native wildlife or habitats. One way to reduce anticipated trail impacts to snowy plovers, such as along the Bay Trail spine, would be to seasonally close those trail segments during plover nesting season or require docent-led access during that period, with open access the rest of the year.

Thank you for your consideration of these comments.

Sincerely,

Jeff Miller
Director

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June 23, 2017

Comments on the Eden Landing Salt Pond Complex Restoration Plan Alternatives Relative to Anadromous Steelhead *(Onchorhynchus mykiss)*

Prepared for: Alameda Creek Alliance

Prepared by: Tim Caldwell, McBain Associates
Natalie Stauffer-Olsen, Trout Unlimited
Scott McBain, McBain Associates

O-ACA-6

INTRODUCTION

A large purchase of solar salt production ponds in the Southern San Francisco Bay by the United States Fish and Wildlife Service and the California Department of Fish and Wildlife was done to restore the salt ponds to tidal marshes. This has become known as the South Bay Salt Pond Restoration Project. The goals of this project are to restore the salt ponds to ecologically functional tidal marshes and wetlands that provide habitat for wildlife, birds, and aquatic organisms, provide public access for wildlife viewing and recreation, and flood management in the Southern San Francisco Bay. There are three pond complexes that are undergoing restoration, Alviso, Ravenwood, and Eden Landing. The subject of this comment is the Eden Landing complex, which is currently in phase 2 of restoration planning. Phase 2 of the Eden Landing Complex is steered at restoring and enhancing ponds south of Old Alameda Creek. The purpose of this document is to provide comment on the restoration alternatives for the Eden Landing Complex on behalf of the Alameda Creek Alliance, specifically on the potential benefits and risks associated with the alternatives to steelhead (*Onchorhynchus mykiss*) and other anadromous fish that may use the restored ponds.

There is very little scientific information available that describes the use of restored salt ponds by juvenile *O. mykiss*. To prepare these comments, we reviewed literature on the use of coastal estuaries by juvenile *O. mykiss*, with a focus on systems from California, with the assumption that *O. mykiss* may utilize restored ponds similarly. Secondarily, we initiated correspondence with many of the lead authors on these papers to get their current opinion and hypotheses on the role the salt pond restoration may play in benefiting juvenile *O. mykiss* through increased growth, survival, and fitness.

First, we summarize the relative literature and expert opinions on how *O. mykiss* may use the restored salt ponds and risks to *O. mykiss* which may be associated with project alternatives. We also provide a recommendation of the preferred alternative and comment on potential changes that could be made based on the reviews of literature and expert opinion, with a focus on benefits for *O. mykiss*. We then conclude with recommendations on monitoring and research that could be done in the near term to better inform final design and implementation of Eden Landing Phase 2 that may better benefit *O. mykiss*.

O-ACA-6 (cont.)

SUMMARY OF LITERATURE PERTINENT TO THE USE OF TIDAL MARSHES AND RESTORED PONDS BY SALMONIDS IN THE SOUTHERN SAN FRANCISCO BAY

1) **Hobbs, J, (2015). Steelhead smolt outmigration and survival study: Year 2 Stream Surveys.**

Summary of research: Researchers attempted to determine how juvenile *O. mykiss* from Guadalupe River would utilize a water control structure on managed salt ponds in the Alviso Salt Pond Complex Restoration project. Ultimately, the goal was to understand if juvenile *O. mykiss* were at a risk of entrainment or if they successfully utilized the habitat as a rearing area that increased growth rates, survival and population. They also determined how predators such as striped bass may have utilized water control structures for predation. In 2014, 32 juvenile *O. mykiss* were PIT tagged in Guadalupe River and tracked with PIT antennae placed at 3 of the 5 slots on the water control structure at the A8 pond notch. In addition, 18 Striped Bass (*Morone saxatilis*) were tagged near the notch. Unfortunately, the antennae did not cover the entire A8 notch and one of their antenna was destroyed by high flows, thus they were only able to asses 2 of the 5 slots in the water control structure. None of the *O. mykiss* tagged in Guadalupe River were detected at the A8 notch; however, the researchers suggest that it may have been due to poor coverage (3 slots were not instrumented) of the antennae. While none of the tagged *O. mykiss* were detected, 3 different *M. saxatilis* were detected, and one of the fish was detected multiple times, suggesting it was spending significant time in the notch habitat. This provides evidence to suggest that predators will target breaches, and with only one breach per pond, the risk of predation to juvenile *O. mykiss* would be high. The researchers also interviewed anglers that frequent the notch and reported that *M. saxatilis* up to 50 lbs have been caught there and sometimes 50 fish per day.

Potential implications for the Eden Landing Complex restoration: This paper suggests that predation rates could be high at breaches and water control structures, and it is unclear if *O. mykiss* will access the restored ponds or how they could become entrained. The maximum number of breaches possible would likely dilute predation pressure at any one water control structure/breach.

O-ACA-7

2) **Hayes, S.A., et al. (2008). Steelhead growth in a small central California watershed: Upstream and estuarine rearing patterns. Transactions of the American Fisheries Society. 137:114–128.**

Summary of research: The goals of this paper were to assess and compare growth rates in stream rearing habitat and estuary rearing habitat in a typical coastal California watershed (Scott Creek). The authors tagged and recaptured juvenile *O. mykiss* to determine growth rates among habitats. The *O. mykiss* that were rearing in the stream grew at 0.01% per day during summer, while those rearing in the estuary grew at a significantly higher rate (0.2–0.8% per day). This suggests that *O. mykiss* which reared in the estuary grew larger and had a higher probability of ocean survival and returning to spawn as an adult.

O-ACA-7 (cont.)

Potential implications for the Eden Landing Complex restoration: This paper suggests that if juvenile *O. mykiss* could access the salt ponds effectively and with suitable habitat conditions (i.e. dissolved oxygen, salinity, and water temperature) they have the potential to grow at a higher rate. This is significant because juvenile rearing habitat is currently limiting in Alameda Creek and salt pond restoration has the potential to increase the rearing habitat available. However, there is considerable uncertainty in the salinity levels that the fish will be able to physiologically endure. The current design may not allow enough freshwater to enter the restored ponds, which may reduce the ability of *O. mykiss* to rear within the restored ponds.

O-ACA-8

3) **Bond, M.H., et. al., (2008). Marine survival of steelhead (*Oncorhynchus mykiss*) enhanced by a seasonally closed estuary. Canadian Journal of Fish and Aquatic Sciences. 65: 2242–2252.**

Summary of research: In this publication, the researchers continued analysis from Hayes et. al. (2008), and determined the adult spawning return rate and size of ocean entry by juveniles from estuary reared and stream reared *O. mykiss* in Scott Creek, CA. This was done using PIT tagged fish and by back calculating the size of juvenile at ocean entry from returning adults via a fish scale radius to fish length regression. Based on the tagged fish analysis, 87% of returning adults had spent time rearing in the estuary. Via the scale and length analysis, the authors estimate that 95% of the returning adults were estuary reared fish. This suggests that fish which rear in the estuary for the summer before entering the ocean in the fall grow to a significantly larger size and have a higher probability of ocean survival than those which only reared in the estuary.

Potential implications for the Eden Landing Complex restoration: This study supports a hypothesis that if juvenile *O. mykiss* can access the restored tidal pond without significant predation, entrainment associated mortality, and with favorable water quality conditions, then restoration may help alleviate a likely juvenile rearing constraint on the Alameda Creek water shed. Higher growth rates and larger size smolts will increase their probability of ocean survival and returning to spawn as adults. However, in the current design, salinity levels may be too high for juvenile *O. mykiss* to utilize the habitat.

O-ACA-9

4) **Cannata, S.P. (1998). Observations of steelhead trout (*Oncorhynchus mykiss*), Coho Salmon (*O. kisutch*) and water quality of the Navarro River Estuary/Lagoon, May 1996 to December 1997.**

Summary of research: This paper described the use of a coastal estuary/lagoon system in Northern California by *O. mykiss* and Coho Salmon (*Oncorhynchus kisutch).* In addition, the research assessed dissolved oxygen, salinity, and temperature to determine if parts of the estuary became unable to sustain salmonid life (i.e. anoxic or hyper-saline environments). The research documented use of the estuary system throughout the entire year by young-of-year, age-1 and age-2 juvenile *O. mykiss*. In a comparison between estuary reared and river reared *O. mykiss* that were greater than 110 mm in length, fish from the estuary had a higher body weight. The authors also suggest that a large proportion of the juvenile *O. mykiss* population utilizes the estuary for rearing year-round.

O-ACA-9 (cont.)

Water quality was measured with the goal of relating temperature, dissolved oxygen, and salinity to fish abundance. They observed that once the estuary became completely closed off from tidal influences from sand bar formation, a halocline forms. A halocline forms when there is a difference in salinity levels along a depth gradient, with the warmer and denser saline water settled below the cooler and less dense freshwater is at the top. This is most apparent in the areas closest to the ocean. Because of this phenomenon, habitat can increase or decrease relative to streamflow. For example, in years with low streamflow, areas stratified by the halocline may be larger relative to years with higher streamflow, because less freshwater is delivered and the potential of the halocline breaking down decreases. When the estuary is stratified by levels of salinity, concentration of dissolved oxygen and temperature reach lethal levels for juvenile salmonids in the deeper waters and fish mush seek out refuge in surface waters, nearshore zones, or areas further upstream, which was observed by this study.

Potential implications for the Eden Landing Complex restoration: This study provides evidence to suggest that *O. mykiss* would utilize tidal areas if they are provided safe access. In addition, this study highlights the importance of water quality within the tidal area. Water quality models should be developed for the ponds being restored to determine if environmental conditions would be suitable for *O. mykiss* if they were in the ponds.

O-ACA-10

5) **Zedonis, P.A. (1990). The biology of juvenile steelhead (*Oncorhynchus mykiss*) in the Mattole River estuary/lagoon. Master's Thesis. Humboldt State University.**

Summary of research: This study was similar in design and outcome to Cannata et. al. (1998). Juvenile *O. mykiss* catch per unit effort and population estimates were made for lower and upper areas along the Mattole River Estuary. Results suggest that juvenile *O. mykiss* utilize the estuary for rearing year-round. However, during summer and when the estuary becomes closed off, the formation of a halocline can limit habitat as dissolved oxygen concentration and temperature reach lethal levels in the deep-water areas closest to the ocean. This effect is particularly problematic during low streamflow years. This study also examined diet of juvenile *O. mykiss* in the estuary, which were dominated by invertebrates and there was no evidence of food limitation.

Potential implications for the Eden Landing Complex restoration: This study suggests that estuaries (most comparable habitat to restored salt ponds with information on *O. mykiss*) are highly fertile nursery areas, and under the right water quality conditions could increase growth rates of juvenile *O. mykiss*. Water quality modeling or monitoring would be beneficial in determining the suitability for juvenile *O. mykiss* rearing in the restored ponds. Similarly, identification of a freshwater source that would dilute salinity and create a brackish system would likely result in more suitable rearing habitat for juvenile *O. mykiss*. In the current plan, salinity maybe too high for *O. mykiss* to successfully utilize the restored ponds. Monitoring of fish movement and habitat selection would be beneficial in determine how well they could utilize the restored ponds.

O-ACA-11

SUMMARY OF EXPERT OPINIONS PERTINENT TO THE USE OF TIDAL MARSHES AND RESTORED PONDS BY SALMONIDS IN THE SOUTHERN SAN FRANCISCO BAY

1) Dr. James Hobbs (University of California – Davis)

Dr. Hobbs was the author on the first paper reviewed above which was the only study that examined use of the salt ponds by *O. mykiss*. His main concerns about design were predation risks at breach points, which was observed from his study which noted the presence of predators at breach points and water control structures. To avoid this, multiple breach points for each pond are ideal so that *O. mykiss* avoid congregating in one location where they are vulnerable to predators. Dr. Hobbs also recommends not doing any managed ponds and to use the full tidal restoration alternatives. In addition, he suggests that breaching ponds in order furthest from bay to closest to bay is recommended so that sediment does not accumulate in the closest to bay pond and block natural restoration of those furthest from the bay. Dr. Hobbs also suggests that if the ponds are designed to benefit *O. mykiss, O. tshawtscha* (Chinook Salmon) would also benefit.

O-ACA-12

2) Mike Wallace (California Department of Fish and Wildlife)

Mike Wallace has authored reports on the use of juvenile *O. kisutch* (Coho Salmon) in Humboldt Bay. Based on his observations and studies on *O. kisutch,* Mr. Wallace stressed considerable uncertainty about how *O. mykiss* may use the restored ponds, but would likely result in some use. His primary concern was about the water quality issues that may arise in the restored ponds, and that it is possible that short term anoxic conditions could be detrimental to any *O. mykiss*, and suggests that water quality be modeled. He also suggests adding deeper pools and large wood cover to the restored tidal ponds, which may act as refugia for juvenile *O. mykiss* to reduce stranding mortality and predation during the tidal cycles.

O-ACA-13

3) Dr. Morgan Bond (NOAA)

Dr. Bond was an author of one of the peer reviewed papers above (Bond et al. 2008), and suggests that there is no real comparable habitat to the tidal ponds, so finding peer-reviewed literature and white papers may be difficult. She reiterated her results from the paper and suggests there could be considerable movements between the streams and restored ponds over a large variety of time scales (i.e. from daily to annual movement). The ability to search for and forage in preferred habitat likely increases growth through increased food availability, and condition through improved water quality conditions such as temperature, DO, and salinity.

O-ACA-14

COMMENTS ON PLAN ALTERNATIVES

We feel that it is beneficial that the plan alternatives included designs that could facilitate the use of the restored ponds by juvenile *O. mykiss* as rearing habitat through breaches and tidal restoration. Based on our literature reviews and interviews, we believe that providing adequate access to the ponds and ensuring favorable water quality would likely allow juvenile *O. mykiss* to grow at a faster rate and out-migrate at a larger size, which increases the probability of ocean survival and returning to spawn. However, based on our review of literature, contact with experts, and our own opinions we do have some comments to the plan alternatives. Below we summarize our concerns with the plan alternatives: predation risk, connectivity, and water quality.

1) Predation Risk

Alternative plans B–D included various breaches and channel constructions that have the potential to be utilized by juvenile *O. mykiss* for rearing habitat. However, these plans included only one breach for each pond, which may increase the risk for predation on juvenile *O. mykiss* as predators are likely to congregate at the breaches (Hobbs 2015). We suggest that along the Alameda Creek Flood Control Channel (ACFCC) and on the bay side of the ponds, multiple breaches be put in place on each pond to decrease the potential of predation at pond breaches. The addition of the bay side breach would allow easier out migration and connectivity with the Bay, while simultaneously reducing the risk of predation. Monitoring predator use could also be done in the current Phase 1 portion of the Eden Complex to better understand the risk of predation to juvenile *O. mykiss* and help inform design of Phase 2.

O-ACA-15

2) Connectivity

The breaches and channel construction in the current plan alternatives provide only a single location in and out of each pond. Based on our literature review, we feel that multiple points of connectivity are critical for juvenile *O. mykiss* to best utilize the pond habitat when suitable environmental conditions exist. For example, Bond et al. (1998) and Cannata (1998) suggest that in most estuaries, *O. mykiss* must be able to move freely and efficiently between estuary and freshwater habitats to successfully utilize the fertile environments provided by the estuary. While salt ponds will not necessarily function the same way that an estuary will, we expect some similarities during certain seasons and hydrological conditions. Thus, we suggest creating multiple points of access to each pond along the ACFCC and the bay to increase connectivity between habitats. To help inform the design of Phase 2, monitoring of juvenile *O. mykiss* habitat use of Phase 1 could be done. This would determine the level of connectivity required to make the habitat suitable and be valuable in the design of breaches.

O-ACA-16

3) Water Quality

O. mykiss are adapted to thrive in certain temperature and dissolved oxygen ranges, and levels too far outside of those ranges can be stressful or lethal. Studies have found that *O. mykiss* utilize estuaries, but seek refuge in freshwater when conditions became unfavorable (Hayes et al. 2008, Cannata 1998). To address this concern, we suggest water quality monitoring and/or water quality modeling to determine the sub-daily levels of dissolved oxygen and temperatures that would occur in the restored ponds. The Eden Landing Phase

O-ACA-16 (cont.)

1 project provides a unique opportunity to conduct this type of monitoring and research. For example, water quality monitoring (particularly water temperature and salinity) could be performed to evaluate seasonal rearing habitat suitability at a nearby site to inform Phase 2 designs. We also suggest the addition of pools (with cover) with a residual depth of 2–3 feet to provide juvenile *O. mykiss* refugia should they become entrained within the ponds. Structure cover, such as large wood, should also be added to these areas to provide cover to juvenile *O. mykiss* to reduce predation risk by birds, mammals, or other fish.

O-ACA-17

RECOMMENDATIONS

Based on current information available on potential *O. mykiss* use of restored tidal marsh/ponds, Alternative B would be most likely to benefit to juvenile *O. mykiss* because it provides full tidal restoration and does not include any managed ponds, thus providing the most amount of habitat for juvenile salmonids. We would like to see uncertainties regarding predation, connectivity, and water quality can be addressed in the upcoming design phases (30% to 100% designs). We also support a phased restoration approach with an adaptive management plan and S.M.A.R.T. (specific, measurable, achievable, relevant and time-bound) goals and objectives to measure success of the first phase(s) and to inform subsequent phases of the restoration.

O-ACA-18

Given the considerable uncertainty about how *O. mykiss* will utilize the newly restored habitat, we recommend monitoring and research which will aid in the adaptive management plan for the pond restorations. For example, we suggest considering fish tagging efforts on the Eden Landing Phase 1 followed by monitoring after the Phase 2 monitoring restoration project to help better understand how fish utilize the restored ponds and better inform the design and monitoring or modeling of water quality within the restored ponds to determine habitat suitability for *O. mykiss*. Directly tagging *O. mykiss* would be the most effective way of monitoring *O. mykiss* use of the restored salt ponds; however, Alameda Creek has a very small population of wild *O. mykiss,* thus any tag-induced mortality could be very detrimental. Similarly, tagging hatchery produced *O. mykiss* and releasing them would dilute the genetic pool of the current wild population, and is therefore not recommended. As an alternative, we suggest that tagging hatchery juvenile *O. tshawytscha* (Chinook Salmon) be considered to monitor the use of the restored ponds by anadromous salmonids. While *O. tshawytscha* and *O. mykiss* will likely utilize the restored habitat differently for their different life stages, monitoring juvenile *O. tshawytscha* habitat use would still provide improved understanding of how anadromous salmonids may utilize restored salt ponds.

O-ACA-19

Given the substantial amount of resources and time spent restoring the Eden Landing Complex salt ponds, we believe that it is best to review all plans in detail to best inform the design so that it will be beneficial ecologically. Based on our literature review and input from experts, this restoration project, with the appropriate design, could help support the recovery of an *O. mykiss* population in Alameda Creek, as well as benefit anadromous salmonid production from other bay area streams. We look forward to continuing our engagement in the design and plans by providing relevant scientific and design input.

Response to Alameda Creek Alliance (O-ACA)

O-ACA-1

See MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative for implementation as part of the Phase 2 project at Eden Landing. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes the maximum number of connections outlined in the Draft EIS/R: two connections to the Bay Ponds and one to the Southern Ponds. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. The Bay Ponds would be opened to tidal flows from several breaches on the northern border with OAC and from two locations along the southern border with the ACFCC and there would be interior breaches to connect the four Bay Ponds to each other. The Southern Ponds would be opened to muted tidal flows through a culvert system, making them accessible to salmonids as well. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative.

The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals unless monitoring and implementation of the Adaptive Management Plan provide a basis for determining that tidal restoration of Ponds E6 and E5 is most beneficial. Similarly, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

O-ACA-2

The attachment was reviewed and considered during selection of the Preferred Alternative. Specific issues raised by McBain Associates are addressed below in response to comments O-ACA-6 through O-ACA-19. As discussed in response to comment O-ACA-1, the Preferred Alternative includes fish habitat restoration and enhancement features intended to reduce predation risk and increase habitat connectivity between the ACFCC and the ponds, within the ponds themselves, and between the ponds and OAC.

O-ACA-3

The addition of pools and structural cover will be further considered during detailed design. As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate. Also note that a bottom elevation of -4 feet NAVD88 was chosen for many of the pilot channels in the Bay Ponds to allow for about 1 foot of water in the channels during the lowest spring tide to prevent fish stranding (discussed in Appendix D). During mean lower low water (-1.1 feet NAVD88), about 3 feet of water would remain in the channels.

O-ACA-4

One of the primary design goals for the tidally restored ponds is to regularly fill and drain. The filling increases exchange and allows sediment accretion throughout the pond's interior, while the draining allows for vegetation growth in the restored marsh. As bottom elevations increase, pools and pockets may develop that hold water. Even in the short-term, transition zones to upland areas may not be fully flushed on a daily basis and differential settling may create some areas that pool. The SBSP Restoration Project proponents support adaptive management and science-based monitoring. Estuarine fish would be monitored as per the Adaptive Management Plan. Species richness and abundance of native fish species would be monitored in a range of habitats including restored marshes and associated unvegetated shallow water areas, major and minor sloughs, and deep and shallow-water ponds. Some of these habitats would likely be high food-production habitat.

O-ACA-5

As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 7, Public Access Trails (Routes, Elevations, and Parking), the trail route chosen for the Preferred Alternative was selected, in part, to reduce potential adverse impacts on sensitive wildlife species from use of the spine trail open year-round (no long-term seasonal closures, except for approximately 10 days in November through January for sport waterfowl hunting).

O-ACA-6

As discussed in response to comment O-ACA-1 and MCR 5, Fish Habitat Restoration, ACFCC would have two connections to the Bay Ponds and one to the Southern Ponds in the Preferred Alternative. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. Because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, CDFW intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-ACA-7

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative includes multiple connections between the ACFCC and the southern Eden Landing ponds which would provide increased habitat connectivity for migrating salmonids and other native fish. As per the Adaptive Management Plan, estuarine fish would be monitored in foraging and rearing habitats within the project. Water quality parameters such as dissolved oxygen would also be monitored. Note that salinity and water temperature would be set by ambient conditions: the estuarine environment would reflect the combined mixture of fluvial flows and water from the Bay that passes through breaches and culverts, with the interior of the ponds generally expected to be well mixed due to tidal exchange. As such, salinity is expected to be lower when there is high fluvial outflow.

O-ACA-8

See response to comment O-ACA-7.

O-ACA-9

As described in response to comment O-ACA-4, one of the primary design goals for the restored tidal ponds is to regularly fill and drain. The filling increases exchange and allows sediment accretion throughout the pond's interior, while the draining allows for vegetation growth in the restored marsh. The creation of pilot channels would facilitate the filling and draining of the ponds. Small channels are expected to form on the pond bottoms which also facilitate drainage. Although sediment accretion would raise bottom elevations, the formation of a feature such as a sand bar that inhibits tidal exchange throughout the pond interior and creates a halocline is not expected when regularly inundated. When marsh habitat is fully developed, some pools and pockets may develop that hold water which does not get regularly flushed with the tides, but channel development should occur allowing smaller channels and pond interiors to drain to deeper channels expected to fully drain to the Bay. This expectation of a well-mixed environment is supported by the results of the two dimensional hydrodynamic modeling conducted for the preliminary design (see Appendix D, Attachment 1). As discussed in Section 3.3.3 of the EIR, dissolved oxygen concentrations are correlated with hydraulic residence time and when mixing is high, hydraulic residence times are typically short and dissolved oxygen concentrations remain high.

O-ACA-10

See response to comments O-ACA-7 and O-ACA-9. Also note that the Navarro River and Mattole River estuaries/lagoons have limited tidal exchange due to long-shore transport of beach sand which blocks the opening at the mouth of the estuary. This differs from restored tidal ponds where the tidal prism would be increased due to breaches in the Bay Ponds and where the downgradient habitat is predominately mudflats (not sandy beaches). Conditions near the breach locations are expected to be erosional, not depositional, after restoration due to the increased tidal prism. (This has been the case at other restored ponds, such as the Island Ponds in Alviso, Napa Plant site, and North Bay salt ponds.) As such, the Bay Ponds are expected to well mixed and fill and drain with water from Alameda Creek, OAC, and the Bay, on a twice daily basis.

O-ACA-11

See response to comments O-ACA-1 and MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative. Implementing the suggested breaching sequence for the ponds will be further considered during detailed design, but the restoration of the Bay Ponds is expected to be first, then other pond groupings.

O-ACA-12

As per the Adaptive Management Plan, estuarine fish would be monitored in foraging and rearing habitats within the project. Water quality parameters such as dissolved oxygen would also be monitored. Note that anoxic conditions are not expected to develop in the Bay Ponds if it fully fills and drains with the tides and multiple connections to OAC and to the ACFCC will facilitate tidal exchange. As discussed in response to comment O-ACA-6, if adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-ACA-13

As discussed in response to comment O-ACA-1 and MCR 5, Fish Habitat Restoration, multiple connections between ACFCC and the Bay Ponds are intended to provide habitat connectivity and access to potential foraging and rearing habitat in the ponds.

O-ACA-14

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative includes multiple connections between the ACFCC and the southern Eden Landing ponds which would provide increased habitat connectivity for migrating salmonids and other native fish. However, the bay-facing levee, including Pond E2 west levee, would be improved, rather than breached. The improved levees are expected to maintain or improve flood risk management and reduce the potential for scour of the restored habitat.

Estuarine fish would be monitored in the restored area as per the Adaptive Management Plan. As discussed in response to comment O-ACA-6, because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-ACA-15

See response to comments O-ACA-1 and MCR 5, Fish Habitat Restoration, regarding habitat connectivity. See response to comment O-ACA-14 regarding improvement to the bay-facing levee. Also note that steelhead and estuarine fish were monitored in the Phase 1 area, per the Adaptive Management Plan.

O-ACA-16

See response to comment O-ACA-7 and O-ACA-9 regarding salinity, temperature, water quality monitoring, and modeling. See response to comment O-ACA-3 regarding the addition of pools and structural cover.

O-ACA-17

See response to comment O-ACA-1, MCR 1, Selection of the Preferred Alternative, and MCR 5, Fish Habitat Restoration, regarding the types of fish habitat restoration and enhancements included in the Preferred Alternative. See also OACA-3 and MCR 2, Details of Designs, regarding the SBSP Restoration Project Management Team's commitment to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public.

O-ACA-18

See response to comment O-ACA-14 regarding monitoring of estuarine fish in the restored ponds per the Adaptive Management Plan. See also O-ACA-4 regarding the SBSP Restoration Project proponent's support of science-based monitoring. It should also be noted that CDFW fisheries staff generally do not support the use of hatchery fish as a proxy for wild run fish; this issue was addressed in the Phase 1 Pond A8 studies.

O-ACA-19

The project proponents will continue to coordinate with interested parties during design and construction of SBSP Restoration Project, Phase 2 at the ELER. See response to comment O-ACA-3 and MCR 2, Details of Designs, regarding the SBSP Restoration Project Management Team's commitment to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public.

Bay Planning Coalition (O-BPC)

Bay Planning Coalition

June 5, 2018

Ms. Brenda Buxton, Deputy Program Manager
California State Coastal Conservancy
1515 Clay Street
Oakland, CA 94111
VIA E-MAIL TO: phase2comments@southbayrestoration.org

Re: Comments on the South Bay Salt Pond Restoration Project Phase 2 Draft Environmental Impact Statement/Environmental Impact Report for Eden Landing Ecological Reserve

Dear Ms. Buxton:

O-BPC-1

Bay Planning Coalition (BPC) writes to express its support for the South Bay Salt Pond (SBSP) Restoration Project Phase 2 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Eden Landing Ecological Reserve (ELER). BPC is a nonprofit, member organization that advocates for sustainable commerce, industry, infrastructure, recreation and the natural environment connected to the San Francisco Bay and its watershed. Together with our nearly 150 member organizations, we work diligently to ensure, among other things, that land on the Bay is used wisely and developed in economically and environmentally sound ways.

The Phase 2 actions described in this Draft EIS/EIR tier from the 2007 Final EIS/EIR and consist of projects in some of the areas of the ELER. Phase 2 would incrementally advance the 50-year plan to convert up to 90% of the former salt ponds to tidal marsh, while at least 10% would remain as enhanced managed ponds.

BPC actively promotes the restoration of tidal marsh and the vital opportunity to beneficially reuse dredged sediment to achieve restoration goals, including, but not limited to, flood risk management. The continuation of the SBSP Restoration Project and its new actions in Phase 2 will be achieved more expeditiously with the beneficial use of dredged sediment.

For example, the ELER tidal salt marsh restoration alternatives under consideration include construction of a large earthen bayfront feature as well as upland transition zones and/or raised pond bottom elevations. All of these restoration and/or flood protection features could make use of dredged material from nearby port navigation channels, the ports of Oakland and Richmond, and the closest in proximity being the Port of Redwood City's federal channel.

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Bay Planning Coalition

O-BPC-1 (cont.)

The beneficial use of dredged material is a common action for all alternatives and will assist to improve habitat complexity and allow appropriate ELER management. The proposed construction design concept(s) is described in the Draft EIS-EIR's Appendix E, "*Preliminary Design Memorandum of Dredged Material Placement at Southern Eden Landing*".

Another important related project, supported by BPC, is the California State Coastal Conservancy's non-federal cost-sharing proposal, *Resilient San Francisco Bay Project*, for consideration as one of the ten selected projects in the beneficial use pilot program established by the U.S. Army Corps of Engineers pursuant to Section 1122 of the Water Resources Development Act of 2016.

Montezuma, Cullinan Ranch, Eden Landing and Bel Marin Keyes are the four placement sites in the proposal with Eden Landing and Bel Marin Keyes awaiting permits and all would then be eligible for dredged material placement under the Resilient San Francisco Bay Project (if selected as one of the ten).

BPC fully endorses the ELER Phase 2 project and accompanying Draft EIS/EIR and Appendix E. We look forward to the Final certified environmental document so that the ELER site permitting can be accomplished as soon thereafter as possible to enable dredged material placement for restoration and shoreline resilience.

Sincerely yours,

John A. Coleman
Chief Executive Officer
Bay Planning Coalition

Cc: LTC Travis Rayfield, San Francisco District, U.S. Army Corps of Engineers
Jason Brush, U.S. EPA, Region IX
Larry Goldzband, San Francisco Bay Conservation and Development Commission
Bruce Wolfe, San Francisco Bay Regional Water Quality Control Board
John Krause, California Department of Fish and Wildlife
John Bourgeois, South Bay Salt Pond Restoration Project

Response to Bay Planning Coalition (O-BPC)

O-BPC-1

The project proponents appreciate BPC's support of the project. As discussed in MCR 1, Selection of the Preferred Alternative, and MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the Preferred Alternative for Phase 2 at Eden Landing includes the potential beneficial reuse of dredge material to raise pond bottom elevations and to build habitat transition zones in several ponds. Dredge material would be placed in the Bay Ponds (E1, E2, E4, and E7) and may be used to raise portions of Ponds E5 and E6, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of those ponds to tidal marsh.

Also note that, the SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material. The project would benefit from the incorporation of dredge material but does not depend on it. The inclusion of beneficial reuse of dredge material in the Phase 2 Preferred Alternative at Eden Landing should not be interpreted as a commitment to wait indefinitely for that material to be supplied to the project site.

Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper and Ohlone Audubon Society (O-CR1)

Comments submitted via electronic mail only

Anne Morkill, Project Leader
U.S. Fish and Wildlife Service
Don Edwards San Francisco Bay NWR
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21 May 2018

Brenda Buxton
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Electronic Mail address: *phase2comments@southbayrestoration.org*

Re: Draft Environmental Impact Statement/Report (DEIS/DEIR), Phase 2, Eden Landing Ecological Reserve Complex, South Bay Salt Pond Restoration Project

Dear Ms. Morkill and Ms. Buxton,

O-CR1-1

This responds to the DEIS/R for proposed Phase 2 actions of the South Bay Salt Pond Restoration Project (SBSPRP) at the Eden Landing Ecological Reserve. We thank you for the opportunity to provide comments and incorporate by reference comments submitted on behalf of the Citizens Committee to Complete the Refuge by Dr. Peter Baye.

Our environmental organizations have been involved in the South Bay Salt Pond Restoration Project (SBSPRP) from the beginning. We support the restoration of tidal marsh in the South Bay and have been pleased to see the progress being made during the Interim Stewardship Program and during the implementation of Phase 1 actions. We appreciate the contribution of scientific information stemming from the applied science studies of the project.

We strongly support tidal marsh restoration in the South Bay, and understand the important ecological functions and values of tidal marshes (e.g. fisheries, nutrient recycling, water quality, flood control). Equally important however, is the project objective of maintaining current migratory and resident waterbird species that have come to utilize the existing salt ponds and associated structures such as levees. As has been reported by Warnock et al[1],

> "San Francisco Bay contains the most important salt pond complexes for waterbirds in the United States, supporting more than a million waterbirds through the year (Accurso 1992; Page et al. 1999; Takekawa et al. 2001). Single day counts of waterbirds in the salt ponds during winter months can exceed 200,000 individuals (Harvey et al. 1992), and single day counts during peak spring migration have exceeded 200,000 shorebirds in a single salt evaporation pond (Stenzel and Page 1988)."

[1] Warnock, N., Page, G.W., Ruhlen, T.D., Nur, N., Takekawa, J.Y., and Hanson, J.T., 2002, Management and conservation of San Francisco Bay salt ponds: Effects of pond salinity, area, tide, and season on pacific flyway waterbirds: v. 25, iss. SPECIAL PUBL.2, p. 79-92.

CCCR Comments SBSPRP ELER Phase 2 DEIS/DEIR 5-21-18 Page 1 of 8

O-CR1-2 Based upon the importance of managed ponds to migratory and resident waterbirds, the uncertainty of how many of the SBSPRP ponds will ultimately be converted to tidal marsh and the uncertainty of whether ponds not converted in Phases 1 and 2 will have sufficient carrying capacity to maintain the species diversity and abundance of our migratory and resident waterbirds, we recommend Alternative D as the preferred Alternative for Phase 2 at the Eden Land Ecological Reserve (ELER).

O-CR1-3 Public access alternatives:

Due to the uncertainty regarding the suite of waterbirds the Inland and Southern ponds will be managed for, we strongly urge that Proposed Trail Route 3 is selected. If, as the restoration proceeds, monitoring reveals human disturbance will not be an issue for foraging, roosting or nesting waterbirds, additional trails could be incorporated to the project. Currently, there is regular usage of the trail along the Alameda Creek Flood Control Channel (ACFCC) by pet owners walking dogs off-leash. Connection of public access routes to the trail along the flood control channel could result in unintended management issues. As an example, posted restrictions were found to provide no deterrence to dog owners walking their dogs off-leash on Bair Island trails. The lack of compliance with posted restrictions ultimately resulted in the prohibition of dog walking on Bair Island trails.

We strongly oppose the proposed alignment of the proposed trail (purple slashed lines) depicted in Alternative C as this alignment (e.g. human disturbance) could have adverse impacts to California Black Rail and Ridgway's Rail use of occupied habitat in Old Alameda Creek.

O-CR1-4 Levee breach of Alameda Creek Flood Control Channel into Bay Ponds E2 and E4:

This action has been proposed in Alternative B. What are the ramifications of including this component under Alternative D?

O-CR1-5 Additional questions and comments:

We appreciate the inclusion of some of the information requested in our scoping comments, e.g. existing pond salinities, pond bed elevations, identification of bird guilds currently utilizing the ponds. However, we do have questions, comments and concerns regarding the actions proposed in Phase 2.

- Alternative D is described as the phased implementation of tidal marsh restoration, with the caveat that "...if ongoing wildlife monitoring conducted under the AMP shows that the pond-associated wildlife species continue to require pond habitat, the Inland Ponds and Southern Ponds could be retained in that managed pond configuration indefinitely."

The description of the beneficial reuse of dredged material indicates that the target elevation of pond bottoms will be 6.5 feet NAVD88 and that both the Bay and Inland ponds will be filled. There is no indication this aspect of implementation will be phased. If that is the case, will it still be possible to manage the Inland ponds for diving or piscivorous bird guilds as those are the major guilds that will be displaced by conversion of the Bay ponds to tidal marsh?

O-CR1-6
- Habitat Islands – What methodology will be employed to prevent the development of cracks in habitat islands created from dredged materials? Bay mud can form deep cracks as it dries which could pose a threat to chicks of nesting birds.

O-CR1-6 (cont.)

Ground cloth may be required under gravel, oyster shells or sand to prevent vegetation on islands designed for use by nesting Western Snowy Plovers or California Least Terns.

O-CR1-7

- Page 3.5-17 lists the California Least Tern as an "uncommon to rare forager." Page 3.5-13 states, Ponds E1 and E2 and the shallow bay outboard of the ponds are regularly used as foraging areas by the California Least Terns during the post-breeding period in late summer. Please correct the inconsistency and also describe what suitable pond replacement habitat exists locally for the E1 and E2 ponds.

O-CR1-8

- Table 3.5-2 Special-Status Animal Species and Their Potential to Occur in the Phase 2 Eden Landing Ponds: The text pertaining to the Black Skimmer (*Rynchops* niger) should be revised to reflect that a few individuals of this species have been regularly observed nesting on ponds at the Hayward Shoreline. Dave Riensche of the East Bay Regional Park District can be contacted for additional information. This information has also been documented in the Colonial Waterbird Nesting Summaries for the South San Francisco Bay conducted by the San Francisco Bay Bird Observatory dating back at least to 2008.

O-CR1-9

- Page 3.5-56:

> "San Francisco Bay is one of the most important stopover and wintering areas on the west coast for these species. Within San Francisco Bay, the majority of these birds are typically found in the South Bay. In the South Bay, these small shorebirds forage primarily on intertidal mudflats at low tide and to a lesser extent along the margins of ponds or in shallow ponds. These birds roost and nest on sandy or gravel islands, salt flats, and levees.
>
> Conversion of former salt ponds to tidal habitats is expected to increase the availability of intertidal mudflat foraging area at low tide in the short term, as some of the breached ponds would provide intertidal mudflat and shallow water habitats for some time before accreting enough sediment to become vegetated. *However, in the long term, sedimentation patterns of the South Bay are expected to result in a loss of intertidal mudflat, both due to conversion to emerging fringe marsh and conversion to subtidal habitat due to scour as a result of increased tidal flux and eventually because of sea-level rise.* The latter of these is expected to occur even in the absence of the SBSP Restoration Project, but mudflat loss is expected to be greater if ponds are breached and tidal habitats restored (2007 Final EIS/R) as part of the SBSP Restoration Project. However, intertidal mudflats are the dominant habitat of the South Bay, and only a small percentage of the total area of mudflats is within or adjacent to the Phase 2 areas and even a small portion of those are expected to be adversely affected by Phase 2 actions at southern Eden Landing.
>
> …Overall, the staged and sequential transition of all of southern Eden Landing's ponds to tidal marsh over a decade or more, with opportunities under the AMP to retain *some of those ponds as enhanced managed ponds to provide suitable habitat for small shorebirds would provide maximum flexibility in providing shorebird habitat (as well as habitat for other guilds of birds)* while still moving toward full tidal restoration here. While some adverse effects on small shorebird population are expected, the implementation of Alternative Eden D is unlikely to reduce flyway-level populations 20 percent below baseline levels and would thus have a less-than-significant impact on small shorebirds." [emphasis added]

Plans such as the The Southern Pacific Shorebird Conservation Plan (SPSCP) (2003)[2] highlight the importance of manage ponds for small and medium shorebirds. That plan identified historic, natural salt pan habitat as "open areas amongst

[2] Hickey, C., W.D. Shuford, G.W. Page, and S. Warnock. 2003. Version 1.1. The Southern Pacific Shorebird Conservation Plan: A Strategy for supporting California's Central Valley and coastal shorebird populations. PRBO Conservation Science, Stinson Beach, CA.

CCCR Comments SBSPRP ELER Phase 2 DEIS/DEIR 5-21-18 Page 3 of 8

O-CR1-9 (cont.) the marshes" that "once served as supra-tidal foraging and roosting sites for many shore species, and as nesting areas for plovers, stilts, and avocets." Naturally occurring salt pans were subsequently replaced by man-made salt ponds that have "displaced their natural forerunners." However, "*very shallow ponds often contain drier areas that serve as excellent salt panne mimics*." [emphasis added]

O-CR1-10 In addition to pond depth as a limiting factor for small and medium shorebirds, the distance of day and night roosting sites to foraging mudflat habitat in the Bay requires research. A study conducted by Matt Leddy of plovers in a crystallizer pond in Redwood City, indicates there may be diurnal and nocturnal differences in roosting site selection, as well as differences in the amount of space required. [study attached]

O-CR1-11 According to the DEIS/R, the Bay ponds also support diving ducks, piscivorous birds and California Least Tern foraging habitat. The Southern ponds are reported to support dabbling ducks and diving ducks. The Inland and Southern ponds represent 40% of the total Phase 2 footprint, what is the carrying capacity of these ponds and the Phase 1 managed ponds? How can the remaining ponds be managed to support the divergent needs of waterbird species that currently use the Phase 2 ponds. What species diversity and abundance of pond-dependent waterbirds is possible within the remaining managed pond footprint (at ELER Phase 2)?

O-CR1-12

- Impact 3.5-4 Loss of intertidal mudflats and reduction of habitat for mudflat-associated wildlife species.

Is funding available to study the impacts of the proposed actions at ELER on the intertidal mudflats adjacent to the project? Similar studies at other pond locations were constrained by funding limitations. How will monitoring of the mudflats occur adjacent to the ELER complex?

O-CR1-13

- Phase 2 Impact 3.5-5: Potential habitat conversion impacts to Western Snowy Plover. Page 3.5-65 has the comment "…the Inland Ponds and Southern Ponds would be retained as managed ponds and enhanced to provide similar, though slightly less flexible control over water depth, salinity and other characteristics."

Please explain what is meant by this statement and how this impacts the ability of the Inland and Southern ponds to support the needs of bird guilds displaced by conversion of the Bay ponds to tidal marsh habitat.

O-CR1-14 Do Western Snowy Plover utilize Pond E6C and other Inland or Southern ponds for nesting? If so, what mitigation measures would be implemented during the introduction of dredged material to the Inland ponds?

O-CR1-15

- Phase 2 Impact 3.5-6: Potential reduction in the numbers of breeding, pond-associated waterbirds (avocets, stilts, and terns) using the South Bay due to reduction in habitat, concentration effects, displacement by nesting California gulls, and other project-related effects.

We concur with the observation:

> "Restoration of managed ponds to tidal marsh could result in a loss of nesting and foraging habitat for some of these species [*American Avocets, Black-necked Stilts, Forster's Terns, Caspian Terns listed previously*]. Large areas of unoccupied nesting habitat are available and could offset habitat loss due to conversion to tidal marsh. If available habitat is concentrated, it could make populations more vulnerable to predation. California Gulls use the same habitat type as avocets, stilts, and terns. Gulls displaced by loss of nesting habitat due to tidal marsh restoration could disrupt avocet, stilt, and tern colonies (2007 EIS/R)." [emphasis added]

One question that comes to mind is whether "unoccupied nesting habitat" is actually nesting habitat, or whether it is unoccupied because it is perceived by the species as unsuitable. If available habitat is concentrated, not only are

O-CR1-15 (cont.)

populations more vulnerable to predation, individuals may also have to expend increased investments of energy due to interspecific competition for nesting territory and food, which could also have adverse impacts on populations. And while nesting islands may provide separation from terrestrial predators, they provide no deterrence for avian predators such as raptors, and in the case of chicks – raptors, corvids, California Gulls and large waders such as Great Blue Heron.

O-CR1-16

The DEIS/R mentions gull control. This certainly can be effective, but is also labor intensive in general and difficult to implement where islands are involved.

O-CR1-17

Of particular concern is the comment, "Recent and ongoing monitoring of converted ponds indicates that populations of avocets and stilts are in decline, potentially as a result of loss of historic nesting islands. In general these species are not moving as the ponds are restored." Is this a referring to a South Bay regional phenomenon or a trend that is being observed in managed ponds that are converted to tidal marsh?

O-CR1-18

- Phase 2 Impact 3.5-7: Potential reduction in the numbers of non-breeding, salt-pond-associated birds (e.g., phalaropes, Eared Grebes, and Bonaparte's Gulls) as a result of habitat loss.

The DEIS/R notes that currently "there is moderate use of the southern Eden Landing Ponds by phalaropes and somewhat higher use by eared grebes." The document does not indicate which ponds are used by these species. To what extent do these species utilize the Phase 1 ponds? To what extent could the remaining and altered (Inland ponds - raised pond bottoms) provide suitable habitat?

De La Cruz et al.[3] have reported, "Within the Project ponds, those with deeper water or greater area supported higher abundances of foraging and roosting eared grebes…Optimal depths for foraging and roosting eared grebes in Project ponds were >0 m and 1.29 m, respectively." Eared Grebes also require ponds of higher salinities (approximately 109 ppt) while De La Cruz et al. report that "foraging and roosting dabbling and diving ducks (including northern shoveler and ruddy duck), piscivores, terns and waders were most abundant in ponds with relatively low salinity (≤33 ppt)."

O-CR1-19

This gets back to the question of how many different habitat requirements can be fulfilled within the remaining managed ponds (including those in Phase 1) and can these ponds support sufficient numbers of birds to prevent population decline?

- Phase 2 Impact 3.5-8: Potential reduction in foraging habitat for diving ducks, resulting in a substantial decline in flyway-level populations.

See comment above.

O-CR1-20

- Phase 2 Impact 3.5-9: Potential reduction in foraging habitat for ruddy ducks, resulting in a substantial decline in flyway-level populations.

In the discussion of the impact under Alternative C the EIS/R states, "…the ability to manage water quality, quantity, and circulation would be enhanced and foraging habitat for ruddy duck is expected to be maintained to provide moderately deep open water similar to or improved relative to the existing conditions." Under Alternative D however, the pond bottoms of the Inland ponds would be elevated with the introduction of dredged material. It is not clear from the

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[3] De La Cruz, S.E.W., Smith, L.M., Moskal, S.M., Strong, C., Krause, J., Wang, Y., and Takekawa, J.Y., 2018, Trends and habitat associations of waterbirds using the South Bay Salt Pond Restoration Project, San Francisco Bay, California: U.S. Geological Survey Open-File Report 2018–1040, 136 p., https://doi.org/10.3133/ofr20181040.

O-CR1-20 (cont.) discussion provided what impact this difference would have on the ability to provide roosting and foraging habitat for Ruddy Duck populations.

O-CR1-21 The Alternative D analysis includes the comment, "Also, ruddy ducks may be able to forage in other adjacent managed ponds, including the northern Eden Landing." We do not question that the northern Eden Landing ponds may provide habitat for Ruddy Ducks, but we would emphasize the words "may provide" for ponds that are still being used for salt production. Caution is necessary regarding any assumptions that ponds currently used for salt production will supply alternative habitat for species displaced by restoration of managed ponds to tidal marsh, as we have no control over the salinities, or pond depths for salt production ponds and conditions within these ponds may shift as needed for salt production.

O-CR1-22

- Phase 2 Impact 3.5-10: Potential habitat conversion impacts on California least terns.

According to Google Earth estimates, the Hayward Regional Shoreline Park nesting colony is less than 3 miles from the northern levee of Pond E1 and just over 4 miles from the southern levee of Pond E2. If foraging terns from the Hayward colony are foraging at the Eden Landing ponds, the distance is consistent with that observed at the Alameda NWR colony. While foraging habitat may be available in the Bay the fact that this species is regularly seen foraging in Ponds E1 and E2 indicates a preference for habitat provided by these ponds. Will removal of these managed ponds have an impact on the energy required to relocate and travel to new foraging grounds, or result in an increase in the length of time adults are absent from the nesting colony? What impacts would this have on chick survival and have these impacts been considered in making the level of significance determination?

O-CR1-23

- Phase 2 Impact 3.5-11: Potential loss of pickleweed-dominated tidal salt marsh habitat for the salt marsh harvest mouse and salt marsh wandering shrew and further isolation of these species' populations due to breaching activities and scour.

The conceptual figure for Alternative D depicts a wide habitat transition zone along the bayward edge of Ponds E1 and E2, habitat mounds adjacent to the pilot channel between Ponds E1-E7 and E2-E4, as well as breached internal levees between E1-E2 and E7-E4. Will flood refuge habitat for species like the salt marsh harvest mouse be provided within the interior of the vast 680+ acre E1 pond? Will this be incorporated into the project design or is it this hoped this would develop naturally over time? We would urge incorporation of flood refuge for species like the salt marsh harvest mouse within the marsh plain, rather than just at the edges of the current salt pond footprint. Detailed comments are provided in the Technical Memorandum submitted by Dr. Peter Baye.

O-CR1-24

- Phase 2 Impact 3.5-12: Potential disturbance to or loss of sensitive wildlife species due to ongoing monitoring, maintenance, and management activities.

Is it correct to assume vector control activities would be carried out only with coordination with California Department of Fish and Wildlife staff to ensure timing and manner in which these activities are conducted will not adversely impact listed species or waterbirds?

O-CR1-25

- Phase 2 Impact 3.5-13: Potential effects of habitat conversion and pond management on steelhead. Phase 2 Impact 3.5-14: Potential impacts to estuarine fish.

We support the creation of tidal marsh habitat to support fish populations. Is there a particular reason the levee breaches from Alameda Creek Flood Control Channel have not been included in Alternative D?

O-CR1-26

- Phase 2 Impact 3.5-15: Potential impacts to piscivorous birds.

The EIS/R emphasizes that "American White Pelicans do not forage in open waters of the Bay, preferring instead non-tidal waterbodies." Other than Pond SF2, what other ponds, not including those used for salt production, support American White Pelicans? As we stated earlier, caution must be used in relying on salt production ponds as management for wildlife is not the primary function of these ponds. Will the Inland ponds, Southern ponds and Phase 1 managed ponds be able to sustain existing ELER waterbird diversity and abundance and habitat for pond specialists such as the American White Pelican?

O-CR1-27

- Phase 2 Impact 3.5-16: Potential impacts to dabbling ducks.

Our comments remain consistent with questions raised for other waterbird guilds. The EIS/R reports:

> "Based on long-term monitoring data, the winter populations of dabbling ducks doubled from 2002 to 2006 during Initial Stewardship Plan operations in the SBSP Restoration Project ponds. The fall and spring pond counts have increased during the same period and since implementation of Phase 1 have leveled with some fluctuations. *These results may indicate the ponds have reached carrying capacity (De La Cruz et al., in press), alternatively, the spatial and temporal redistribution of dabbling duck use of tidal restoration areas, enhanced managed ponds and other remaining managed ponds have reached equilibrium*. Additional tidal restoration could result in similar dispersion of some dabbling ducks over the entire SBSP Restoration Project area. A possible exception to this expected dispersion is the northern shoveler, the most abundant wintering dabbling duck, which appears to prefer ponds to open bay or tidal marsh habitat. The response of this species to Phase 2 actions will be monitored under the AMP, but this species has been observed in large numbers using a wide range of salinity in the ponds, from low (30 ppt) to moderately high (120 ppt) which will remain available throughout Eden Landing and the South Bay." [emphasis added]

The information provided above raises the question of what other managed pond restorations have taught us regarding length of time it takes before a pond converted to tidal marsh is able to provide habitat for dabbling ducks and other waterbird guilds. As an example, and based upon information provided in the EIS/R, it would appear the Bay ponds will not provide any foraging habitat benefit until they have been filled with dredge material and opened to tidal action. If the managed ponds have reached carrying capacity for the dabbling duck guild or the use of tidal restoration areas, enhanced ponds and managed ponds have reached equilibrium, what impact will the temporal loss of foraging habitat have on the population? This is an issue that may become more important in the future as additional ponds are converted to tidal marsh, particularly for species with higher fidelity to managed ponds.

O-CR1-28

- Phase 2 Impact 3.5-17: Potential impacts to harbor seals.

We strongly support the requirement for an underwater noise analysis prior to project implementation to avoid potential underwater noise impacts to harbor seals. We also urge that cushion blocks or bubble curtains and the use of the "soft start" technique be required.

O-CR1-29

- Phase 2 Impact 3.5-18: Potential recreation-oriented impacts to sensitive species and their habitats.

We urge the SBSPRP project team to identify the proposed trail alignment and Route 3 alternative as identified in Alternative D to avoid adverse impacts to listed species, species of concern, migratory, nesting and roosting waterbirds.

O-CR1-30

- Phase 2 Impact 3.5-19: Potential Impacts to special-status plants.

We support the implementation of protective measures identified in this section.

- Phase 2 Impact 3.5-20: Colonization of mudflats and marsh plain by non-native Spartina and its hybrids.

O-CR1-30 (cont.)

We support utilizing the Invasive Spartina Project's 2010 BMPs to inform restoration and management actions.

- Phase 2 Impact 3.5-21: Colonization by non-native Lepidium.

Colonization of the Phase 2 action area by *Lepidium* poses a significant adverse threat and BMPs and measures identified in the Adaptive Management Program must be implemented.

O-CR1-31

Closing remarks:

The SBSPRP has collected an extensive amount of data through literature search, cooperative exchanges of data or directed field studies specific to addressing key uncertainties. Much of this information is available in the Technical Document section of the SBSPRP website. However, until very recently this data has not been summarized for public consumption (We were just informed today that a summary document of some of the Phase 1 scientific study data has been released). Information such as trends in waterbird use of ponds outside the SBSPRP footprint does not appear to have been summarized, so it is difficult for members of the public to understand the backdrop against which the proposed restoration projects are occurring (e.g. What are the trends of waterbird populations throughout the South Bay and San Francisco Bay region?) It would be extremely helpful if more of this information could be synthesized, to enable the public to provide substantive comments to proposed restoration designs.

O-CR1-32

With respect to waterbird populations, monitoring over a long period of time and at a broad scale (i.e. not just within the project area) is critical. A positive response may be indicated in years 1 and 2, years 3 and 5 could show different responses and may be more indicative of long-term responses. USGS recently published a document that analyzes trends of waterbird abundance and diversity across differing physical environmental conditions. Studies such as these are crucial to informing our understanding of waterbird needs and potentially to their responses to actions taken. Does funding exist to continue this work in the long-term?

Does adequate funding exist to continue monitoring and scientific studies intended to address key uncertainties?

As we stated at the beginning of our letter, we are strongly supportive of tidal marsh restoration within the south bay, but we are also deeply committed to sustaining habitat and species diversity. Thank you for the opportunity to provide comments. We ask that we be kept informed of any additional opportunities to provide public comments.

Sincerely,

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A Comparison of Diurnal and Nocturnal Use of a Salt Pond Roosting Site by Semipalmated Plovers

Matt Leddy mtleddy@sbcglobal.net May 21, 2018

Introduction

Former salt ponds in central and southern San Francisco Bay are currently being converted or being considered for conversion to alternative habitats or are at risk from urban development. Analyses of these salt ponds as a biological resource for high-tide roosting shorebirds have been limited to diurnal observations (Athearn et al., 2012; Ackerman et al., 2014; SBSPRP, 2015; Washburn et al., 2015). However, not taking nocturnal roosting needs into account may fail to identify an important resource, since roost selection and roosting behavior of shorebirds may be very different at night compared to the daytime. These differences include:

· A particular site being used only for night roosting (Spencer, 2010; Sanders et al., 2013),

· Species composition and abundances at a roost differing between night and day (Rohweder, 2001),

· Night-roosting birds occupying individual roosting sites compared to aggregated day-roosting birds (Thibault and McNeil, 1994; Colwell, 2010), requiring more space on a geographical scale,

· Individuals being more spread out from each other (Spencer, 2010), and in smaller flocks (Conklin and Cowell 2007; Spencer, 2010) at night, requiring a greater amount of space on a local scale, and

· A greater distance between foraging grounds and night roosts compared to daytime roosts due to predation pressure (Conklin and Cowell 2007; Rogers 2003; Sanders et al. 2013; Piersma et al. 2006).

It seems clear given these differences, that the ecological requirements of nocturnal roosting shorebirds should be taken into consideration prior to any conversion of nocturnal roosting habitat for alternate uses.

The objective of this study was to determine if there are differences in the high-tide roosting behavior of semipalmated plovers (*Charadrius semipalmatus*) on a former salt pond at night compared to daytime. Various aspects were examined, including comparison of night and day abundance, temporal patterns of abundance, and spatial patterns of distribution. Since former salt ponds will ultimately be preserved as roosting habitat, converted to alternate aquatic habitats (i.e., salt marsh) or to urban uses, the benefits of adding nocturnal observations to understanding the importance former salt ponds utilized for high-tide roosting by shorebirds are discussed.

Crystallizer Pond 1 (CRY1), is an approximately 24-ha (60-acre) former salt pond in Redwood City, San Mateo County, CA located in southern San Francisco Bay (Fig.1). It is within the approved expansion boundary for the Don Edwards National Wildlife Refuge, so could potentially be purchased and converted from salt pond to alternate wetland habitat (i.e., salt marsh), but is currently in private ownership and so could also be converted to urban uses. The extent to which waterbirds use this pond is likely to be a factor in any future decision on mitigation for loss of CRY1 from either of these conversions.

1

Figure 1. Location of Crystallizer Pond 1 and the Redwood City Salt Pond Complex.

Semipalmated plovers occur as both fall and spring migrants and winter residents on San Francisco Bay. On CRY1, the birds arrive in early August and use the pond as a high-tide roost until rainwater begins filling the pond late October to November.

Within San Francisco Bay, a large proportion of the plover population occurs south of the San Mateo Bridge (Stenzel et al. 2002; Wood et al. 2010). High-tide surveys made on CRY1 from 2010-2017 document the pond's continuous use, with as many as 1700 plovers counted at a single time (pers. obs.). To put that number into perspective, San Francisco Bay-wide surveys at 320 roosting sites had totals of 3267, 1970, and 1485 plovers in November of 2006, 2007 and 2008 respectively (Wood et al., 2010). Crystallizer Pond 1 may be a significant seasonal roost site for semipalmated plovers on San Francisco Bay.

Methods Summary

This study utilized paired day/night counts of high-tide roosting semipalmated plovers in permanent photoquadrats. To ensure that all observations could be completed within two hours of high tide, and that a large enough geographic area of the pond was represented, thirty quadrats, spaced 100' apart were established. Photoquadrat depth ranged from 185 to 252 meters, resulting in quadrats of unequal area (444-605 m^2), although quadrats in which plovers were present ranged from 444-526 m^2. Ten paired daytime/nighttime observations were made from August 2015 to January 2016, and ten from August to December 2016. Each paired observation consisted of a daytime photo series followed by a series on the next high tide that night, or a nighttime series followed by a series on the next high tide the following day. Day and night digital photos for each quadrat were used to document bird abundance. Each daytime observation consisted of a photo series followed by an actual count of all birds on the entire pond. The highest number of plovers on one count was 900 birds. Details of the methods used are in the second part of this report.

Results

I utilized plovers/quadrat as a unit of measurement to analyze the data because of the close linear relationship between the actual number of plovers on the pond vs. the total number of plovers/quadrat during the daytime ($R^2 = 0.9073$), whereas for density (plovers/m^2), $R^2 = 0.9011$ ($N = 15$; dates when there were no plovers both day and night were excluded from this analysis). In addition, utilizing plovers/quadrat allowed for the calculation of Morisita's index of dispersion (Morisita, 1959), whereas fractions generated by using plovers/m^2 did not.

2

The night/day difference in abundance of plovers varied by year (Table 1), with no statistically significant differences. In the absence of nocturnal surveys, CRY1 would have been identified as a high-tide day roost, but its identity as a night roost, and the relative abundance of plovers at night would have remained unknown.

Year(s)	Sample size	Nighttime total number of plovers in all quadrats	Daytime total number of plovers in all quadrats	Mann-Whitney U (two-tailed) [1.]	Mann-Whitney U Test critical value of U at $p \leq 0.05$ [1.]
2015	8	225	350	21	13
2016	6	93	43	8.5	5
Both years	14	318	393	93.5	55

Table 1. Abundace of semipalmated plovers on CRY1. [1.] Dates when no birds were present both day and night were excluded from the test.

<u>Temporal Patterns of Abundance</u>

Roosting semipalmated plovers consistently used CRY1 both day and night until rainfall began filling the pond (Fig. 2), a pattern consistent with other studies that have found water depth to be an important factor in the presence or absence of individual shorebird species (Long and Ralph, 2001; Dias 2009; Colwell and Taft 2000; Canepuccia et al. 2007).

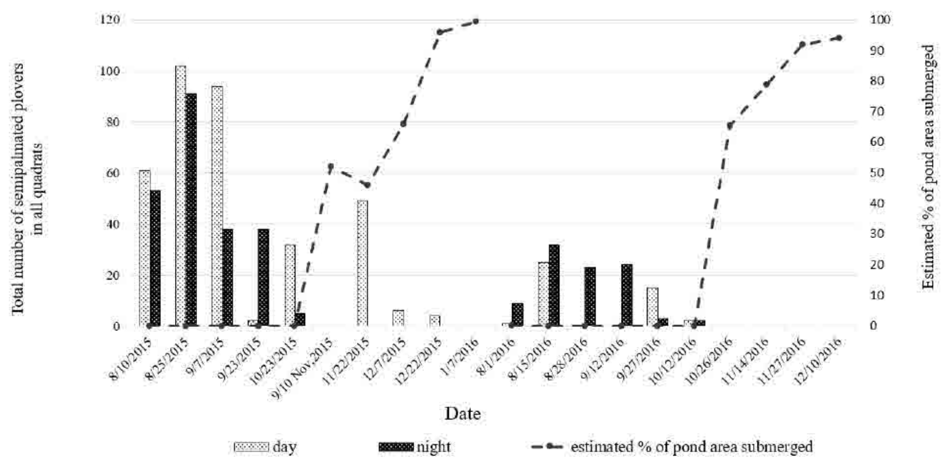

Figure 2. Daytime and nightime number of semipalmated plovers on Crystallizer Pond 1 and average percent of all quadrat areas submerged (visually estimated from photoquadrats).

Differences between night and daytime behavior of the plovers may explain two patterns seen in Figure 2. Firstly, warm dry weather persisted into late November in 2015, resulting in evaporation of water from the pond, reemergence of pond bottom, and the return of daytime roosting plovers but not nighttime birds. One possible explanation would be that nocturnal roosting plovers may respond differently to surface water at night, and that water is more of a limiting factor at night for roost selection.

3

Secondly, the night population was more stable in 2016 and in 2015 prior to the beginning of rain in November, although when data for the entire 2015 season is included, the daytime population was more stable (Table 2). Conklin and Cowell (2007) found that individual dunlin had higher fidelity to primary night roosts compared to day, and used fewer roosts. Although this current study did not track individual birds, these preliminary findings suggest that the semipalmated plover population may have greater fidelity to the pond at night compared to day.

Nighttime		Daytime	
Year and pond conditions	Proportional Variability (PV)	Year and pond conditions	Proportional Variability (PV)
2015 (prior to rains, pond dry)	0.574	2015 (prior to rains, pond dry)	0.651
2015 (includes dates when pond partially submerged)	0.882	2015 (includes dates when pond partially submerged)	0.768
2016 (pond dry)	0.648	2016 (pond dry)	0.905

Table 2. Proportional Variability (PV) of semipalmated abundance on CRY1. PV = 0 when there is no fluctuation in abundance over time; as variation increases PV increases up to a value of 1.

Proportional Variability was selected for this analysis rather than the Coefficient of Variation because it is nonparametric and proportional, with a maximum value of one. The difference between the two is that the Coefficient of Variation compares data points to the average, whereas Proportional Variability compares data points directly to each other (Heath and Borowski, 2013).

<u>Spatial Patterns of Distribution</u>

Within Crystallizer Pond 1, the plovers roosted exclusively at the north end of the pond during both night and day (Fig. 3). Selective use of the north end could be due to a number of reasons, such as proximity to nearby mudflat foraging areas, variation in water depth, safety from predators, wind patterns, or other unknown factors. Semipalmated plovers forage on mudflats in Westpoint Slough less than a kilometer away at low tide (pers. obs.), and predatory birds are present. On one observation day, a peregrine falcon caught a least sandpiper from a mixed flock of roosting least sandpipers and plovers on CRY1.

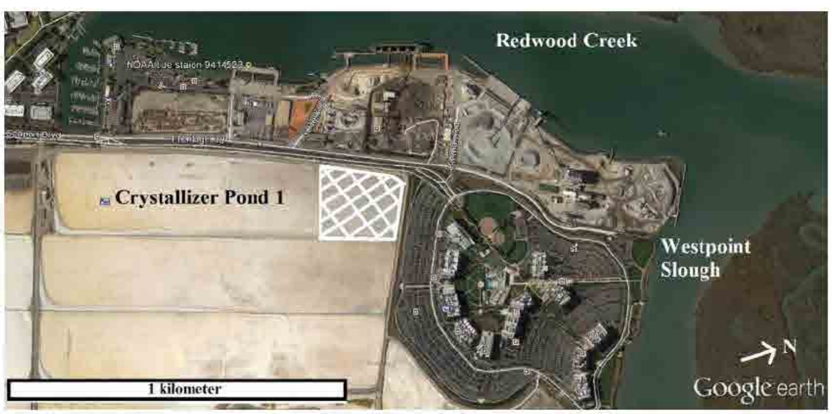

Figure 3. Area of Crystallizer Pond 1 used by roosting semipalmated plovers (cross-hatched).

4

At night, the roosting plovers were more dispersed in the pond than during the daytime. The average Morisita's index during the night (8.84), was less than during the day (21.36). This difference was highly significant (Mann-Whitney U Test, two-tailed, U = 20, critical value of U at $p \leq 0.01$ is 21, N = 14). If organisms are distributed uniformly, this index = 0 (maximum dispersion), values greater than 1 occur when organisms are aggregated, with the maximum aggregation value being the number of samples (in this case, 30 if all the birds were in a single quadrat). An index value of 1 = random distribution.

As a result of being more dispersed at night, the plovers used more of the pond area at night compared to daytime (Fig. 4).

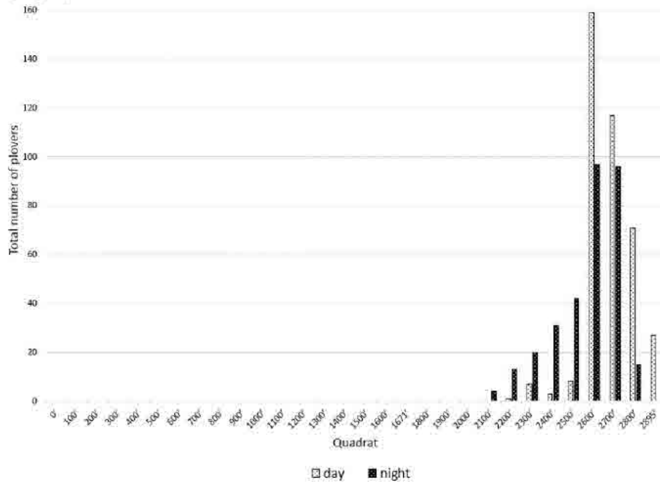

Figure 4. Distribution of semipalmated plovers on Crystallizer Pond 1. Composite data from 14 day/night paired counts when birds were present, August - December 2015 and August - October 2016.

Regarding the actual size of the area used by the birds, 95% of the total number of night-roosting plovers utilized 3.1 hectares of CRY1, whereas 95% of the daytime birds utilized only 1.93 hectares (Fig. 5).

Figure 5. Area in Crystallizer Pond 1 utilized by 95% of night (left) and day (right) roosting semipalmated plovers.

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Discussion

The South San Francisco Bay Salt Pond Restoration Project is in the process of converting about 15,100 acres of former salt ponds into various habitats (salt marsh and various types of managed ponds) for various species (waterfowl and shorebirds) and for various uses (nesting, foraging and roosting). This complex project relies on field observations to generate science-based models in order to determine the optimum ratio of habitats and their management for all the waterbirds, and to determine which ponds will be converted for which uses. The benefits of including night-roosting data into the decision making process are discussed below.

Identifying Nocturnal Roosts

Since shorebirds may roost at locations where they don't occur during the daytime, at the very least, all nocturnal shorebird roosts in San Francisco Bay should be identified. In addition to roost locations, ideally the composition of waterbird species and abundances would also be documented. Without this information, roosts that are only used at night could be lost.

To put the identification of night roosts into the context of CRY1, without nocturnal observations this pond would be compared to other ponds, ponds which might or might not be used as a night roost. Its biological importance would be undervalued.

Documenting CRY1 as both a night and day roost located less than a kilometer from foraging habitat on Westpoint Slough identifies this pond as a high-value roost for semipalmated plovers, since the birds don't have to fly farther at night to find a safe roost than they do during the day. Warnock and Takekawa (1996) found that radio-marked individual western sandpipers moved the same distance between night and day locations in southern San Francisco Bay, so salt ponds suitable for both day and night use may be present in this region for other shorebird species as well.

Prior to any consideration of converting this pond to alternate wetland habitats or urban uses, similar observations would need to be made on other ponds within the home range of the semipalmated plover.

Nocturnal and Diurnal Roost Fidelity

Consistent use of a pond should be higher at night compared to day if shorebirds exhibit a higher fidelity to night roosts as found by Conklin and Cowell (2007), and suggested by this study. As a biological resource, a pond with greater abundance of birds has greater value than one with lower abundance; however the consistency of use (fidelity) should also be taken into consideration. One possible metric would be to divide abundance at a site by the Proportional Variance (a non-parametric test with a maximum value of one) over time. In this way, a pond with fewer birds but greater consistency of use would increase in value compared to a pond with higher abundance but less consistent use.

Data from the many diurnal surveys that have already been completed on roosting shorebirds could be used to explore the possible advantage of using abundance/proportional variance as a unit of measurement to indicate the resource value of a roost. If this metric is found to better characterize the biological value of a pond, it would incorporate the importance of roost fidelity into the environmental assessment of both night and day roosts.

Pond Water at Night vs. Day

The presence of water is an important factor in shorebird roost site selection. The difference between night and day in the pattern of use of CRY1 by semipalmated plovers, with the submergence and re-

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emergence of pond bottom, suggests that the bird's response to water may differ between night and day. The results from this study are very preliminary and need to be further investigated over a range of conditions and for additional species. For example, unlike the plovers, black-necked stilts were observed foraging in CRY1 both night and day when the pond began to fill with rain water, so stilts may be less affected by water conditions at night than are semipalmated plovers. One important comparison, however, the abundance of stilts night and day, could not be determined using the methods of this study.

Roosting shorebirds reacting differently to water at night compared to day could have implications for the presence of water in ponds being managed for roosting. Additional studies on the current diurnal and nocturnal shorebird use of the existing "island ponds" SF2 and A16 in San Francisco Bay (SBSPRP, 2008) at existing water conditions would be invaluable in this respect.

It should be noted that the absence of semipalmated plovers with the advent of winter rainfall in November is not a reflection of the overall suitability of CRY1; from August into March it is utilized by roosting and foraging snowy plovers, least and western sandpipers, dunlin, American avocets and black-necked stilts during the day, and by foraging stilts at night (pers. obs.).

<u>Spatial Requirements of Nocturnal and Diurnal Roosting Shorebirds</u>

The results of this study others and suggest that roosting shorebirds may need more area at night compared to daytime, either within a pond or within a region. In the context of the South Bay Salt Pond Restoration Project, field work identifying night roosts and quantifying species and abundances would be invaluable. This would eliminate the possibility of underestimating roosting requirements, which could occur if surveys are conducted only during the daytime.

Understanding the amount of area in a salt pond needed for roosting may allow for more flexibility when a pond is converted to alternate wetland habitats. In the case of Crystallizer Pond 1, only the northern portion is used by roosting plovers, which could make the remainder of the pond available for conversion to alternate wetland habitats such as salt marsh (if physically feasible).

When designing an area-use study for bird distribution within a pond, the spacing and size of sampling units will be important for discriminating between night/day space uses. In CRY1, the plovers roosted on a total of 5 ha, and the 100-foot resolution of this study revealed the differences in space use between night and day. In this particular case, other scales, such as a 6.25 ha grid (Athearn et al., 2012; Ackerman et al. 2014) would not distinguish between the two, but the 50X50m grid of Ackerman et al. (2014) would provide the needed level of detail.

<u>Conclusions</u>

Understanding nocturnal roosting requirements is essential to an appreciation of the ecology of migratory shorebirds. Adding nocturnal observations of roosting shorebirds requires additional resources, and so needs to provide significant new information regarding night roosts as a biological resource. Commitment of resources seems well warranted since limiting observations to diurnal roost counts may completely fail to identify ponds utilized at night, document relative importance in terms of abundance and fidelity, and underestimate the amount of acreage needed by night roosting shorebirds.

Nocturnal observations provide the following information about Crystallizer Pond 1 as a biological resource for shorebirds on San Francisco Bay:

· CRY1 is a night roost as well as a day roost for semipalmated plovers. In the absence of nocturnal

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observations, as a biological resource CRY1 would have been compared to other ponds being used as day roosts which may or may not be used nocturnally.

· CRY1 is consistently used as both a night and day roost by semipalmated plovers, and being located less than a kilometer from foraging habitat on Westpoint Slough may be a high-value roost for these birds.

· Night roosting semipalmated plovers on CRY1 utilize more of the pond area than day roosting birds.

· Day and night roosting semipalmated plovers stop using CRY1 when rainfall begins filling the pond; nocturnal roosting birds may be more sensitive to the presence of water than are diurnal roosting birds.

· CRY1 is used both day and night by foraging black-necked stilts, although the relative abundance and amount of area utilized night and day within the pond are unknown.

Additionally observation:

· The wall separating CRY1 from CRY2 is used as a roost by black-bellied plovers during the day, but not at night (based on photoquadrats). Without nocturnal observations, conclusions drawn from diurnal observations alone would suggest that CRY1 provides for the high-tide roosting requirements of the plovers. In contrast, black-bellied plovers roost night and day on the oyster shell beaches adjacent to mudflats in Foster City, about 6.5 km northwest of CRY1 (pers. obs.). Without nocturnal observations, these two roosting sites would seem to be equally important to the plovers.

Given the dearth of information on night-roosting shorebirds, mitigation measures for the potential loss of Crystallizer Pond 1 as a night roost would be a difficult task. Utilizing an existing night roost site as mitigation is insupportable. Any site not currently used for night roosting that is being considered must undergo alteration and demonstrate that it has become a new night roost prior to the loss of the old one.

<u>Methods Details</u>

Thirty photo location reference points were established along Seaport Blvd at 100’ intervals, starting with a 0’ marker near the south end of the pond and going north to a 2900’ marker near the end of the pond .Two exceptions were at 1700’ and 2900’, where photo locations were shifted 29’ and 5’ respectively to avoid fences blocking photos (Fig. 6). No birds were observed in the pond south of the 0’ marker (night and day photos and day direct observations).

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Figure 6. Location of photo locations along Seaport Boulevard

At each photo location, a Nikon D5200 digital SLR camera was set up on a tripod oriented perpendicular to the sidewalk with the camera positioned a reference mark. A Nikon 55 – 300mm lens was used, set at a focal length of 130mm, allowing the entire depth of the pond to fit into photos at all the photo locations. At night, camera shutter speed was 30 seconds, the f-stop was 4.8 – 5.6, the ISO 100, and manual focus was used. Each photo was reviewed in the field and retaken as needed until an in-focus photo was obtained.

Nocturnal photos were taken after astronomical twilight as determined by the Astronomical Applications Department of the U.S. Naval Observatory. Light sources were the moon on some nights, and urban sources on all nights. All observations were made within two hours of high tide.

Photoquadrats were created using basic principles of perspective drawing. Crystallizer Pond 1 has a wooden wall along its east side, and adjacent to CRY1 is Crystallizer Pond 2 with a similar east wall. These two walls are parallel to each other (Fig. 7) and have posts spaced four feet apart as measured from a Google earth image.

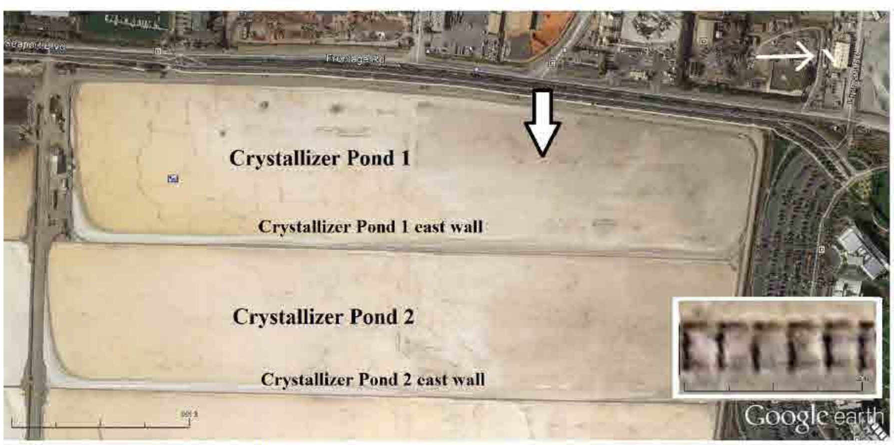

Figure 7. Parallel east walls of CRY1 and CRY2. Arrow indicates direction photos were taken from Seaport Boulevard. Inset shows post spacing on CRY1 east wall.

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In each photo, the two parallel east walls and four-foot post spacing allowed for the creation of an 8' (2.4 meter) wide photoquadrat at each observation point, with the centerline of the photo as the quadrat center (Figs. 8-10).

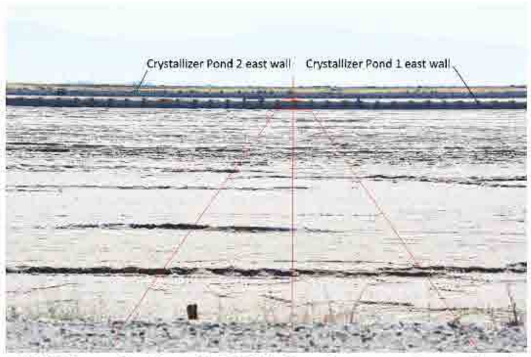

Figure 8. Photoquadrat at 2700' mark, Sept 7, 2015. Quadrat constructed using 4' spaced posts and parallel east walls of Crystallizer Pond 1 and Crystallizer Pond 2. Lines drawn thicker for illustration.

Figure 9. 2700' photoquadrat during daytime, August 25, 2015

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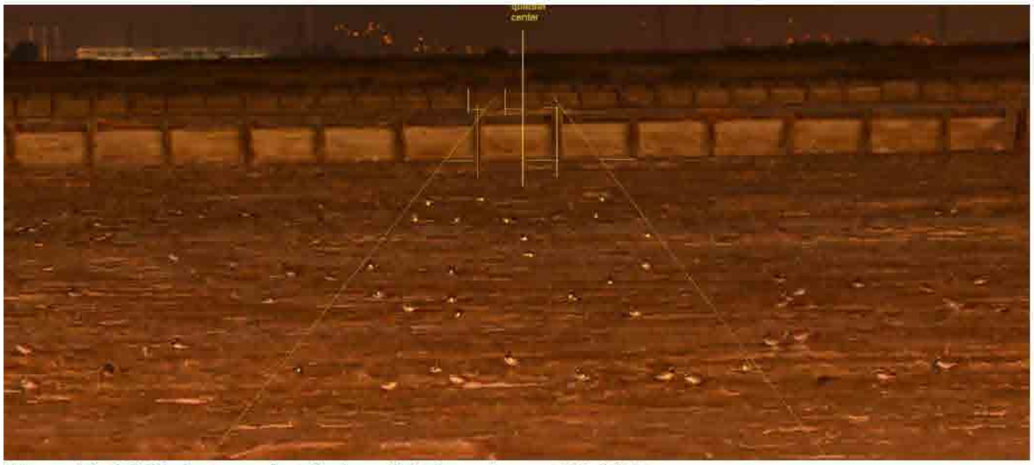

Figure 10. 2700' photoquadrat during nighttime, August 25, 2015

If a photoquadrat on a particular date had birds in it both day and night, any horizontal variation in camera orientation between day and night was compensated for by shifting one photo centerline to the right and the other to the left the same distance so that both photoquadrats had the same centerline. The maximum distance photos centerlines were shifted to line them up was 5.2 meters, the minimum was 0.05 meters and the average was 1.87 meters.

Within each photoquadrat, the plovers found within, or touching the lines of the quadrat, were counted. Objects that were not readily identifiable but may have been birds were counted and marked with a question mark. The difference in the number of "unidentifiable" objects between night (total 17) and day (total 19) was not statistically different (Mann-Whitney U Test, two-tailed, U = 167.5, critical value of U at $p \leq 0.05$ is 127, N = 20).

Basic perspective drawing principles were used to divide each photoquadrat as needed to estimate the proportion of each quadrat that was submerged.

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Response to Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper and Ohlone Audubon Society (O-CR1)

O-CR1-1

The overarching goal of the SBSP Restoration Project is the restoration and enhancement of wetlands in the South Bay while providing for flood risk management and wildlife-oriented public access and recreation. As such, the Preferred Alternative was selected to maximize tidal marsh restoration while still balancing multiple restoration goals.

Comments from Dr. Peter Baye are addressed in I-PB1-1 to I-PB2-16.

O-CR1-2

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden D and the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the project's intended ecological goals. Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. The Southern Ponds would be opened to muted tidal flows through a culvert system during the first phase of restoration; however, those ponds could be operated more as true managed ponds and not left open to constant muted tidal flows if ongoing monitoring shows that more managed ponds are needed for bird habitat. This is consistent with an adaptive management approach to the phased restoration of the Southern Ponds.

O-CR1-3

Potential recreation-oriented impacts to sensitive species and their habitats are discussed in Section 3.5.3 of the EIR. As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the preferred trail alignment through southern Eden Landing is Trail Route 1. Trail Routes 2 and 3, the community connector at Westport Way, and the spur trail shown in Alternative Eden C are not included in the Preferred Alternative. Trail Route 1 was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Trail Route 3 and the associated "community connector" trail to Union City Boulevard are not included in the Preferred Alternative because of a strong negative response to it by others and because of the concern that the community connector would draw more outside trail users to the area and encourage them to park on existing streets. Bicycle and pedestrian links would still connect to the south via the Alameda Creek Regional Trail. The new trails would have restricted hours (sunrise to sunset in ELER), but the spine trail would be open year-round except for approximately 10 days in November through January for sport waterfowl hunting. If East Bay Regional Park District agrees to operate the Bay Trail spine, dogs would be prohibited as is the case for their current operation of the spine along northern Eden Landing.

O-CR1-4

Although Alternative Eden D remains as described in the Draft EIS/R, the Preferred Alternative is comprised of individual components selected from the various action alternatives as discussed in MCR 1; however, the connection between ACFCC and Pond E2 will no longer be through large culverts, as initially described, but instead through a full breach. This breach would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail. Because effects from levee breaches are analyzed in each of the action alternatives and because a connection between ACFCC and Pond E2 is analyzed with Alternative Eden B, the effects of breaching the ACFCC are within the range of conditions analyzed in the EIR.

O-CR1-5

Alternative Eden D includes the beneficial reuse of up to 6 MCY of dredged material in the Bay and Inland Ponds. The preliminary design does not include prioritization sequencing for the ponds; however, the Bay Ponds would likely receive the dredge material before the Inland Ponds to minimize disruption to pond operations and to minimize the amount of infrastructure needed to transport the dredge material. As discussed in MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the Preferred Alternative includes the potential beneficial reuse of dredge material to raise pond bottom elevations and to build habitat transition zones in the Bay Ponds (Ponds E1, E2, E4, and E7) and potentially in Ponds E5 and E6, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of those ponds to tidal marsh. Dredge materials would not be placed in Ponds E5 and E6 if they remain managed ponds during the time period of dredge material placement. Ponds E5 and E6 could be operated to provide deep, open water habitat suitable for diving ducks, depending on whether those ponds would be restored to full tidal action at a later stage (e.g., if diving duck use does not increase substantially). Pond E6C would retained and enhanced as a managed pond and be seasonally dry or flooded, for snowy plover and other breeding waterbirds in spring and summer, and for overwintering diving ducks.

Divers and piscivorous birds are expected to use deeper ponds until they fill in with sediment and become too shallow. Even then, they would likely use the deeper channels to some extent. Fish habitat would be improved by Phase 2 action, which in turn should help the piscivores. In addition, some of the northern Eden Landing ponds and nearby Cargill-managed ponds (such as ponds N1A and N2A) provide for some deeper water habitat.

O-CR1-6

Habitat islands would be made from remnant levees, not dredge materials, and would be designed appropriately and treated as needed to prevent deep cracking, as was done for Phase 1 pond enhancements in Ponds E12, E13, and in E14. Vegetation management would occur as needed to for suitable habitat for plovers and terns.

O-CR1-7

The sentence indicating “regular use” was revised in Section 3.5.1 of the Final EIR. Note that Ponds E1 and E2 are used intermittently by least terns, but not in large numbers and not every year. Other nearby ponds with higher numbers of least terns include Ponds N1A and N2A (both Cargill managed ponds, south of Eden Landing). For the most part, least terns use the South Bay as post-breeding dispersal, after they have finished nesting at nearby colonies such as Alameda Point and Hayward Shoreline, and new breeding and post breeding staging at the recently established colony at Pond E14, and on their way south for the winter.

O-CR1-8

Clarifying text included in Table 3.5-2 of the Final EIR.

O-CR1-9

See response to comment O-CR1-2 regarding the project's need to balance multiple types of habitat restoration and the mix of ponds and tidal restoration included in the Preferred Alternative.

O-CR1-10

The SBSP Restoration Project proponents have monitored waterbirds over multiple years and De La Cruz (2018) has summarized trends and habitat associations for waterbirds in the South Bay. Our research indicates no effect on distance of ponds to the Bay for foraging shorebirds. This study can be found at https://pubs.er.usgs.gov/publication/ofr20181040

O-CR1-11

See response to comment O-CR1-2 regarding the mix of managed ponds and tidal restoration included in the Preferred Alternative. Ponds managed in northern Eden Landing, such as Ponds E8, E6B and E6A, and Ponds E10 and E11 all provide suitable diving duck habitat in the winter. Pond E6C is proposed to be maintained as seasonal habitat for western snowy plover and other pond-nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. The other Inland Ponds and the Southern Ponds would be adaptively managed. Monitoring and assessment would be conducted as per the Adaptive Management Plan which would inform potential operational changes for those ponds.

As discussed in Section 3.5.3 of the EIR and response to comment O-CR1-5, divers and piscivorous birds that currently use the Bay Ponds are expected to continue to use those ponds until they fill in with sediment and become too shallow which may take years (even then, they will use the deeper channels to some extent), but some may disperse from the Phase 2 area at ELER into other Eden Landing ponds as noted above, into Cargill operated ponds or other areas in the South Bay and North Bay.

O-CR1-12

Monitoring will be conducted as per the Adaptive Management Plan. As with all publicly provided facilities, services, and potential experiences, agency funding levels can vary over time. As such, SBSP Restoration Project and CDFW management will actively seek to ensure that costs and funding are appropriately considered, estimated, and aggressively sought through various federal, state, regional and local funding sources.

O-CR1-13

This sentence was comparing the differences between Alternative Eden C and Alternative Eden D. Alternative Eden C includes a water control structure in the mid-complex levee that could be used for operations of the Inland Ponds.

As discussed in Section 3.5.3 of the EIR and response to comment O-CR1-5, divers and piscivorous birds that currently use the Bay Ponds are expected to continue to use those ponds until they fill in with sediment and become too shallow which may take years (even then, they will use the deeper channels to some extent), but some may disperse from the Phase 2 area at ELER.

O-CR1-14

Western snowy plovers have not been recorded nesting in the Bay Ponds or Pond E5, but they have nested in Pond E6 (1 nest each in 2015 and 2018), along the north eastern border, on higher ground, and they have nested in Pond E6C in 2015 (8 nests), 2016 (8 nests), 2017 (2 nests), and 2018 (1 nest).

The Preferred Alternative includes the potential placement of dredge material in the Bay Ponds and in Ponds E5 and E6. If dredge material is added into these ponds, it would either not happen during the nesting season, surveys would be done to ensure no nesting birds, or the area would be flooded prior to nesting season to prevent the loss of nesting birds.

O-CR1-15

Section 3.5.3 of the EIR discusses potential effects to avocets, stilts, and terns from the long-term transition of ponds to tidal marsh habitat as well how levee lowering and habitat islands could provide new nesting opportunities in the interim. Issues raised regarding suitability and predation are being considered in the design. With the possible exception of northern harriers, avian predators are not expected to increase due to project actions.

O-CR1-16

Gull control would be implemented if California gulls attempted to begin a new colony in areas where snowy plovers currently nest. It is labor intensive, and requires a long-term, concerted effort. However, the Restoration Project has been successful in the past hazing gulls out of sensitive areas.

O-CR1-17

The SBSP Restoration Project proponents have seen a loss of avocets and stilts throughout the South Bay. While they have lost some historic nesting sites (such as Pond A8), other sites (such as New Chicago Marsh) have also had lower numbers. It is not clear if this is a South Bay issue, or something happening at a larger, flyway scale. The SBSP Restoration Project is currently developing a large-scale survey to determine locations and numbers of nesting avocets , stilts and terns that will be conducted in SBSP Restoration Project area as well as other areas around the South Bay, consistent with a similar study conducted previously in the 2001 to 2002.

O-CR1-18

See the discussion under Impact 3.5-7 for an analysis of potential effects to phalaropes, Eared Grebes, and Bonaparte's Gulls.

Based on SFBBO/USGS counts for 2003-2015, phalaropes are most abundant on ponds M4, M1, N4AA, N7, and N3 (greater than 600 total birds counted, all Cargill managed ponds) and Eared Grebes are most abundant on ponds M4, M3, A15, N3, N1 (greater than 25,000 total birds counted, all ponds except A15 are Cargill managed ponds). As both of these species/guilds like higher salinity ponds, it is not unusual that they are using these ponds.

As referred to in the comment, different species/guilds have different optimal salinities and pond depths and therefore the southern Eden Landing Ponds are not currently, nor would they be in the future, the ideal habitat for every species/guild. As discussed in response to comment O-CR1-11, the Preferred Alternative has a mix of tidal restoration and adaptively managed ponds. Monitoring and assessment would be conducted as per the Adaptive Management Plan to inform potential operational changes for the Inland and Southern Ponds.

O-CR1-19

See the discussion under Impact 3.5-8 for an analysis of potential effects to diving ducks. See also response to comment O-CR1-18.

O-CR1-20

As discussed under Impact 3.5-9, foraging occurs primarily in ponds, with relatively few individuals using tidal habitats. With the introduction of dredge materials into the Inland Ponds under Alternative Eden D, pond elevations would increase and foraging habitat could be reduced. However, the improved water control structures would allow operational flexibility when managing water depth; and therefore maintaining seasonal habitat or flooding the ponds would continue to be an operational decision.

O-CR1-21

Impact 3.5-9 provides a discussion of the change in ruddy duck use in Pond E9, E2, E4, E6A, E6E, E7, E8, E8X, and E10 as well as variations found in the San Francisco Estuary as a whole. These observations support the statement that ruddy ducks have been found to forage in nearby managed ponds when tidal flows are restored to adjacent areas.

O-CR1-22

Impact 3.5-10 provides a discussion of observed foraging distances for least terns and approximate distances from nearby colonies to the ELER Phase 2 area. As noted in that section and discussed in response to comment O-CR1-7, Ponds E1 and E2 are used intermittently by least terns, but not in large numbers and not every year. For the most part, least terns use Ponds E1 and E2 and the larger South Bay as post-breeding dispersal, after they have finished nesting at nearby colonies such as Alameda Point and Hayward Shoreline, and new breeding and post breeding staging at the recently established colony at Pond E14, and on their way south for the winter.

O-CR1-23

Refuge habitat has been incorporated at internal levees to maximum extent possible. Additional habitat is expected to develop over time as elevations increase.

O-CR1-24

As discussed in Section 3.9.1 of the EIR, mosquito control techniques employed by the ACMAD are implemented at ELER and emphasize control of larvae through source reduction, source prevention, larviciding, use of predatory fish, and/or other chemical and biological means, as opposed to the spraying of adults. The existing need for mosquito abatement has been limited, as very few areas in ELER have had mosquito issues.

O-CR1-25

See response to comment O-CR1-4. Although Alternative Eden D remains as described in the Draft EIS/R, the Preferred Alternative includes a the connection between ACFCC and Pond E2 which will no longer be through large culverts, as initially described, but instead through a full breach. This breach would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail.

O-CR1-26

As discussed in Impact 3.5-15, pond-associated piscivores, such as the American white pelican, would likely redistribute locally as a result of the loss of managed pond habitat (e.g., to Cargill-managed ponds or to retained managed ponds in northern Eden Landing). Although there is opportunity for them to redistribute to northern Eden Landing, they may prefer Cargill or Refuge ponds. According to data taken from SFBBO/USGS counts for 2003-2015, American white pelicans are most abundant on ponds N3A, A5, AB2, A17, and A1 (greater than 8,500 total birds counted, all but one are Refuge managed ponds; N3A is a Cargill managed pond).

As discussed in response to comment O-CR1-18, different species/guilds have different optimal conditions and therefore the southern Eden Landing Ponds are not currently, nor would they be in the future, the ideal habitat for every species/guild. The Preferred Alternative includes a mix of tidal restoration and adaptively managed ponds. Monitoring and assessment would be conducted as per the Adaptive Management Plan to inform potential operational changes in the Inland and Southern Ponds.

O-CR1-27

As discussed in Impact 3.5-16, dabbling ducks forage in a variety of habitats in the South Bay, including mudflats, shallow subtidal habitats, tidal sloughs and marsh channels, marsh ponds, managed and muted tidal marsh, seasonal wetlands, managed ponds, and water treatment plants. With tidal restoration of the Bay Ponds, open water pond foraging habitat for dabbling ducks would decline, but tidal marsh and mudflat foraging habitat would increase. Pond elevations may be raised relatively quickly by dredge material placement or relatively slowly by sediment accretion over a period of many years, but because dabbling ducks forage in a wide variety of habitat types, it may be misleading to assume a temporal loss in foraging habitat as they would likely utilize the ponds with either configuration.

O-CR1-28

As discussed in Impact 3.5-17, an underwater noise analysis would be completed during later stages of design and project permitting and would reflect more refined estimates for the size and composition of temporary mooring piles required for the offloading facility and booster pump(s).

O-CR1-29

See response to comment O-CR1-3.

O-CR1-30

As indicated in Section 3.5.3 of the EIR, project actions include preconstruction surveys for special-status plant species, implementation of the Adaptive Management Plan, and collaboration with the Invasive Spartina Project.

O-CR1-31

SBSP Restoration Project proponents support adaptive management and science-based monitoring. Periodic science updates as well as recent literature and technical studies are posted on the SBSP Restoration Project website.

O-CR1-32

Monitoring would be conducted as per the Adaptive Management Plan. As discussed in response to comment O-CR1-12, as with all publicly provided facilities, services, and potential experiences, agency funding levels can vary over time. As such, SBSP Restoration Project management actively seek to ensure that costs and funding are appropriately considered, estimated, and aggressively sought through various federal, state, regional and local funding sources.

Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper, and Ohlone Audubon Society (O-CR2)

Comments submitted via electronic mail only

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5 June 2018

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Re: Draft Environmental Impact Statement/Report (DEIS/DEIR), Phase 2, Eden Landing Ecological Reserve Complex, South Bay Salt Pond Restoration Project

Dear Ms. Morkill and Ms. Buxton,

O-CR2-1

This responds to the DEIS/R for proposed Phase 2 actions of the South Bay Salt Pond Restoration Project (SBSPRP) at the Eden Landing Ecological Reserve. We thank you for the opportunity to provide comments and incorporate by reference comments submitted on behalf of the Citizens Committee to Complete the Refuge by Dr. Peter Baye.

Our environmental organizations have been involved in the South Bay Salt Pond Restoration Project (SBSPRP) from the beginning. We support the restoration of tidal marsh in the South Bay and have been pleased to see the progress being made during the Interim Stewardship Program and during the implementation of Phase 1 actions. We appreciate the contribution of scientific information stemming from the applied science studies of the project.

We strongly support tidal marsh restoration in the South Bay, and understand the important ecological functions and values of tidal marshes (e.g. fisheries, nutrient recycling, water quality, flood control). Equally important however, is the SBSPRP objective of maintaining current migratory and resident waterbird species that have come to utilize the existing salt ponds and associated structures such as levees. As has been reported by Warnock et al. 2002[1],

> "San Francisco Bay contains the most important salt pond complexes for waterbirds in the United States, supporting more than a million waterbirds through the year (Accurso 1992; Page et al. 1999; Takekawa et al. 2001). Single day counts of waterbirds in the salt ponds during winter months can exceed 200,000 individuals (Harvey et al. 1992), and single day counts during peak spring migration have exceeded 200,000 shorebirds in a single salt evaporation pond (Stenzel and Page 1988)."

[1] Warnock, N., Page, G.W., Ruhlen, T.D., Nur, N., Takekawa, J.Y., and Hanson, J.T., 2002, Management and conservation of San Francisco Bay salt ponds: Effects of pond salinity, area, tide, and season on pacific flyway waterbirds: v. 25, iss. SPECIAL PUBL.2, p. 79-92.

O-CR2-1 (cont.)

Takekawa et al. 2006[2] cautioned,

> "converting from one wetland habitat type to another, such as converting salt ponds to tidal marsh, will likely benefit some species at the expense of others. Most shorebirds prefer more open habitats rather than tidal marsh plain habitats (Warnock & Takekawa 1995). Development of coastal zones and interior valley wetlands have resulted in fewer areas available for migratory waterbirds in the flyway, and alternative wetlands may not exist outside of the San Francisco Bay estuary to compensate for loss of waterbird habitats in the ecosystem...**Eliminating artificial salt ponds without providing alternative habitats may reduce or extirpate avian species from the ecosystem**"

O-CR2-2

Based upon the importance of managed ponds to migratory and resident waterbirds, the uncertainty of how many of the SBSPRP ponds will ultimately be converted to tidal marsh, the uncertainty of whether ponds not converted in Phases 1 and 2 will have sufficient carrying capacity to maintain the species diversity and abundance of our migratory and resident waterbirds, and the lack of alternative suitable habitats outside of the SF Bay estuary, we recommend Alternative D as the preferred Alternative for Phase 2 at the Eden Land Ecological Reserve (ELER). However, we refer you to the comment letter provided by Dr. Peter Baye regarding components of Alternative D such as the proposed location of the habitat transition zone and the need for areas of high tide refuge within the interior of Pond E2 for species such as the salt marsh harvest mouse.

O-CR2-3

Public access alternatives:

Due to the uncertainty regarding the suite of waterbirds the Inland and Southern ponds will be managed for, we strongly urge that Proposed Trail Route 3 is selected. If, as the restoration proceeds, monitoring reveals human disturbance will not be an issue for foraging, roosting or nesting waterbirds, additional trails could be incorporated to the project. Currently, there is regular usage of the trail along the Alameda Creek Flood Control Channel (ACFCC) by pet owners walking dogs off-leash. Connection of public access routes to the trail along the flood control channel could result in unintended management issues. As an example, posted restrictions were found to provide no deterrence to dog owners walking their dogs off-leash on Bair Island trails. The lack of compliance with posted restrictions ultimately resulted in the prohibition of dog walking on Bair Island trails.

We strongly oppose the proposed alignment of the proposed trail (purple slashed lines) depicted in Alternative C as this alignment (e.g. human disturbance) could have adverse impacts to California Black Rail and Ridgway's Rail use of occupied habitat in Old Alameda Creek.

O-CR2-4

Levee breach of Alameda Creek Flood Control Channel into Bay Ponds E2 and E4:

This action has been proposed in Alternative B. What are the ramifications of including this component under Alternative D?

O-CR2-5

Additional questions and comments:

[2] Takekawa, J. Y., Miles, A. K., Schoellhamer, D. H., Athearn, N. D., Saiki, M. K., Duffy, W. D., ... & Jannusch, C. A. (2006). Trophic structure and avian communities across a salinity gradient in evaporation ponds of the San Francisco Bay estuary. Hydrobiologia, 567(1), 307-327.

O-CR2-5 (cont.)

We appreciate the inclusion of some of the information requested in our scoping comments, e.g. existing pond salinities, pond bed elevations, identification of bird guilds currently utilizing the ponds. However, we do have questions, comments and concerns regarding the actions proposed in Phase 2.

- Alternative D is described as the phased implementation of tidal marsh restoration, with the caveat that "...if ongoing wildlife monitoring conducted under the AMP shows that the pond-associated wildlife species continue to require pond habitat, the Inland Ponds and Southern Ponds could be retained in that managed pond configuration indefinitely."

The description of the beneficial reuse of dredged material indicates that the target elevation of pond bottoms will be 6.5 feet NAVD88 and that both the Bay and Inland ponds will be filled. There is no indication this aspect of implementation will be phased. If that is the case, will it still be possible to manage the Inland ponds for diving or piscivorous bird guilds as those are the major guilds that will be displaced by conversion of the Bay ponds to tidal marsh?

O-CR2-6

- Habitat Islands – What methodology will be employed to prevent the development of cracks in habitat islands created from dredged materials? Bay mud can form deep cracks as it dries which could pose a threat to chicks of nesting birds.

  Ground cloth may be required under gravel, oyster shells or sand to prevent vegetation on islands designed for use by nesting Western Snowy Plovers or California Least Terns.

O-CR2-7

- Page 3.5-17 lists the California Least Tern as an "uncommon to rare forager." Page 3.5-13 states, Ponds E1 and E2 and the shallow bay outboard of the ponds are regularly used as foraging areas by the California Least Terns during the post-breeding period in late summer. Please correct the inconsistency and also describe what suitable pond replacement habitat exists locally for the E1 and E2 ponds.

O-CR2-8

- Table 3.5-2 Special-Status Animal Species and Their Potential to Occur in the Phase 2 Eden Landing Ponds: The text pertaining to the Black Skimmer (*Rynchops* niger) should be revised to reflect that a few individuals of this species have been regularly observed nesting on ponds at the Hayward Shoreline. Dave Riensche of the East Bay Regional Park District can be contacted for additional information. This information has also been documented in the Colonial Waterbird Nesting Summaries for the South San Francisco Bay conducted by the San Francisco Bay Bird Observatory dating back at least to 2008.

O-CR2-9

- Page 3.5-56:

  > "San Francisco Bay is one of the most important stopover and wintering areas on the west coast for these species. Within San Francisco Bay, the majority of these birds are typically found in the South Bay. In the South Bay, these small shorebirds forage primarily on intertidal mudflats at low tide and to a lesser extent along the margins of ponds or in shallow ponds. These birds roost and nest on sandy or gravel islands, salt flats, and levees.
  >
  > Conversion of former salt ponds to tidal habitats is expected to increase the availability of intertidal mudflat foraging area at low tide in the short term, as some of the breached ponds would provide intertidal mudflat and shallow water habitats for some time before accreting enough sediment to become vegetated. *However, in the long term, sedimentation patterns of the South Bay are expected to result in a loss of intertidal mudflat, both due to conversion to emerging fringe marsh and conversion to subtidal habitat due to scour as a result of increased tidal flux and eventually because of sea-level rise.* The latter of these is expected to occur even in the absence of the SBSP Restoration Project, but mudflat loss is expected to be greater if ponds are breached and tidal habitats restored (2007 Final EIS/R) as part

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O-CR2-9 (cont.)

> of the SBSP Restoration Project. However, intertidal mudflats are the dominant habitat of the South Bay, and only a small percentage of the total area of mudflats is within or adjacent to the Phase 2 areas and even a small portion of those are expected to be adversely affected by Phase 2 actions at southern Eden Landing.
>
> ...Overall, the staged and sequential transition of all of southern Eden Landing's ponds to tidal marsh over a decade or more, with opportunities under the AMP to retain *some of those ponds as enhanced managed ponds to provide suitable habitat for small shorebirds would provide maximum flexibility in providing shorebird habitat (as well as habitat for other guilds of birds)* while still moving toward full tidal restoration here. While some adverse effects on small shorebird population are expected, the implementation of Alternative Eden D is unlikely to reduce flyway-level populations 20 percent below baseline levels and would thus have a less-than-significant impact on small shorebirds." [emphasis added]

Plans such as the Southern Pacific Shorebird Conservation Plan (SPSCP) (2003)[3] highlight the importance of manage ponds for small and medium shorebirds. That plan identified historic, natural salt pan habitat as "open areas amongst the marshes" that "once served as supra-tidal foraging and roosting sites for many shore species, and as nesting areas for plovers, stilts, and avocets." Naturally occurring salt pans were subsequently replaced by man-made salt ponds that have "displaced their natural forerunners." However, "*very shallow ponds often contain drier areas that serve as excellent salt panne mimics*." [emphasis added]

O-CR2-10

In addition to pond depth as a limiting factor for small and medium shorebirds, the distance of day and night roosting sites to foraging mudflat habitat in the Bay requires research. A study conducted by Matt Leddy of plovers in a crystallizer pond in Redwood City, indicates there may be diurnal and nocturnal differences in roosting site selection, as well as differences in the amount of space required. [study attached]

O-CR2-11

According to the DEIS/R, the Bay ponds also support diving ducks, piscivorous birds and California Least Tern foraging habitat. The Southern ponds are reported to support dabbling ducks and diving ducks. The Inland and Southern ponds represent 40% of the total Phase 2 footprint, what is the carrying capacity of these ponds and the Phase 1 managed ponds? How can the remaining ponds be managed to support the divergent needs of waterbird species that currently use the Phase 2 ponds? What level of species diversity and abundance is possible for pond-dependent waterbirds within the remaining managed pond footprint (at ELER Phase 2)? De La Cruz et al. 2018[4] recently published a report on the importance of managed ponds within the SBSPRP for birds, showing that bird diversity and abundance increased within project ponds over the study period compared to a decreasing trend within salt production ponds. Results from this study highlight the need for managed ponds to enhance waterbird habitat. For example, larger ponds have higher bird abundance and ponds with at least one island support "higher abundances of all roosting guilds as well as of foraging dabbling and diving ducks, piscivores, terns, and waders."[5] Results from the De La Cruz et al. 2018 report justify the need for managed ponds and should be used to inform pond configurations for ELER Phase 2.

O-CR2-12

- Impact 3.5-4 Loss of intertidal mudflats and reduction of habitat for mudflat-associated wildlife species.

Is funding available to study the impacts of the proposed actions at ELER on the intertidal mudflats adjacent to the project? Similar studies at other pond locations were constrained by funding limitations. How will monitoring of the mudflats occur adjacent to the ELER complex?

[3] Hickey, C., W.D. Shuford, G.W. Page, and S. Warnock. 2003. Version 1.1. The Southern Pacific Shorebird Conservation Plan: A Strategy for supporting California's Central Valley and coastal shorebird populations. PRBO Conservation Science, Stinson Beach, CA.
[4] De La Cruz et al. op.cit

O-CR2-13

- Phase 2 Impact 3.5-5: Potential habitat conversion impacts to Western Snowy Plover. Page 3.5-65 has the comment "...the Inland Ponds and Southern Ponds would be retained as managed ponds and enhanced to provide similar, though slightly less flexible control over water depth, salinity and other characteristics."

Please explain what is meant by this statement and how this impacts the ability of the Inland and Southern ponds to support the needs of bird guilds displaced by conversion of the Bay ponds to tidal marsh habitat. As noted in the EIS/R, and by Takekawa et al. 2006[5], pond salinity is an important driver of fish populations and maintaining adequate pond depth is important for diving avian benthivores. If they are to provide suitable habitat for macroinvertebrates and fish prey species, the inland and southern ponds should be carefully managed with *more* rather than "*less* flexible control."

O-CR2-14 Do Western Snowy Plovers utilize Pond E6C and other Inland or Southern ponds for nesting? If so, what mitigation measures would be implemented during the introduction of dredged material to the Inland ponds?

O-CR2-15

- Phase 2 Impact 3.5-6: Potential reduction in the numbers of breeding, pond-associated waterbirds (avocets, stilts, and terns) using the South Bay due to reduction in habitat, concentration effects, displacement by nesting California gulls, and other project-related effects.

We concur with the observation:

> "Restoration of managed ponds to tidal marsh could result in a loss of nesting and foraging habitat for some of these species [*American Avocets, Black-necked Stilts, Forster's Terns, Caspian Terns listed previously*]. Large areas of unoccupied nesting habitat are available and could offset habitat loss due to conversion to tidal marsh. If available habitat is concentrated, it could make populations more vulnerable to predation. California Gulls use the same habitat type as avocets, stilts, and terns. Gulls displaced by loss of nesting habitat due to tidal marsh restoration could disrupt avocet, stilt, and tern colonies (2007 EIS/R)." [emphasis added]

One question that comes to mind is whether "unoccupied nesting habitat" is actually nesting habitat, or whether it is unoccupied because it is perceived by the species as unsuitable. If available habitat is concentrated, not only are populations more vulnerable to predation, individuals may also have to expend increased investments of energy due to interspecific competition for nesting territory and food, which could also have adverse impacts on populations. And while nesting islands may provide separation from terrestrial predators, they provide no deterrence for avian predators such as raptors, and in the case of chicks – raptors, corvids, California Gulls and large waders such as Great Blue Heron.

O-CR2-16 The DEIS/R mentions gull control. This certainly can be effective, but is also labor intensive in general and difficult to implement where islands are involved.

O-CR2-17 Of particular concern is the comment, "Recent and ongoing monitoring of converted ponds indicates that populations of avocets and stilts are in decline, potentially as a result of loss of historic nesting islands. In general these species are not moving as the ponds are restored." Is this a referring to a South Bay regional phenomenon or a trend that is being observed in managed ponds that are converted to tidal marsh?

O-CR2-18

- Phase 2 Impact 3.5-7: Potential reduction in the numbers of non-breeding, salt-pond-associated birds (e.g., phalaropes, Eared Grebes, and Bonaparte's Gulls) as a result of habitat loss.

[5] Takekawa et al. op. cit.

O-CR2-18 (cont.)

The DEIS/R notes that currently "there is moderate use of the southern Eden Landing Ponds by phalaropes and somewhat higher use by eared grebes." The document does not indicate which ponds are used by these species. To what extent do these species utilize the Phase 1 ponds? To what extent could the remaining and altered (Inland ponds - raised pond bottoms) provide suitable habitat?

De La Cruz et al.[6] have reported, "Within the Project ponds, those with deeper water or greater area supported higher abundances of foraging and roosting eared grebes...Optimal depths for foraging and roosting eared grebes in Project ponds were >0 m and 1.29 m, respectively." Eared Grebes also require ponds of higher salinities (approximately 109 ppt) while De La Cruz et al. report that "foraging and roosting dabbling and diving ducks (including northern shoveler and ruddy duck), piscivores, terns and waders were most abundant in ponds with relatively low salinity (≤33 ppt)."

O-CR2-19

This gets back to the question of how many different habitat requirements can be fulfilled within the remaining managed ponds (including those in Phase 1) and can these ponds support sufficient numbers of birds to prevent population decline?

- Phase 2 Impact 3.5-8: Potential reduction in foraging habitat for diving ducks, resulting in a substantial decline in flyway-level populations.

See comment above.

O-CR2-20

- Phase 2 Impact 3.5-9: Potential reduction in foraging habitat for ruddy ducks, resulting in a substantial decline in flyway-level populations.

In the discussion of the impact under Alternative C the EIS/R states, "...the ability to manage water quality, quantity, and circulation would be enhanced and foraging habitat for ruddy duck is expected to be maintained to provide moderately deep open water similar to or improved relative to the existing conditions." Under Alternative D however, the pond bottoms of the Inland ponds would be elevated with the introduction of dredged material. It is not clear from the discussion provided what impact this difference would have on the ability to provide roosting and foraging habitat for Ruddy Duck populations.

O-CR2-21

The Alternative D analysis includes the comment, "Also, ruddy ducks may be able to forage in other adjacent managed ponds, including the northern Eden Landing." We do not question that the northern Eden Landing ponds may provide habitat for Ruddy Ducks, but we would emphasize the words "may provide" for ponds that are still being used for salt production. Caution is necessary regarding any assumptions that ponds currently used for salt production will supply alternative habitat for species displaced by restoration of managed ponds to tidal marsh, as we have no control over the salinities, or pond depths for salt production ponds and conditions within these ponds may shift as needed for salt production.

O-CR2-22

- Phase 2 Impact 3.5-10: Potential habitat conversion impacts on California least terns.

According to Google Earth estimates, the Hayward Regional Shoreline Park nesting colony is less than 3 miles from the northern levee of Pond E1 and just over 4 miles from the southern levee of Pond E2. If foraging terns from the Hayward colony are foraging at the Eden Landing ponds, the distance is consistent with that observed at the Alameda NWR colony. While foraging habitat may be available in the Bay the fact that this species is regularly seen foraging in Ponds E1

[6] De La Cruz, S.E.W., Smith, L.M., Moskal, S.M., Strong, C., Krause, J., Wang, Y., and Takekawa, J.Y., 2018, Trends and habitat associations of waterbirds using the South Bay Salt Pond Restoration Project, San Francisco Bay, California: U.S. Geological Survey Open-File Report 2018–1040, 136 p., https://doi.org/10.3133/ofr20181040.

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O-CR2-22 (cont.) and E2 indicates a preference for habitat provided by these ponds. Will removal of these managed ponds have an impact on the energy required to relocate and travel to new foraging grounds, or result in an increase in the length of time adults are absent from the nesting colony? What impacts would this have on chick survival and how were these impacts considered when making the level-of-significance determination?

O-CR2-23

- Phase 2 Impact 3.5-11: Potential loss of pickleweed-dominated tidal salt marsh habitat for the salt marsh harvest mouse and salt marsh wandering shrew and further isolation of these species' populations due to breaching activities and scour.

The conceptual figure for Alternative D depicts a wide habitat transition zone along the bayward edge of Ponds E1 and E2, habitat mounds adjacent to the pilot channel between Ponds E1-E7 and E2-E4, as well as breached internal levees between E1-E2 and E7-E4. Will flood refuge habitat for species like the salt marsh harvest mouse be incorporated within the interior of the vast 680+ acre E1 pond, or is it hoped this would develop naturally over time? We would urge incorporation of flood refuge for species like the salt marsh harvest mouse within the marsh plain, rather than just at the edges of the current salt pond footprint. Detailed comments are provided in the Technical Memorandum submitted by Dr. Peter Baye.

O-CR2-24

- Phase 2 Impact 3.5-12: Potential disturbance to or loss of sensitive wildlife species due to ongoing monitoring, maintenance, and management activities.

Is it correct to assume vector control activities would be carried out in close coordination with California Department of Fish and Wildlife staff to ensure the manner in which these activities are conducted will not adversely impact listed species or waterbirds?

O-CR2-25

- Phase 2 Impact 3.5-13: Potential effects of habitat conversion and pond management on steelhead. Phase 2 Impact 3.5-14: Potential impacts to estuarine fish.

We support the creation of tidal marsh habitat to support fish populations. Is there a particular reason the levee breaches from Alameda Creek Flood Control Channel have not been included in Alternative D?

O-CR2-26

- Phase 2 Impact 3.5-15: Potential impacts to piscivorous birds.

The EIS/R emphasizes that "American White Pelicans do not forage in open waters of the Bay, preferring instead non-tidal waterbodies." Other than Pond SF2, what other ponds, not including those used for salt production, support American White Pelicans? As we stated earlier, caution must be used in relying on salt production ponds as management for wildlife is not the primary function of these ponds. Will the Inland ponds, Southern ponds and Phase 1 managed ponds be able to sustain existing ELER waterbird diversity and abundance and habitat for pond specialists such as the American White Pelican?

O-CR2-27

- Phase 2 Impact 3.5-16: Potential impacts to dabbling ducks.

Our comments remain consistent with questions raised for other waterbird guilds. The EIS/R reports:

> "Based on long-term monitoring data, the winter populations of dabbling ducks doubled from 2002 to 2006 during Initial Stewardship Plan operations in the SBSP Restoration Project ponds. The fall and spring pond counts have increased during the same period and since implementation of Phase 1 have leveled with some fluctuations. *These results may indicate the ponds have reached carrying capacity (De La Cruz et al., in press),*

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O-CR2-27 (cont.)

alternatively, the spatial and temporal redistribution of dabbling duck use of tidal restoration areas, enhanced managed ponds and other remaining managed ponds have reached equilibrium. Additional tidal restoration could result in similar dispersion of some dabbling ducks over the entire SBSP Restoration Project area. A possible exception to this expected dispersion is the northern shoveler, the most abundant wintering dabbling duck, which appears to prefer ponds to open bay or tidal marsh habitat. The response of this species to Phase 2 actions will be monitored under the AMP, but this species has been observed in large numbers using a wide range of salinity in the ponds, from low (30 ppt) to moderately high (120 ppt) which will remain available throughout Eden Landing and the South Bay." [emphasis added]

The information provided above raises the question of what other managed pond restorations have taught us regarding length of time it takes before a pond converted to tidal marsh is able to provide habitat for dabbling ducks and other waterbird guilds. As an example, and based upon information provided in the EIS/R, it would appear the Bay ponds will not provide any foraging habitat benefit until they have been filled with dredge material and opened to tidal action. If the managed ponds have reached carrying capacity for the dabbling duck guild or the use of tidal restoration areas, enhanced ponds and managed ponds have reached equilibrium, what impact will the temporal loss of foraging habitat have on the population? This is an issue that may become more important in the future as additional ponds are converted to tidal marsh, particularly for species with higher fidelity to managed ponds.

O-CR2-28

- Phase 2 Impact 3.5-17: Potential impacts to harbor seals.

We strongly support the requirement for an underwater noise analysis prior to project implementation to avoid potential underwater noise impacts to harbor seals. We also urge that cushion blocks or bubble curtains and the use of the "soft start" technique be required.

O-CR2-29

- Phase 2 Impact 3.5-18: Potential recreation-oriented impacts to sensitive species and their habitats.

We urge the SBSPRP project team to identify the proposed trail alignment and Route 3 alternative as identified in Alternative D to avoid adverse impacts to listed species, species of concern, migratory, nesting and roosting waterbirds.

O-CR2-30

- Phase 2 Impact 3.5-19: Potential Impacts to special-status plants.

We support the implementation of protective measures identified in this section.

- Phase 2 Impact 3.5-20: Colonization of mudflats and marsh plain by non-native Spartina and its hybrids.

We support utilizing the Invasive Spartina Project's 2010 BMPs to inform restoration and management actions.

- Phase 2 Impact 3.5-21: Colonization by non-native Lepidium.

Colonization of the Phase 2 action area by *Lepidium* poses a significant adverse threat and BMPs and measures identified in the Adaptive Management Program must be implemented.

O-CR2-31

Closing remarks:

The SBSPRP has collected an extensive amount of data through literature search, cooperative exchanges of data or directed field studies specific to addressing key uncertainties. Much of this information is available in the Technical Document section of the SBSPRP website. However, until very recently, these data have not been summarized for public consumption (We were just informed on 5/21/2018 that a summary document of some of the Phase 1 scientific study data has been released). Information such as trends in waterbird use of ponds outside the SBSPRP footprint does not

O-CR2-31 (cont.)

appear to have been summarized, so it is difficult for members of the public to understand the backdrop against which the proposed restoration projects are occurring (e.g. what are the trends of waterbird populations throughout the South Bay and San Francisco Bay region?) It would be extremely helpful if more of this information could be synthesized, to enable the public to provide substantive comments to the proposed restoration designs.

O-CR2-32

With respect to waterbird populations, monitoring over a long period of time and at a broad scale (i.e. not just within the project area) is critical. A positive response may be indicated in years 1 and 2, but years 3 and 5, or 10 and 15 could reveal a different trend, which may be more indicative of the long-term response. The recent report by De La Cruz et al. 2018[7] analyzes trends of waterbird abundance and diversity within managed ponds and in salt evaporation ponds across differing physical environmental conditions. Studies such as these are crucial to informing our understanding of waterbird needs and potentially to their responses to actions taken. Does funding exist to continue this work in the long-term? The De La Cruz et al. 2018 study could be updated with data from 2016 and 2017 to further inform the status of birds within project ponds and salt production ponds. The authors also lacked invertebrate data at an appropriate scale to address relationships between prey and waterbird abundance. Future monitoring should include invertebrate sampling to determine if key prey species are present and available for birds with in the SBSPRP. Overall, managed ponds provide important habitat for diverse avian groups and must be maintained as the SBSPRP progresses.

Does adequate funding exist to continue monitoring and scientific studies intended to address key uncertainties?

As we stated at the beginning of our letter, we are strongly supportive of tidal marsh restoration within the south bay, but we are also deeply committed to sustaining habitat and species diversity. Thank you for the opportunity to provide comments. We ask that we be kept informed of any additional opportunities to provide public comments.

Sincerely,

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[7] De La Cruz, et al. op. cit

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Response to Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper, and Ohlone Audubon Society (O-CR2)

O-CR2-1

See response to comment O-CR1-1. Note that the Adaptive Management Plan includes numerous measures that track waterbird densities in the South Bay and potential management actions are triggered depending on the monitoring outcome. Also note that the Preferred Alternative included adaptive management of both the Inland and Southern Ponds, allowing operational flexibility depending on the outcome and response to phased restoration.

O-CR2-2

See response to comment O-CR1-2. See also response to comment O-CR1-23 regarding high tide refuge habitat.

O-CR2-3

See response to comment O-CR1-3. The Preferred Alternative does not include the "spur" trails along, and bridge over, OAC.

O-CR2-4

See response to comment O-CR1-4.

O-CR2-5

See response to comment O-CR1-5.

O-CR2-6

See response to comment O-CR1-6.

O-CR2-7

See response to comment O-CR1-7.

O-CR2-8

See response to comment O-CR1-8.

O-CR2-9

See response to comment O-CR1-9.

O-CR2-10

See response to comment O-CR1-10.

O-CR2-11

See response to comment O-CR1-11. De La Cruz's finding that SBSP Restoration Project ponds provide higher bird abundance and diversity than salt production ponds is consistent with the project's restoration goals and objectives. Also note that the Preferred Alternative includes numerous habitat islands and mounds in the Bay Ponds and the Southern Ponds.

As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate.

O-CR2-12

See response to comment O-CR1-12.

O-CR2-13

See response to comment O-CR1-13.

O-CR2-14

See response to comment O-CR1-14.

O-CR2-15

See response to comment O-CR1-15.

O-CR2-16

See response to comment O-CR1-16.

O-CR2-17

See response to comment O-CR1-17.

O-CR2-18

See response to comment O-CR1-18.

O-CR2-19

See response to comment O-CR1-19.

O-CR2-20

See response to comment O-CR1-20.

O-CR2-21

See response to comment O-CR1-21.

O-CR2-22

See response to comment O-CR1-22.

O-CR2-23

See response to comment O-CR1-23.

O-CR2-24

See response to comment O-CR1-24.

O-CR2-25

See response to comment O-CR1-25.

O-CR2-26

See response to comment O-CR1-26.

O-CR2-27

See response to comment O-CR1-27.

O-CR2-28

See response to comment O-CR1-28.

O-CR2-29

See response to comment O-CR1-29.

O-CR2-30

See response to comment O-CR1-30.

O-CR2-31

See response to comment O-CR1-31.

O-CR2-32

See response to comment O-CR1-32. Note that monitoring is conducted as per the Adaptive Management Plan and additional science-based monitoring is used to address key uncertainties.

California Trout (O-CT)

CALIFORNIA TROUT

FISH · WATER · PEOPLE

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1 May 2018

Attn: Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612
brenda.buxton@scc.ca.gov

Dear Ms. Buxton,

O-CT-1 Thank you for the opportunity to comment on the DEIS for the Eden Landing Phase 2 Project.

California Trout has been based in San Francisco since 1971 and continues to advocate for balancing the needs of wild fish and people for a better California. I am not an expert on salt marsh restoration or estuarine function, but I do have input on the project alternatives and some considerations from a native fish perspective to raise. I have read fisheries consultant Scott McBain's June 23, 2017 letter on salmonid considerations for this specific project (attached) and talked to Dr. Jim Hobbs at UC Davis who has done fish sampling work in tidelands in the North and South Bay for years. My comments on the Eden Landing Phase 2 Project are based upon my research evaluating status and trends of all 31 of California's extant runs of native salmonids: www.caltrout.org/sos/.

The San Francisco Bay of today is highly altered, with its nursery and rearing areas largely destroyed and full of invasive predators. We don't have good information or studies looking at how estuarine habitats are currently utilized by native fishes (McBain's literature review was likely complete but highlighted just how little recent data is available for drawing informed conclusions), making predictions of how certain restoration designs will be used simply best guesses based largely on expert opinion.

The Napa River salt marsh restoration work of a decade ago had fish sampling that may teach us some valuable lessons about restoring bay tidelands for salmonids: http://scc.ca.gov/projects/san-francisco-bay/napa-river-salt-marsh-restoration-project/ Jim Hobbs and other researchers doing the monitoring found that only non-native species

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O-CT-1 (cont.)

used the man-made, deeper channels in the project area, such as striped bass and others. Native fishes tended overwhelmingly to use the shallow margin habitats, perhaps for refuge from myriad non-native predators that patrol the deeper habitats. The fact is that we just do not know why salmonids were not utilizing these restored habitats.

O-CT-2

From a salmonid perspective, estuarine habitats serve two primary purposes: 1) rich foraging opportunities and 2) nursery areas with predator refuge for juveniles. Changing proportions of the portfolio of salmonid life histories utilize different estuarine habitats for varying amounts of time depending upon many factors such as water year type, environmental conditions, seasonality, density dependence, and others. However, salt marsh/estuarine habitats serve primarily as areas for juvenile fish to grow for their arduous journey to the Pacific or to return to freshwater to eventually spawn. With this in mind, I raise some points for design consideration for the Eden Landing Phase 2 Project:

1. To the extent practicable, deep, straight channels should be avoided in favor of diverse channels with some deeper holes, large woody cover, meanders, and habitat diversity. This gives juvenile fishes opportunities to escape predators.

O-CT-3

2. We need areas for the water to slow down and back up into fingers that don't get flushed every tidal cycle to provide food for juvenile salmonids. By slowing the water down and increasing residence time of the water for a few days to days to weeks (especially from February - April, when the majority of our juvenile salmonids are entering the bay from tributaries or the delta), food can concentrate in areas and provide rich foraging opportunities for many species. If each little channel is constructed to connect to one another in study design, then the water and food gets flushed too frequently via tidal cycles to accumulate. The water must be spread out in shallow tidal fingers to get plenty of sunlight to drive primary production and provide food for juvenile fishes. Historically, a large proportion of juvenile salmonids likely spent days to weeks in the bay putting on weight before emigrating to the Pacific: we should create some diverse habitats (that are severely lacking in the bay now) to allow some segment of the remaining populations the habitat to encourage them to stick around and feed and grow to increase survival at sea if we want to have any hope of recovery for our salmonids. This life history has probably been lost, because juvenile fish that dally in the bay are probably not surviving in large numbers to complete their life cycles and spawn successfully, so we must try to re-create the habitats the led to this life history expression in the first place. This idea is a central tenet of building resilience in populations and is a key to recovering native salmonids.

O-CT-4

3. Multiple entrances and exits to restored tidelands, managed ponds, etc. should be incorporated to ensure that non-native predators, such as striped bass, don't stack up at the mouths of the inlet/outlet channels ready to ambush juvenile salmonids or other native fishes, as they tend to do now in Alviso Slough in the South Bay.

O-CT-5

4. A variety of levee breaches should be explored in the phased approach suggested so certain habitats become inundated in succession, rather than all at once. “Notched" levees or "benches" at different elevations on a levee spill at different locations during different storm and tide levels, ensuring one section of levee

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O-CT-5 (cont.)

doesn't bear the entire brunt of flood flows, such as during king tides, and also avoid stranding of fish and other aquatic species, especially in managed ponds.

O-CT-6

In terms of specific recommendations, "Alternative Eden D" seems like the best alternative from a native fish perspective because of its extensive tidal marsh and managed pond restoration, as well as its temporary use of levees as part of an adaptive management framework. However, I think incorporating some of the pilot channels for fish habitat connectivity that are currently lacking in alternative D would be beneficial for native fishes, especially if such channels incorporate large woody debris refuge strategically placed near the entrance to these channels and where they meet smaller fingers to provide refuge from predators, such as the root wads shown in Figure ES-4. Large wood structures should be placed adjacent to flowing water in/adjacent to channels to encourage scouring to create some depth complexity, and should be sized so they do not wash away in the course of regular tidal cycles or even fairly regular storms.

O-CT-7

I also recommend exploration of utilizing different breach techniques in all adjacent parcels to the existing flood control channel to allow juveniles being flushed out of the existing Alameda Creek fire hose a chance to seek velocity refuge at multiple locations during different types of flows. This would include breaching/levee work at E1C, E2C, E4, and E2, at a minimum, plus any parcels adjacent to pilot channel work.

O-CT-8

Finally, the phased approach outlined in the project proposal, along with implementation of an adaptive management plan, is the best approach for this work. The reality is we don't know enough about how native fishes utilize restored estuarine habitat in California at this time because we have not funded sufficient monitoring and there are so few remaining juvenile salmonids rearing in the bay today that it is hard to study their habits at all. I encourage the design and implementation team to be thoughtful about designing and incorporating long-term monitoring of native fish utilization of different habitat types both pre- and post-project for the benefit of recovery for all salmonids and the lessons to be learned before expenditure of significant amounts of taxpayer funds that will follow in bay tidelands and estuary restoration in the future.

Thank you for your consideration and for the opportunity to comment on the project.

Respectfully,

Patrick Samuel

/s/ Patrick Samuel
Bay Area Program Manager
California Trout

Cc: Evan Buckland, Alameda County Water District
Jeff Miller, Alameda Creek Alliance
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June 23, 2017

Comments on the Eden Landing Salt Pond Complex Restoration Plan Alternatives Relative to Anadromous Steelhead *(Onchorhynchus mykiss)*

Prepared for: Alameda Creek Alliance

Prepared by: Tim Caldwell, McBain Associates
Natalie Stauffer-Olsen, Trout Unlimited
Scott McBain, McBain Associates

O-CT-9

INTRODUCTION

A large purchase of solar salt production ponds in the Southern San Francisco Bay by the United States Fish and Wildlife Service and the California Department of Fish and Wildlife was done to restore the salt ponds to tidal marshes. This has become known as the South Bay Salt Pond Restoration Project. The goals of this project are to restore the salt ponds to ecologically functional tidal marshes and wetlands that provide habitat for wildlife, birds, and aquatic organisms, provide public access for wildlife viewing and recreation, and flood management in the Southern San Francisco Bay. There are three pond complexes that are undergoing restoration, Alviso, Ravenwood, and Eden Landing. The subject of this comment is the Eden Landing complex, which is currently in phase 2 of restoration planning. Phase 2 of the Eden Landing Complex is steered at restoring and enhancing ponds south of Old Alameda Creek. The purpose of this document is to provide comment on the restoration alternatives for the Eden Landing Complex on behalf of the Alameda Creek Alliance, specifically on the potential benefits and risks associated with the alternatives to steelhead (*Onchorhynchus mykiss*) and other anadromous fish that may use the restored ponds.

There is very little scientific information available that describes the use of restored salt ponds by juvenile *O. mykiss*. To prepare these comments, we reviewed literature on the use of coastal estuaries by juvenile *O. mykiss*, with a focus on systems from California, with the assumption that *O. mykiss* may utilize restored ponds similarly. Secondarily, we initiated correspondence with many of the lead authors on these papers to get their current opinion and hypotheses on the role the salt pond restoration may play in benefiting juvenile *O. mykiss* through increased growth, survival, and fitness.

First, we summarize the relative literature and expert opinions on how *O. mykiss* may use the restored salt ponds and risks to *O. mykiss* which may be associated with project alternatives. We also provide a recommendation of the preferred alternative and comment on potential changes that could be made based on the reviews of literature and expert opinion, with a focus on benefits for *O. mykiss*. We then conclude with recommendations on monitoring and research that could be done in the near term to better inform final design and implementation of Eden Landing Phase 2 that may better benefit *O. mykiss*.

O-CT-9 (cont.)

SUMMARY OF LITERATURE PERTINENT TO THE USE OF TIDAL MARSHES AND RESTORED PONDS BY SALMONIDS IN THE SOUTHERN SAN FRANCISCO BAY

1) **Hobbs, J, (2015). Steelhead smolt outmigration and survival study: Year 2 Stream Surveys.**

Summary of research: Researchers attempted to determine how juvenile *O. mykiss* from Guadalupe River would utilize a water control structure on managed salt ponds in the Alviso Salt Pond Complex Restoration project. Ultimately, the goal was to understand if juvenile *O. mykiss* were at a risk of entrainment or if they successfully utilized the habitat as a rearing area that increased growth rates, survival and population. They also determined how predators such as striped bass may have utilized water control structures for predation. In 2014, 32 juvenile *O. mykiss* were PIT tagged in Guadalupe River and tracked with PIT antennae placed at 3 of the 5 slots on the water control structure at the A8 pond notch. In addition, 18 Striped Bass (*Morone saxatilis*) were tagged near the notch. Unfortunately, the antennae did not cover the entire A8 notch and one of their antenna was destroyed by high flows, thus they were only able to asses 2 of the 5 slots in the water control structure. None of the *O. mykiss* tagged in Guadalupe River were detected at the A8 notch; however, the researchers suggest that it may have been due to poor coverage (3 slots were not instrumented) of the antennae. While none of the tagged *O. mykiss* were detected, 3 different *M. saxatilis* were detected, and one of the fish was detected multiple times, suggesting it was spending significant time in the notch habitat. This provides evidence to suggest that predators will target breaches, and with only one breach per pond, the risk of predation to juvenile *O. mykiss* would be high. The researchers also interviewed anglers that frequent the notch and reported that *M. saxatilis* up to 50 lbs have been caught there and sometimes 50 fish per day.

Potential implications for the Eden Landing Complex restoration: This paper suggests that predation rates could be high at breaches and water control structures, and it is unclear if *O. mykiss* will access the restored ponds or how they could become entrained. The maximum number of breaches possible would likely dilute predation pressure at any one water control structure/breach.

O-CT-10

2) **Hayes, S.A., et al. (2008). Steelhead growth in a small central California watershed: Upstream and estuarine rearing patterns. Transactions of the American Fisheries Society. 137:114–128.**

Summary of research: The goals of this paper were to assess and compare growth rates in stream rearing habitat and estuary rearing habitat in a typical coastal California watershed (Scott Creek). The authors tagged and recaptured juvenile *O. mykiss* to determine growth rates among habitats. The *O. mykiss* that were rearing in the stream grew at 0.01% per day during summer, while those rearing in the estuary grew at a significantly higher rate (0.2–0.8% per day). This suggests that *O. mykiss* which reared in the estuary grew larger and had a higher probability of ocean survival and returning to spawn as an adult.

O-CT-10 (cont.)

Potential implications for the Eden Landing Complex restoration: This paper suggests that if juvenile *O. mykiss* could access the salt ponds effectively and with suitable habitat conditions (i.e. dissolved oxygen, salinity, and water temperature) they have the potential to grow at a higher rate. This is significant because juvenile rearing habitat is currently limiting in Alameda Creek and salt pond restoration has the potential to increase the rearing habitat available. However, there is considerable uncertainty in the salinity levels that the fish will be able to physiologically endure. The current design may not allow enough freshwater to enter the restored ponds, which may reduce the ability of *O. mykiss* to rear within the restored ponds.

O-CT-11

3) **Bond, M.H., et. al., (2008). Marine survival of steelhead (*Oncorhynchus mykiss*) enhanced by a seasonally closed estuary. Canadian Journal of Fish and Aquatic Sciences. 65: 2242–2252.**

Summary of research: In this publication, the researchers continued analysis from Hayes et. al. (2008), and determined the adult spawning return rate and size of ocean entry by juveniles from estuary reared and stream reared *O. mykiss* in Scott Creek, CA. This was done using PIT tagged fish and by back calculating the size of juvenile at ocean entry from returning adults via a fish scale radius to fish length regression. Based on the tagged fish analysis, 87% of returning adults had spent time rearing in the estuary. Via the scale and length analysis, the authors estimate that 95% of the returning adults were estuary reared fish. This suggests that fish which rear in the estuary for the summer before entering the ocean in the fall grow to a significantly larger size and have a higher probability of ocean survival than those which only reared in the estuary.

Potential implications for the Eden Landing Complex restoration: This study supports a hypothesis that if juvenile *O. mykiss* can access the restored tidal pond without significant predation, entrainment associated mortality, and with favorable water quality conditions, then restoration may help alleviate a likely juvenile rearing constraint on the Alameda Creek water shed. Higher growth rates and larger size smolts will increase their probability of ocean survival and returning to spawn as adults. However, in the current design, salinity levels may be too high for juvenile *O. mykiss* to utilize the habitat.

O-CT-12

4) **Cannata, S.P. (1998). Observations of steelhead trout (*Oncorhynchus mykiss*), Coho Salmon (*O. kisutch*) and water quality of the Navarro River Estuary/Lagoon, May 1996 to December 1997.**

Summary of research: This paper described the use of a coastal estuary/lagoon system in Northern California by *O. mykiss* and Coho Salmon (*Oncorhynchus kisutch).* In addition, the research assessed dissolved oxygen, salinity, and temperature to determine if parts of the estuary became unable to sustain salmonid life (i.e. anoxic or hyper-saline environments). The research documented use of the estuary system throughout the entire year by young-of-year, age-1 and age-2 juvenile *O. mykiss.* In a comparison between estuary reared and river reared *O. mykiss* that were greater than 110 mm in length, fish from the estuary had a higher body weight. The authors also suggest that a large proportion of the juvenile *O. mykiss* population utilizes the estuary for rearing year-round.

O-CT-12 (cont.)

Water quality was measured with the goal of relating temperature, dissolved oxygen, and salinity to fish abundance. They observed that once the estuary became completely closed off from tidal influences from sand bar formation, a halocline forms. A halocline forms when there is a difference in salinity levels along a depth gradient, with the warmer and denser saline water settled below the cooler and less dense freshwater is at the top. This is most apparent in the areas closest to the ocean. Because of this phenomenon, habitat can increase or decrease relative to streamflow. For example, in years with low streamflow, areas stratified by the halocline may be larger relative to years with higher streamflow, because less freshwater is delivered and the potential of the halocline breaking down decreases. When the estuary is stratified by levels of salinity, concentration of dissolved oxygen and temperature reach lethal levels for juvenile salmonids in the deeper waters and fish mush seek out refuge in surface waters, nearshore zones, or areas further upstream, which was observed by this study.

<u>Potential implications for the Eden Landing Complex restoration</u>: This study provides evidence to suggest that *O. mykiss* would utilize tidal areas if they are provided safe access. In addition, this study highlights the importance of water quality within the tidal area. Water quality models should be developed for the ponds being restored to determine if environmental conditions would be suitable for *O. mykiss* if they were in the ponds.

O-CT-13

5) **Zedonis, P.A. (1990). The biology of juvenile steelhead (*Oncorhynchus mykiss*) in the Mattole River estuary/lagoon. Master's Thesis. Humboldt State University.**

<u>Summary of research</u>: This study was similar in design and outcome to Cannata et. al. (1998). Juvenile *O. mykiss* catch per unit effort and population estimates were made for lower and upper areas along the Mattole River Estuary. Results suggest that juvenile *O. mykiss* utilize the estuary for rearing year-round. However, during summer and when the estuary becomes closed off, the formation of a halocline can limit habitat as dissolved oxygen concentration and temperature reach lethal levels in the deep-water areas closest to the ocean. This effect is particularly problematic during low streamflow years. This study also examined diet of juvenile *O. mykiss* in the estuary, which were dominated by invertebrates and there was no evidence of food limitation.

<u>Potential implications for the Eden Landing Complex restoration</u>: This study suggests that estuaries (most comparable habitat to restored salt ponds with information on *O. mykiss*) are highly fertile nursery areas, and under the right water quality conditions could increase growth rates of juvenile *O. mykiss*. Water quality modeling or monitoring would be beneficial in determining the suitability for juvenile *O. mykiss* rearing in the restored ponds. Similarly, identification of a freshwater source that would dilute salinity and create a brackish system would likely result in more suitable rearing habitat for juvenile *O. mykiss*. In the current plan, salinity maybe too high for *O. mykiss* to successfully utilize the restored ponds. Monitoring of fish movement and habitat selection would be beneficial in determine how well they could utilize the restored ponds.

O-CT-14

SUMMARY OF EXPERT OPINIONS PERTINENT TO THE USE OF TIDAL MARSHES AND RESTORED PONDS BY SALMONIDS IN THE SOUTHERN SAN FRANCISCO BAY

1) Dr. James Hobbs (University of California – Davis)

Dr. Hobbs was the author on the first paper reviewed above which was the only study that examined use of the salt ponds by *O. mykiss*. His main concerns about design were predation risks at breach points, which was observed from his study which noted the presence of predators at breach points and water control structures. To avoid this, multiple breach points for each pond are ideal so that *O. mykiss* avoid congregating in one location where they are vulnerable to predators. Dr. Hobbs also recommends not doing any managed ponds and to use the full tidal restoration alternatives. In addition, he suggests that breaching ponds in order furthest from bay to closest to bay is recommended so that sediment does not accumulate in the closest to bay pond and block natural restoration of those furthest from the bay. Dr. Hobbs also suggests that if the ponds are designed to benefit *O. mykiss, O. tshawtscha* (Chinook Salmon) would also benefit.

O-CT-15

2) Mike Wallace (California Department of Fish and Wildlife)

Mike Wallace has authored reports on the use of juvenile *O. kisutch* (Coho Salmon) in Humboldt Bay. Based on his observations and studies on *O. kisutch,* Mr. Wallace stressed considerable uncertainty about how *O. mykiss* may use the restored ponds, but would likely result in some use. His primary concern was about the water quality issues that may arise in the restored ponds, and that it is possible that short term anoxic conditions could be detrimental to any *O. mykiss*, and suggests that water quality be modeled. He also suggests adding deeper pools and large wood cover to the restored tidal ponds, which may act as refugia for juvenile *O. mykiss* to reduce stranding mortality and predation during the tidal cycles.

O-CT-16

3) Dr. Morgan Bond (NOAA)

Dr. Bond was an author of one of the peer reviewed papers above (Bond et al. 2008), and suggests that there is no real comparable habitat to the tidal ponds, so finding peer-reviewed literature and white papers may be difficult. She reiterated her results from the paper and suggests there could be considerable movements between the streams and restored ponds over a large variety of time scales (i.e. from daily to annual movement). The ability to search for and forage in preferred habitat likely increases growth through increased food availability, and condition through improved water quality conditions such as temperature, DO, and salinity.

O-CT-17

COMMENTS ON PLAN ALTERNATIVES

We feel that it is beneficial that the plan alternatives included designs that could facilitate the use of the restored ponds by juvenile *O. mykiss* as rearing habitat through breaches and tidal restoration. Based on our literature reviews and interviews, we believe that providing adequate access to the ponds and ensuring favorable water quality would likely allow juvenile *O. mykiss* to grow at a faster rate and out-migrate at a larger size, which increases the probability of ocean survival and returning to spawn. However, based on our review of literature, contact with experts, and our own opinions we do have some comments to the plan alternatives. Below we summarize our concerns with the plan alternatives: predation risk, connectivity, and water quality.

1) Predation Risk

Alternative plans B–D included various breaches and channel constructions that have the potential to be utilized by juvenile *O. mykiss* for rearing habitat. However, these plans included only one breach for each pond, which may increase the risk for predation on juvenile *O. mykiss* as predators are likely to congregate at the breaches (Hobbs 2015). We suggest that along the Alameda Creek Flood Control Channel (ACFCC) and on the bay side of the ponds, multiple breaches be put in place on each pond to decrease the potential of predation at pond breaches. The addition of the bay side breach would allow easier out migration and connectivity with the Bay, while simultaneously reducing the risk of predation. Monitoring predator use could also be done in the current Phase 1 portion of the Eden Complex to better understand the risk of predation to juvenile *O. mykiss* and help inform design of Phase 2.

O-CT-18

2) Connectivity

The breaches and channel construction in the current plan alternatives provide only a single location in and out of each pond. Based on our literature review, we feel that multiple points of connectivity are critical for juvenile *O. mykiss* to best utilize the pond habitat when suitable environmental conditions exist. For example, Bond et al. (1998) and Cannata (1998) suggest that in most estuaries, *O. mykiss* must be able to move freely and efficiently between estuary and freshwater habitats to successfully utilize the fertile environments provided by the estuary. While salt ponds will not necessarily function the same way that an estuary will, we expect some similarities during certain seasons and hydrological conditions. Thus, we suggest creating multiple points of access to each pond along the ACFCC and the bay to increase connectivity between habitats. To help inform the design of Phase 2, monitoring of juvenile *O. mykiss* habitat use of Phase 1 could be done. This would determine the level of connectivity required to make the habitat suitable and be valuable in the design of breaches.

O-CT-19

3) Water Quality

O. mykiss are adapted to thrive in certain temperature and dissolved oxygen ranges, and levels too far outside of those ranges can be stressful or lethal. Studies have found that *O. mykiss* utilize estuaries, but seek refuge in freshwater when conditions became unfavorable (Hayes et al. 2008, Cannata 1998). To address this concern, we suggest water quality monitoring and/or water quality modeling to determine the sub-daily levels of dissolved oxygen and temperatures that would occur in the restored ponds. The Eden Landing Phase

O-CT-19 (cont.)

1 project provides a unique opportunity to conduct this type of monitoring and research. For example, water quality monitoring (particularly water temperature and salinity) could be performed to evaluate seasonal rearing habitat suitability at a nearby site to inform Phase 2 designs. We also suggest the addition of pools (with cover) with a residual depth of 2–3 feet to provide juvenile *O. mykiss* refugia should they become entrained within the ponds. Structure cover, such as large wood, should also be added to these areas to provide cover to juvenile *O. mykiss* to reduce predation risk by birds, mammals, or other fish.

O-CT-20

RECOMMENDATIONS

Based on current information available on potential *O. mykiss* use of restored tidal marsh/ponds, Alternative B would be most likely to benefit to juvenile *O. mykiss* because it provides full tidal restoration and does not include any managed ponds, thus providing the most amount of habitat for juvenile salmonids. We would like to see uncertainties regarding predation, connectivity, and water quality can be addressed in the upcoming design phases (30% to 100% designs). We also support a phased restoration approach with an adaptive management plan and S.M.A.R.T. (specific, measurable, achievable, relevant and time-bound) goals and objectives to measure success of the first phase(s) and to inform subsequent phases of the restoration.

O-CT-21

Given the considerable uncertainty about how *O. mykiss* will utilize the newly restored habitat, we recommend monitoring and research which will aid in the adaptive management plan for the pond restorations. For example, we suggest considering fish tagging efforts on the Eden Landing Phase 1 followed by monitoring after the Phase 2 monitoring restoration project to help better understand how fish utilize the restored ponds and better inform the design and monitoring or modeling of water quality within the restored ponds to determine habitat suitability for *O. mykiss*. Directly tagging *O. mykiss* would be the most effective way of monitoring *O. mykiss* use of the restored salt ponds; however, Alameda Creek has a very small population of wild *O. mykiss,* thus any tag-induced mortality could be very detrimental. Similarly, tagging hatchery produced *O. mykiss* and releasing them would dilute the genetic pool of the current wild population, and is therefore not recommended. As an alternative, we suggest that tagging hatchery juvenile *O. tshawytscha* (Chinook Salmon) be considered to monitor the use of the restored ponds by anadromous salmonids. While *O. tshawytscha* and *O. mykiss* will likely utilize the restored habitat differently for their different life stages, monitoring juvenile *O. tshawytscha* habitat use would still provide improved understanding of how anadromous salmonids may utilize restored salt ponds.

O-CT-22

Given the substantial amount of resources and time spent restoring the Eden Landing Complex salt ponds, we believe that it is best to review all plans in detail to best inform the design so that it will be beneficial ecologically. Based on our literature review and input from experts, this restoration project, with the appropriate design, could help support the recovery of an *O. mykiss* population in Alameda Creek, as well as benefit anadromous salmonid production from other bay area streams. We look forward to continuing our engagement in the design and plans by providing relevant scientific and design input.

Response to Response to California Trout (O-CT)

O-CT-1

See MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative for implementation as part of the Phase 2 project at Eden Landing. Note that one of the primary design goals for the restored tidal ponds is to regularly fill and drain to allow for tidal exchange and for vegetation growth in the restored marsh. The pilot channels would assist with the filling and draining of the ponds. For the preliminary design, the bottom elevation of the deeper pilot channels in the Bay Ponds was set at -4 feet NAVD88 to allow for about 1 foot of water in the channel during the lowest spring tide to prevent fish stranding. Smaller spur channels would have bottom elevations of 0 feet NAVD88, and once breached, additional shallow channels are expected to form on the bottom of the ponds that connect back to these main drainage channels. As such, a variety of bottom channel elevations are expected in the ponds.

O-CT-2

See response to comment O-CT-1 regarding bottom elevations for channels. The inclusion of deeper holes and large woody cover would be considered during detailed design. As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate.

O-CT-3

See response to comments O-CT-1 and O-CT-2 regarding design considerations.

O-CT-4

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative includes the maximum number of connections between the ACFCC and the restored ponds outlined in the Draft EIS/R: two connections to the Bay Ponds and one to the Southern Ponds. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. Because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-CT-5

As discussed in MCR 1, the Preferred Alternative includes levee lowering as well as levee breaches. Levee lowering would occur at Pond E1’s northern levee and Pond E2’s southern levee west of the breaches. The levee lowering is expected to increase hydraulic connectivity between channels and marshes.

O-CT-6

As discussed in response to comment O-CT-4 and MCR 5, Fish Habitat Restoration, ACFCC would have two connections to the Bay Ponds and one to the Southern Ponds in the Preferred Alternative. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. These connections also include their associated pilot channels. See also response to comment O-CT-2 regarding consideration of deeper holes and large woody cover during detailed design.

O-CT-7

See response to comment O-CT-6 regarding the different types of connections proposed between ACFCC and the restored ponds.

O-CT-8

As described in response to comment O-CT-4, the Preferred Alternative includes an adaptive management approach for restoration of the Southern Ponds. Note that the SBSP Restoration Project proponents support adaptive management and science-based monitoring. Estuarine fish in foraging and rearing habitats within the ponds would be monitored as per the Adaptive Management Plan. Water quality parameters such as dissolved oxygen would also be monitored.

O-CT-9

As discussed in response to comment O-CT-4, ACFCC would have two connections to the Bay Ponds and one to the Southern Ponds in the Preferred Alternative. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. Because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-CT-10

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative includes multiple connections between the ACFCC and the southern Eden Landing ponds which would provide increased habitat connectivity for migrating salmonids and other native fish. As per the Adaptive Management Plan, estuarine fish would be monitored in foraging and rearing habitats within the project. Water quality parameters such as dissolved oxygen would also be monitored. Note that salinity and water temperature would be set by ambient conditions: the estuarine environment would reflect the combined mixture of fluvial flows and water from the Bay that passes through breaches and culverts, and the interior of the ponds are generally expected to be well mixed due to tidal exchange. As such, salinity is expected to be lower when there is high fluvial outflow.

O-CT-11

See response to comment O-CT-10.

O-CT-12

As described in response to comment O-CT-1, one of the primary design goals for the restored tidal ponds is to regularly fill and drain. The filling increases exchange and allows sediment accretion throughout the pond's interior, while the draining allows for vegetation growth in the restored marsh. The creation of pilot channels would facilitate the filling and draining of the ponds. Small channels are expected to form on the pond bottoms which also facilitate drainage. Although sediment accretion would raise bottom elevations, the formation of a feature such as a sand bar that inhibits tidal exchange throughout the pond interior and creates a halocline is not expected when regularly inundated. When marsh habitat is fully developed, some pools and pockets may develop that hold water which does not get regularly flushed with the tides, but channel development should occur allowing smaller channels and pond interiors to drain to deeper channels expected to fully drain to the Bay. This expectation of a well-mixed environment is supported by the results of the one dimensional and two dimensional hydrodynamic modeling conducted for the preliminary design (see Appendix D, Attachment 1). As discussed in Section 3.3.3 of the EIR, dissolved oxygen concentrations are often correlated with hydraulic residence time and when residence time is short, dissolved oxygen concentrations are generally high.

O-CT-13

See response to comments O-CT-10 and O-CT-12. Also note that the Navarro River and Mattole River estuaries/lagoons have limited tidal exchange which differs from restored tidal ponds which are expected to fill and drain with water from Alameda Creek, OAC, and the Bay, on a twice daily basis.

O-CT-14

See MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative. Implementing the suggested breaching sequence for the ponds will be considered during detailed design.

O-CT-15

As per the Adaptive Management Plan, estuarine fish would be monitored in the restored ponds. Anoxic conditions are not expected to develop in the Bay Ponds if it fully fills and drains with the tides. Multiple connections to OAC and to the ACFCC would facilitate tidal exchange. Dissolved oxygen concentrations will be monitored in the Inland and Southern Ponds. As discussed in response to comment O-CT-4 and O-CT-9, if adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-CT-16

As discussed in MCR 5, Fish Habitat Restoration, multiple connections between ACFCC and the Bay Ponds are intended to provide habitat connectivity and access to potential foraging and rearing habitat in the ponds.

O-CT-17

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative includes multiple connections between the ACFCC and the southern Eden Landing ponds which would provide increased habitat connectivity for migrating salmonids and other native fish. However, the bay-facing levee, including

Pond E2 west levee, would be improved, rather than breached. The improved levees are expected to maintain or improve flood risk management and reduce the potential for scour of the restored habitat.

Estuarine fish would be monitored in the restored ponds as per the Adaptive Management Plan. As discussed in response to comment O-CT-4 and O-CT-9, because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-CT-18

See MCR 5, Fish Habitat Restoration, regarding habitat connectivity. See response to comment O-CT-17 regarding improvement to the bay-facing levee. Also note that steelhead and estuarine fish are monitored in the Phase 1 area, as per the Adaptive Management Plan.

O-CT-19

See response to comment O-CT-10 and O-CT-12 regarding salinity, temperature, water quality monitoring, and modeling. See also response to comment O-CT-1 and O-CT-2 regarding design considerations.

O-CT-20

See MCR 1, Selection of the Preferred Alternative, and MCR 5, Fish Habitat Restoration, regarding the types of fish habitat restoration and enhancements included in the Preferred Alternative. See also O-CT-19 and MCR 2, Details of Designs, regarding the SBSP Restoration Project Management Team's commitment to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public.

O-CT-21

See response to comment O-CT-17 regarding monitoring of estuarine fish in the restored ponds per the Adaptive Management Plan. See also O-CT-8 regarding the SBSP Restoration Project proponent's support of science-based monitoring.

O-CT-22

The project proponents will continue to coordinate with interested parties during design and construction of SBSP Restoration Project, Phase 2 at the ELER. See MCR 2, Details of Designs, regarding the SBSP Restoration Project Management Team's commitment to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public.

Friends of Five Creeks (O-FFC)

Friends of Five Creeks *Volunteers preserving and restoring watersheds of North Berkeley, Albany, Kensington, south El Cerrito and Richmond since 1996*
1236 Oxford St., Berkeley, CA 94709
510 848 9358 *f5creeks@gmail.com* *www.fivecreeks.org*

Brenda Buxton, Deputy Program Manager, State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612

Dear Ms. Buxton,

O-FFC-1

Friends of Five Creeks strongly supports the South Bay Salt Pond Restoration Project. Our all-volunteer nonprofit group has been restoring and maintaining creek habitat from Berkeley to Richmond for 22 years, and we urge you to approve this Project, which helps keep hopes alive that with the right care, our native salmon species could again flourish.

The Salt Pond Restoration Project will restore 2,270 acres of tidal marsh near the mouth of Alameda Creek, where several steelhead were again seen this April, to provide better nursery habitat for young steelhead before they migrate, and improve their passage to the ocean. The most effective measure to accomplish this is Alternative B, to restore all 11 Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

To bring about enhanced habitat for juvenile steelhead, as well as flood prevention and control, we advocate creating connections between restored wetlands and surrounding waterways (Alameda Creek Flood Control Channel, Old Alameda Creek channel, and SF Bay). Constructing a pilot channel between Alameda Creek and Bay Ponds E2 and E4 and breaching the levee will enable fish to reach restored marsh. Connecting to the Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells can allow fresh and brackish water to flow into restored marshes, enabling transitions between water habitats for the fish.

We support raising any levees where needed to manage flood risk, as well as lowering any levee where feasible to increase water and fish transport between channels and marshes. Specifically, raising and improving 2 miles of existing levee between the Bay and Ponds E1 and E2 will both improve the new habitat, and prevent its loss from erosion in the future.

Your support for this Project will help to bring new natural life and human benefits to this region.

Sincerely, Susan Schwartz President, Friends of Five Creeks

Response to Friends of Five Creeks (O-FFC)

O-FFC-1

See MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative for implementation as part of the Phase 2 project at Eden Landing. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes two connections to the Bay Ponds and one to the Southern Ponds. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. The Bay Ponds would be opened to tidal flows from several breaches on the northern border with OAC and from two locations along the southern border with the ACFCC and there would be interior breaches to connect the four Bay Ponds to each other. The Southern Ponds would be opened to muted tidal flows through a culvert system, making them accessible to salmonids as well. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative.

The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals unless monitoring and implementation of the Adaptive Management Plan provide a basis for determining that tidal restoration of Ponds E6 and E5 is most beneficial. Similarly, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Public Sediment Team via SCAPE / Landscape Architecture DPC (O-PST)

SCAPE LANDSCAPE ARCHITECTURE DPC
277 BROADWAY NINTH FLOOR
NEW YORK NY 10007

Tuesday, June 5th, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St, 10th Floor
Oakland, CA 94612

Re: Support and Comments for the South Bay Salt Ponds Restoration Project at Eden Landing Phase II

Dear Ms. Brenda Buxton, Deputy Program Manager,

O-PST-1

The Public Sediment team strongly supports the South Bay Salt Pond (SBSP) restoration project objectives and their advancement at Eden Landing Phase II, particularly the goals related to the restoration of tidal action and sediment flows to the Eden Landing Phase II ponds, the goals to provide public access and recreational opportunities within the complex, and the goals that relate to creating habitats that support all phases of the life cycles of critical species, including anadromous fish within the watershed.

O-PST-2

The Public Sediment team is composed of national and Bay Area design and engineering firms, academic groups, and non-profit organizations and was formed for the regional resilience design challenge, Resilient By Design. The team is led by SCAPE Landscape Architecture, with the Dredge Research Collaborative, Arcadis, UC Davis Department of Human Ecology and Department of Design, Cy Keener, TS Studio, and the Architectural Ecologies Lab. Resilient by Design is a year-long collaborative design challenge bringing together local residents, public officials and local, national and international experts to develop 10 innovative designs around the Bay Area that will strengthen the region's resilience to sea level rise, severe storms, flooding and earthquakes.

As part of the Resilient by Design challenge, the Public Sediment team developed a proposal titled *Unlock Alameda Creek* that links Alameda Creek with the proposed Eden landing Phase II baylands. The proposal provides a sustainable supply of sediment to the baylands for sea level rise adaptation, reconnects migratory fish with their historic spawning grounds, and introduces a network of community spaces that reclaim the creek as a place for people, building an ethos and awareness around our public sediment resources. A conceptual design proposal was developed for this effort, and significant stakeholder support was generated through the design collaboration, including support from the Alameda County Flood Control and Water Conservation District, the State Coastal Conservancy, the East Bay Regional Park District, and the Alameda Creek Alliance. Community participation and support was generated through interactions and co-design events with local middle and high schools, senior centers, and community centers.

Unlock Alameda Creek builds upon the work and alternatives outlined in the DEIS for the SBSP Eden Landing Phase II project and suggests a preferred suite of components for selection. A list of the recommended alternatives and preferred suite of components, and modifications to these components, is listed on the next page. Following this list is a longer description of the *Unlock Alameda Creek* project that illustrates the full vision of these combined options.

SCAPE LANDSCAPE ARCHITECTURE DPC

O-PST-2 (cont.)

Alternatives:

The Public Sediment team supports Alternatives B, C, and D. *Unlock Alameda Creek* was developed assuming that alternative C or D would advance, with the Bay Ponds opened up to tidal action and tidal marsh restoration first (Alternative C), and potential to expand tidal restoration to inland and/or southern ponds in the future (alternative D).

O-PST-3

Components:

Levee Modifications for Flood Risk Management: The Public Sediment team supports a modification to the design elevation of the mid-complex levee developed for Alternative C that would enable a 100' wide breach of the Alameda Flood Control Channel (ACFCC) levee directly to the Bay ponds. In this preferred scenario, the mid-complex levee would need to be raised to mitigate flood risks to adjacent communities. Other modifications to levee structures may be needed, like the lowering of portions of the Old Alameda Creek flood control channel to prevent water buildup in a combination high tide / high rainfall event. Public Sediment supports interventions necessary to mitigate flood risks to achieve the 100' wide breach of the ACFCC. Should Alternative B or D be pursued, our team supports further modifications to these systems to enable the 100' wide breach of the ACFCC to Eden Landing.

In all scenarios, the team supports the modification of the western edge of ponds E1 and E2, known as the 'landmass' proposal, to reduce flood risk and enable a 100' wide breach of the ACFCC. The Public Sediment team strongly believes that the 'landmass' concept can be designed as a hybrid system that incorporates elements of a dynamic gravel or cobble beach and provides habitat for critical species that use these ecosystems. There is historic precedent for these habitats in this region and these habitats have the ability to respond and adapt to increased storm frequency and intensity. See the full *Unlock Alameda Creek* proposal below for details.

O-PST-4

Levee Breaches and Water Control Structures: The Public Sediment team supports a 100' wide breach of the northern portion of the Alameda Creek Flood Control Channel levee into the Bay Ponds. This is a modification to the proposed water control structure in the current document that links the ACFCC with pond E2. A 100' wide breach is needed for sediment delivery to the baylands by the ACFCC. Alameda Creek is the largest supplier of sediment to the South Bay and this resource is critical for the long term survival of the baylands with sea level rise. A 100' wide breach is equally critical for habitat reasons, including the creation of significant transitional space for out-migrating juvenile salmonid species. See the full *Unlock Alameda Creek* proposal below for details.

O-PST-5

Trails and Public Access and Bridges: The Public Sediment team supports a configuration of the Bay trail and public access trails as shown later in this document. This is a modification of proposed trail route 2 shown in option B and includes the acquisition of the Cargill-owned properties at Turk Island, Cal Hill and adjacent ponds. The Public Sediment team supports the removal of the public access trail along the portion of the ACFCC that is made inaccessible with the proposed 100' wide breach of the ACFCC (northern levee only) and proposes to replace this access with expanded trails throughout Eden Landing (as shown in drawing), the acquisition of Turk Island and Cal Hill and adjacent pond properties from Cargill, and a new bridge that would span the ACFCC and connect Cal Hill with Coyote Hills Park. See the full *Unlock Alameda Creek* proposal below for details.

O-PST-6

Dredge Material Placement Infrastructure: The Public Sediment team strongly supports the proposed offloading facility in the Bay's deep-water channel and the use of dredge material for elevation raising of the ponds. While the beneficial use of dredge via offloader is critical at this stage of work, the Public Sediment team also strongly suggests that additional methods of sediment dispersal, like strategic placement or tributary seeding, be included in this work. Eden Landing requires a long-term plan for sediment supply for long term survival, and due to its location in the South Bay, its proximity to Alameda Creek, and its connection to Old Alameda Creek, is an idea testing ground for new pilots around sediment placement in and around the bay, including strategic placement (mudflat feeding), thin layer placement, and tributary seeding. The team supports public events, like walking tours, that make the process of beneficial reuse of dredge material visible to the wider public.

O-PST-7

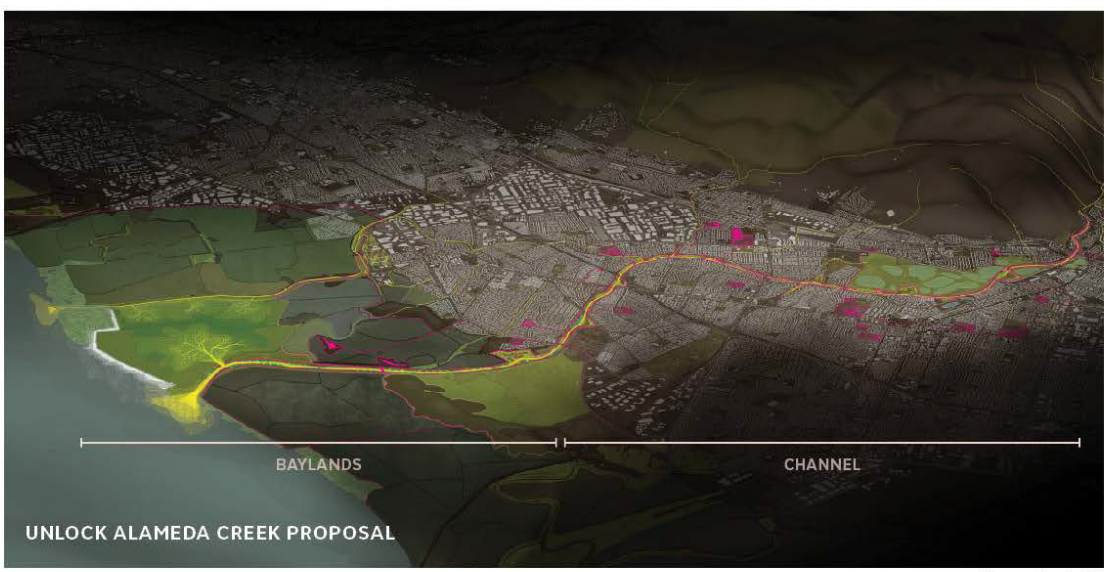
UNLOCK ALAMEDA CREEK

The portions of the *Unlock Alameda Creek* project relating to the alternatives and components for Eden Landing Phase II (*Unlock Alameda Creek*: The Baylands) are summarized below. Please contact gena@scapestudio.com for further information.

A full description, video, and introduction to *Unlock Alameda Creek* can be found here: http://www.resilientbayarea.org/alameda-creek/

INTRODUCTION

Tidal ecosystems are protective infrastructure that cushion the urban edges of the San Francisco Bay. Yet the Bay Area's tidal ecosystems—its marshes, mudflats—are at risk. These systems require sediment to grow vertically in response to sea level rise – without sediment, our baylands will drown. Low sediment supply and bayland drowning represents a slow but devastating scale of loss that threatens ecosystems, recreational landscapes, and places hundreds of thousands of residents and the region's critical drinking water, energy, and transportation systems at risk. To creatively adapt to this challenge our team has focused on sediment, the building block of resilience in the Bay. *Unlock Alameda Creek* is an implementable project that links the creek with the baylands. It provides a sustainable supply of sediment to baylands for sea level rise adaptation, reconnects migratory fish with their historic spawning grounds, and introduces a network of community spaces that reclaim the creek as a place for people, building an ethos and awareness around our public sediment resources.



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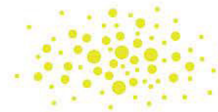
O-PST-7 (cont.)

THE BAYLANDS

Unlock Alameda Creek proposes to directly connect the sediment flows of the fluvial creek system with the future tidal baylands of the Eden Landing South Bay Salt Ponds (SBSP), an ongoing large-scale restoration project. Breaching the creek (and Old Alameda Creek) is critical for long term tidal bayland survival – even in its compromised state, the Alameda Creek watershed moves enough sediment downstream to nourish the restored tidal marshes with slower rates of sea level rise. Although breaching appears simple, it requires the complex choreography of physical and regulatory conditions to balance flood risks, liability, habitat tradeoffs, public access, and sediment planning. *Unlock Alameda Creek* proposes to reconnect the creek to the baylands while balancing the needs of sediment, people, and fish through a set of multi-benefit interventions.



View of proposed breach and pebble dune

PROPOSED BREACH

Today's creek bypasses the Eden Landing Ponds, which host important habitats but are currently cut off from tidal inundation. Because of this disconnection, the ponds are subsiding at an extreme rate, and without action these areas are vulnerable to erosion and overtopping with sea level rise, exposing adjacent neighborhoods to flooding.

Unlock Alameda Creek proposes a multi-part strategy to connect sediment with the baylands. First, large volumes of sediment must be imported to lift the subsided lower ponds to marsh plain elevation before breaching. This provides immediate flood protection benefit and gives marshes a head start on sea level rise. Up to seven million cubic yards of sediment are needed. Potential sources of mud come from dredge material, sediment harvested from upstream reservoirs like Don Castro, and upland construction fill. Sourcing this volume of sediment is no easy task and depends upon an uncertain timeline – even if this volume can't be imported in time, the ponds should be breached as soon as permitting allows to begin slower accretion by tidal means and stop subsidence.

While breaching improves long term flood protection through the creation of sustainable tidal baylands, near-term fluvial and tidal flood risks must be addressed. To breach Alameda a series of interventions must occur. These include modifications to the Old Alameda Creek levee to allow fluvial floodwater to leave the system, the construction of a mid-complex levee to separate managed ponds from tidal ponds, and the construction of a Pebble Dune at the perimeter of the ponds, that performs like a barrier island, by reducing tidal forces and protecting the baylands from wave action and erosion.

With these interventions in placed, the lower northern levee can retire, the creek can be breached, and a new delta can begin to form in the Bay.

O-PST-7
(cont.)

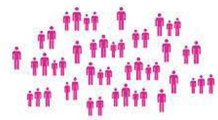

EXISTING ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
SEDIMENT LOAD AT HEAD OF TIDE
UNION CITY
SEDIMENT ENTERING THE BAY
FREMONT
CARGILL
COYOTE HILLS
PROPOSED BREACH OF ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
4. MODIFY AND BREACH OLD ALAMEDA CREEK
3. CONSTRUCT MID COMPLEX LEVEE
6. INCREASE SEDIMENT FLOWS FROM CHANNEL
UNION CITY
5. BREACH
1. IMPORT SEDIMENT
2. BUILD PEBBLE DUNE
FREMONT
CARGILL
COYOTE HILLS

O-PST-8

PROPOSED PUBLIC ACCESS

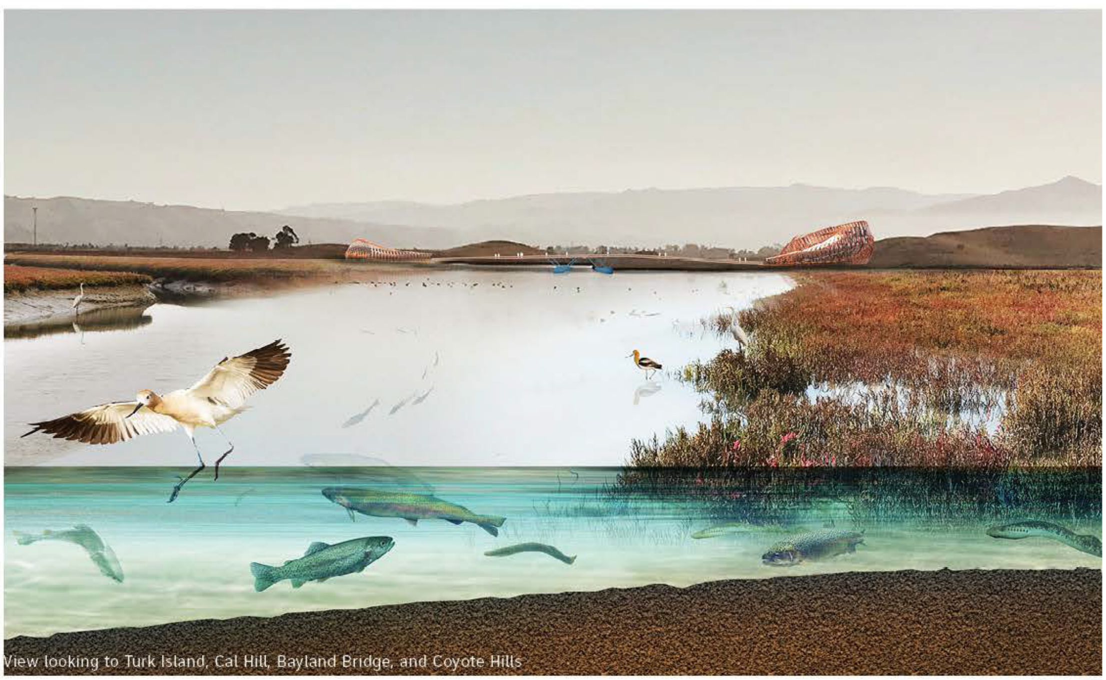
There are very few places in the Bay area to directly access the open water. Although the current Bay trail extends to the water's edge, the north side of the creek trail does not connect to southern paths, and the experience can be flat and monotonous to the average user. Coyote Hills is an incredible resource, it remains difficult to access from the North side of the channel.

Unlock Alameda Creek proposes to create a series of new destinations in the baylands that unlock the larger ecological investments at Eden Landing to the wider public. A new segment of the Bay Trail is expanded into the baylands connecting to the Alameda Creek Levee trail. Turk Island, an exciting topographic destination in a horizontal landscape, becomes a stopover point for travelers on the Bay Trail. At Alameda Creek, the Breach Bridge jumps the channel and moves with the tides, linking the greater path network of Eden Landing and providing a clear overlook to the newly forming delta.



BAYLAND BRIDGE

The Bayland Bridge enables access across the creek, directly linking the trails of Eden Landing and Coyote Hills. Inspired by the bundling and weaving of the historic tule reeds that populated this landscape, the Bayland Bridge is a clear destination in the Bay that reveals the subtle changes of this dynamic environment. The structure is supported by two landings – a vertical tower and an immersive mudroom- that house support structures and provide new experiences in the Bay. The span itself is supported by floating pontoons that rise and fall with the tides, creating a breathing bridge that responds to the patterns of the creek. The Breach Bridge frames the moment where the creek and bay mix, creating a space for people to watch this new tributary delta form over time.



View looking to Turk Island, Cal Hill, Bayland Bridge, and Coyote Hills

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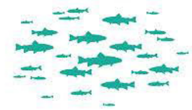
O-PST-8
(cont.)


EXISTING ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
TO CREEK TRAIL
UNION CITY
DISCONNECTED
TRAILS AT BAYS EDGE
FREMONT
CARGILL
COYOTE HILLS
PROPOSED BREACH OF ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
ALVARADO SALT STRUCTURES
TO CREEK TRAIL
TURK ISLAND
UNION CITY
OVERLOOK
BAY TRAIL
FLOODROOM
FREMONT
CARGILL
BAYLAND BRIDGE
COYOTE HILLS

O-PST-9

PROPOSED HABITAT CONNECTIONS

Bayland species require estuarine environments, where fresh and salt water mixes. Juvenile steelhead require this transitional space to adapt to a salt water environment. Other threatened species, like the Salt Marsh Harvest Mouse and the Black Rail depend on these habitats for long-term survival. The channelization of the creek to the bay's edge has severely limited this estuarine zone, transforming what was historically a wide marsh plain of shallow meandering sloughs into a single linear channel.



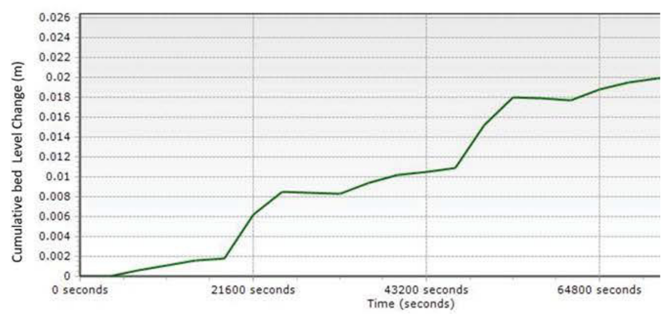
Unlock Alameda Creek aims to link flood protection interventions with habitat creation potential. The Pebble Dune is designed to create a shifting coarse grain beach over time. Secluded from people, the Pebble Dune is ideal for nesting pairs of terns. Large mudflats fed by Alameda Creek's sediment break waves while expanding pupping zones for harbor seals. The Breach is wide and strategically located for fish to find it on their migration routes, expanding into a new tributary delta at the Bay's edge.

THE PEBBLE DUNE

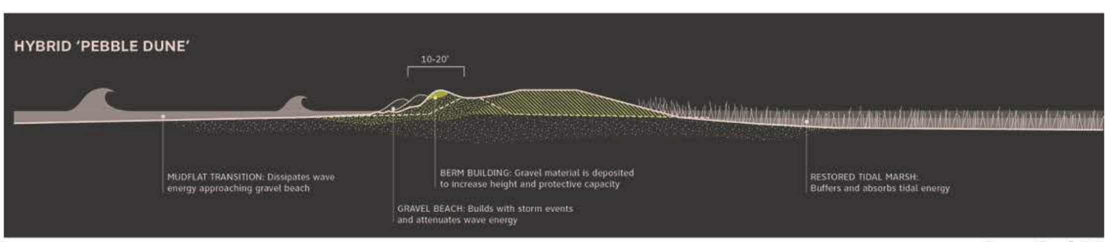
The Pebble Dune is a hybrid between a landmass barrier and a cobble beach. It is a barrier in that it reduces tidal velocity, breaks waves, and protects against erosion that would threaten the salt marshes and neighborhoods beyond. But it also a highly resilient coarse grain beach, that grows vertically with increasing storm energy and wave action while providing critical habitat to nesting terms. Coarse grain beaches were once found in this environment, but the impounding of the watershed and channelization of the creek has prevented this material from making it to the Bay. We propose to revive this lost ecosystem and harvest the creek's gravel during channel construction upstream, bringing it to the bay to create new, shifting habitat at the bay's edge that grows with time to respond to sea level rise.

X BEACH MODELING

For the pebble dune feature, a preliminary analysis of beach response to storm conditions was conducted. The primary focus of this analysis was to understand the potential response of the pebble dune to storm wave conditions at various water levels. This model is intended to be exploratory of the possible responses a pebble beach face may have to the storm wave conditions in the vicinity of the Eden Landing Wetland Restoration Project.



The Deltares XBeach-G program was utilized to conduct the preliminary analysis based on historic storms within the South Bay. XBeach-G is a 1-dimension model which is similar to the SWASH model that solves wave-by-wave flow and surface elevation variations due to short waves in intermediate and shallow water depths. This is particularly important for application on gravel beaches, where due to steep slopes swash motion is mainly at incident wave frequencies.
Beach response to storm wave conditions were modeled for varying beach slopes and grain sizes (D50). The beach profile, wave conditions and water levels used in the analysis included:



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O-PST-9
(cont.)


EXISTING ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
CONSTRAINED TO FLOOD CONTROL CHANNEL
UNION CITY
LIMITED TRANSITION MARSH BEFORE ENTERING THE BAY
FREMONT
CARGILL
COYOTE HILLS
PROPOSED BREACH OF ALAMEDA CREEK FLOOD CONTROL CHANNEL
EDEN LANDING
CONNECTION TO CREEK AND SPAWNING GROUNDS
TRANSITION ZONE
UNION CITY
PEBBLE DUNE HABITAT
FLOODROOM
FREMONT
CARGILL
COYOTE HILLS

O-PST-10

ADAPTIVE MANAGEMENT

A dynamic and ecological system requires adaptive management. *Unlock Alameda Creek* proposes to monitor this changing landscape through a range of sensing strategies, including the monitoring of suspended and deposited sediment, accretion rates, tidal fluxes, vegetative establishment, and pebble dune migration over time. We must plan for uncertainty today, creating a system that can be modified as the climate changes. Marsh restoration targets may need to be adjusted to meet sediment inputs. Managed ponds may need to transition to tidal environments. Edges and inland areas may need nourishment over time. Monitoring and sensing of this environment will inform future adaptive management practices and connect people with critical but remote living infrastructure.

MONITORING AND SENSING

A comprehensive monitoring strategy is needed to both learn from and adaptively manage our living infrastructure. A range of sensing strategies are proposed for learning more about the current dynamics of Alameda Creek, for supporting the adoption *Unlock Alameda Creek* designs, and testing methods for tributary monitoring throughout the Bay. Across these strategies, the sensors and monitoring devices are designed to engage multiple publics--creating visible and didactic moments along the creek for residents, engaging local schools in monitoring activities and creek stewardship, and supporting scientific research.

In the short-term, sensing stations will be deployed throughout the tidal range where there are currently no permanent sensing installations to study tidal sediment flows and the potential breach location. In the long-term, a comprehensive monitoring strategy is deployed alongside the living infrastructure interventions to ask critical questions about creek and bay morphology as well as ecological health. In the fluvial reach, how does sediment move past head of tide and where does it get deposited in the channel? In the tidal reach, how does sediment move? And at the Bay-tidal interface, how quickly is accretion occurring, and how mobile is the gravel barrier?

The monitoring goals are threefold. One, to create a baseline of pre-intervention data to help inform our proposed interventions and measure their effectiveness. Two, to match instrumentation approaches, sampling frequencies, and physical sample collection so that our data will complement existing research efforts within the watershed and throughout the Bay. And three, to make this monitoring infrastructure and the underlying processes it reveals legible to a broader public.

Proposed monitoring points along the system

O-PST-11

BAY STAKEHOLDER CHARRETTE

Currently there is almost no connection between Alameda Creek, Old Alameda Creek, and the baylands. The former tidal wetlands in the area are leveed salt ponds, no longer in production, and hydrologically separated from the flood control channel, a potential source for tidal flows and suspended sediment. The focus of our work was to find ways to reconnect tidal flow between the creeks, the ponds, and the Bay while facilitating current efforts to recreate tidal wetlands at Eden Landing.

The Public Sediment team organized a charrette between the Alameda County Flood Control District, South Bay Salt Ponds Restoration project, CA Fish and Wildlife, and Public Sediment team to discuss how to breach Alameda Creek into the Eden Landing Wetlands. While breaching appears simple, it requires a highly complex series of fluvial, tidal, and combined flood control event considerations for it to occur. A breach scenario, with associated flood control improvements, was developed at this meeting and is articulated in the above description.

CREEK CHARRETTE - NOAA/ NMFS. ACFCD. SBSP. ACA. ACWD. PUBLIC SEDIMENT TEAM

O-PST-12

PROPOSED PILOTS

Unlock Alameda Creek challenges the idea that Bayland investment should occur only at the edge. Measure AA, intended to restore Bay Area wetlands, passed as an example of a truly regional ballot measure. As these funds are spent, it is critical to consider future sediment supply as a factor in this equation and invest in new methods of bayland sustenance, including tributary unlocking and alternative methods of actively dispersing sediment.

Our team has prepared concept calculations that compare potential sediment inputs for Alameda Creek and potential sediment needs for its associated wetland sink, Eden Landing. While there are many unknowns, these calculations are shown across a range of sea level rise projections and potential variabilities in local sediment supply (current, 50% of current, and 200% of current) to incorporate future uncertainties. These calculations assume an accretion rate of 6mm/ year from the Bay annually, and that all of Alameda Creek's sediment is depositing in Eden Landing baylands, a highly unlikely scenario, as much of the sediment moves directly into the Bay.

The discrepancy between supply and need shown below is clear and demands more open dialogue around how we plan and invest in Bayland edges. We can start this process now by investing in projects like Eden Landing Phase II restoration and *Unlock Alameda Creek*. But we also must think bigger and scale up these ideas and developing a

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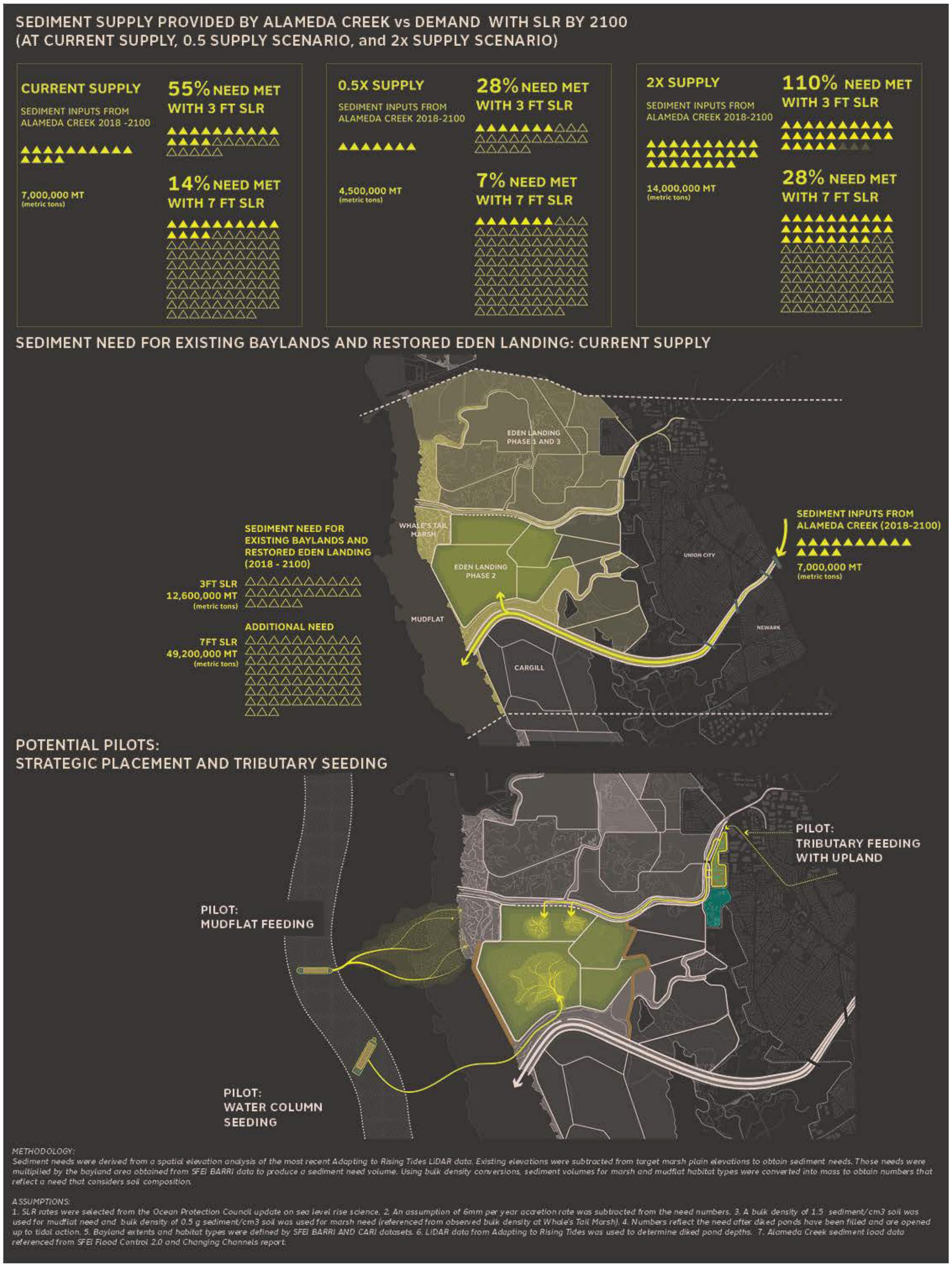
O-PST-12 (cont.)


SEDIMENT SUPPLY PROVIDED BY ALAMEDA CREEK vs DEMAND WITH SLR BY 2100
(AT CURRENT SUPPLY, 0.5 SUPPLY SCENARIO, and 2x SUPPLY SCENARIO)
CURRENT SUPPLY
SEDIMENT INPUTS FROM ALAMEDA CREEK 2018 -2100
7,000,000 MT (metric tons)
55% NEED MET WITH 3 FT SLR
14% NEED MET WITH 7 FT SLR
0.5X SUPPLY
SEDIMENT INPUTS FROM ALAMEDA CREEK 2018-2100
4,500,000 MT (metric tons)
28% NEED MET WITH 3 FT SLR
7% NEED MET WITH 7 FT SLR
2X SUPPLY
SEDIMENT INPUTS FROM ALAMEDA CREEK 2018-2100
14,000,000 MT (metric tons)
110% NEED MET WITH 3 FT SLR
28% NEED MET WITH 7 FT SLR
SEDIMENT NEED FOR EXISTING BAYLANDS AND RESTORED EDEN LANDING: CURRENT SUPPLY
EDEN LANDING PHASE 1 AND 3
WHALE'S TAIL MARSH
EDEN LANDING PHASE 2
MUDFLAT
CARGILL
UNION CITY
NEWARK
SEDIMENT NEED FOR EXISTING BAYLANDS AND RESTORED EDEN LANDING (2018 - 2100)
3FT SLR 12,600,000 MT (metric tons)
ADDITIONAL NEED
7FT SLR 49,200,000 MT (metric tons)
SEDIMENT INPUTS FROM ALAMEDA CREEK (2018-2100)
7,000,000 MT (metric tons)
POTENTIAL PILOTS:
STRATEGIC PLACEMENT AND TRIBUTARY SEEDING
PILOT: TRIBUTARY FEEDING WITH UPLAND
PILOT: MUDFLAT FEEDING
PILOT: WATER COLUMN SEEDING
METHODOLOGY:
Sediment needs were derived from a spatial elevation analysis of the most recent Adapting to Rising Tides LiDAR data. Existing elevations were subtracted from target marsh plain elevations to obtain sediment needs. Those needs were multiplied by the bayland area obtained from SFEI BARRI data to produce a sediment need volume. Using bulk density conversions, sediment volumes for marsh and mudflat habitat types were converted into mass to obtain numbers that reflect a need that considers soil composition.
ASSUMPTIONS:
1. SLR rates were selected from the Ocean Protection Council update on sea level rise science. 2. An assumption of 6mm per year accretion rate was subtracted from the need numbers. 3. A bulk density of 1.5 sediment/cm3 soil was used for mudflat need and bulk density of 0.5 g sediment/cm3 soil was used for marsh need (referenced from observed bulk density at Whale's Tail Marsh). 4. Numbers reflect the need after diked ponds have been filled and are opened up to tidal action. 5. Bayland extents and habitat types were defined by SFEI BARRI AND CARI datasets. 6. LiDAR data from Adapting to Rising Tides was used to determine diked pond depths. 7. Alameda Creek sediment load data referenced from SFEI Flood Control 2.0 and Changing Channels report.

O-PST-12 (cont.)

design/science framework for action that invests wisely in living infrastructure in an era of sediment scarcity and climate change. Collaboration, open discussion, and design/science partnerships are fundamental in meeting this challenge and developing a resilient Bay for all.

The Public Sediment Team is working across disciplines to study new sediment management practices in the Bay Area and consider the planning and management of sediment flows holistically, as an interconnected system that spans uplands and lowlands, incorporating natural processes and human inputs. The SBSP Eden Landing Phase II project aligns closely with the Public Sediment goals- to design with mud for a more resilient Bay and to make sediment a valued and understood public resource. We hope our work with *Unlock Alameda Creek* advances and informs the larger South Bay Salt Pond Restoration Project and we look forward to advancing these works together.

Sincerely,

The Public Sediment Team

Gena Wirth
SCAPE Landscape Architecture

Brett Milligan
Dredge Research Collaborative

Adam Marcus
Architectural Ecologies Lab

Christopher Devick
Arcadis

Brett Snyder
UC Davis Department of Human Ecology and Department of Design

Lee Wright
TS Studio

Page 13 of 13

Response to Public Sediment Team via SCAPE / Landscape Architecture DPC (O-PST)

O-PST-1

The project proponents appreciate your support of the project.

O-PST-2

See MCR 1, Selection of the Preferred Alternative, regarding common components in the action alternatives and the Preferred Alternative.

O-PST-3

The Preferred Alternative is intended to maximize tidal marsh restoration while still balancing multiple restoration goals. As such, the Bay Ponds would be converted to tidal marsh in the initial phase of restoration under the Preferred Alternative. The Preferred Alternative includes the mid-complex levee, levee improvements to the outboard and inland levee, habitat transition zones at multiple locations including the eastern side of Pond E2's outboard levee, and levee breaches at OAC. Several connections are also planned for the ACFCC, with one of the connections between the Bay Ponds and the ACFCC no longer through large culverts, as initially described, but instead through a full breach. This breach would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail.

O-PST-4

As described in O-PST-3, one of the connections between the Bay Ponds and the ACFCC no longer through large culverts, as initially described, but instead through a full breach. The breach would be sized to facilitate sediment transport to the Bay Ponds as well as fish passage. Although the exact breach width will be developed during detailed design, the breach is expected to be less than 200 feet in width.

O-PST-5

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the preferred trail alignment through southern Eden Landing is Trail Route 1. Trail Routes 2 and 3, the community connector at Westport Way, and the spur trail shown in Alternative Eden C were not included in the Preferred Alternative. Trail Route 1 was chosen in part to provide a more bayward experience for trail users (Trail Route 1 is the westernmost of the three considered) and to minimize the amount of land acquisition or easements or agreements necessary from outside parties that would be necessary to complete it. Trail Route 3 and the associated "community connector" trail to Union City Boulevard was not included in the Preferred Alternative because of a strong negative response to it by stakeholders and because of the concern that the community connector would draw more outside trail users to the area and encourage them to park on existing streets. Bicycle and pedestrian links would still connect to the south via the Alameda Creek Regional Trail.

The preferred trail alignment does not exclude the possibility of future acquisition of the Cargill-owned properties at Turk Island, Cal Hill and adjacent ponds, but it does not rely on it. Also, as mentioned in response to comment O-PST-3, the ACFCC breach would be armored to allow for a new public access bridge on the Alameda Creek Regional Trail.

O-PST-6

As discussed in MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the Preferred Alternative for Phase 2 at Eden Landing includes the potential beneficial reuse of dredge material to raise pond bottom elevations and to build habitat transition zones in several ponds. Dredge material would be placed in the Bay Ponds (Ponds E1, E2, E4, and E7) and may be used to raise portions of Ponds E5 and E6, depending on the eventual Adaptive Management Plan-informed decision about the long-term restoration of those ponds to tidal marsh.

The Preferred Alternative does not exclude the possibility of mudflat feeding or tributary seeding being developed at a future date, but it does not include these features.

O-PST-7

As discussed in response to comment O-PST-6, the Preferred Alternative for Phase 2 at Eden Landing includes the potential beneficial reuse of dredge material to raise pond bottom elevations. The SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material.

See also response to comment O-PST-3 for a discussion of other components of the Preferred Alternative, including the mid-complex levee, levee breaches at OAC and the ACFCC. The Preferred Alternative also includes rootwads at Pond E2's outboard levee to help trap sediment and form beach-like areas as a habitat enhancement while providing some erosion protection. Gravels or other coarse materials would be placed at or near the rootwads to provide habitat complexity. These gravels are expected to be placed along approximately 300 linear feet at the toe of the bay-facing levee to form a small, pilot-scale gravel beach. The Preferred Alternative does not exclude the possibility of development of a larger-scale pebble dune/barrier island at a future date, but it does not include this feature.

O-PST-8

See response to comment O-PST-5 regarding the trail alignment selected for the Preferred Alternative. The Preferred Alternative also includes a public access bridge over the ACFCC. However, it is important to acknowledge a few limits on what that inclusion means. First, neither the CDFW nor any of the other SBSP Restoration Project primary entities (the USFWS or the State Coastal Conservancy) owns the land on either side of the ACFCC. The Project therefore holds no unique ability or influence to obtain the necessary funding, permits, or property rights to actually build it. The construction of such a bridge, as with the completion of a portion of the proposed trail through southern Eden Landing, would require property acquisition at fair market value or a permanent public access easement. Therefore, the SBSP Restoration Project proponents/ CDFW are unlikely to be the sole implementer of a public access bridge over the ACFCC on their own. As noted, building that bridge will require a substantial effort to acquire funding for and perform design, permitting, and construction, and to obtain necessary easements or property acquisition. This is very likely to need cooperation between a number of partner agencies to successfully implement.

O-PST-9

See response to comment O-PST-7 for a discussion of the enhancement features proposed in the Preferred Alternative on the western side of the Pond E2's outboard levee. As discussed above, gravels or other coarse materials are expected to be placed along approximately 300 linear feet at the toe of the bay-facing levee to form a small, pilot-scale gravel beach. The Preferred Alternative does not exclude the possibility of development of a larger-scale pebble dune/barrier island at a future date, but it does not include this feature.

O-PST-10

Monitoring and adaptive management actions are integral components of the SBSP Restoration Project Adaptive Management Plan. The monitoring and sensing program envisioned and described in the comment would likely require coordination with a variety of stakeholders and agency groups. Phase 2 project actions at ELER would not preclude development of such a system at a future date.

O-PST-11

See response to comment O-PST-3 regarding the inclusion of a breach at the ACFCC in the Preferred Alternative.

O-PST-12

Your comments have been reviewed and considered during the formation of the Preferred Alternative and in preparation of the Final EIR.

San Francisco Bay Bird Observatory (O-SFBBO)

Benjamin Pearl, Plover Program Director
San Francisco Bay Bird Observatory (SFBBO)
524 Valley Way
Milpitas, CA 95035

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay St., 10th floor
Oakland, CA 94612

June 5th, 2018

To whom it may concern:

O-SFBBO-1 As the Program Director for Snowy Plover projects at the San Francisco Bay Bird Observatory, I would like to provide comments for the proposed actions as listed in the Eden Landing Phase 2 Draft Environmental Impact Statement/Report. Specifically, I am addressing how the proposed actions may affect recovery of the federally threatened Western Snowy Plover (*Charadrius nivosus nivosus*; hereafter Plover) on project lands.

Alternative B, in which the Bay Ponds, Inland Ponds, and Southern Ponds would all be restored to full tidal action, would result in the permanent loss of suitable Snowy Plover habitat. Specifically, ponds E6 and E6C in the Inland Ponds, and ponds E1C, E2C, E4C, and E5C in the Southern Ponds, have supported or currently support breeding Plovers. In 2017, these ponds collectively supported four nests, mainly due to higher water levels throughout the season rendering the habitat mostly unsuitable for nesting Plovers. In 2014, 2015, and 2016, when lower water levels provided more habitat for a longer period of time, these ponds supported at least eight, fifteen, and nine nests, respectively. These ponds provide important alternative habitat to high density breeding ponds in Central (E8, E6B) and Northern Eden Landing (E12-14, E16B), where predators may key in on breeding Plovers, resulting in lowered breeding success. As such, SFBBO considers Alternative B to be the least attractive.

O-SFBBO-2 Alternatives C and D, in which the Bay Ponds would be restored to full tidal action, and the Inland Ponds and Southern Ponds would be enhanced for management, either permanently (Alternative C) or temporarily (Alternative D), represent the preferred alternatives for SFBBO with respect to breeding Plovers. With restoration and appropriate water management afforded by new water control structures, any one of the

O-SFBBO-2 (cont.)

aforementioned Inland or Southern Ponds could become more productive Plover breeding habitat. In turn, this would contribute to the USFWS Recovery Plan goal of 500 breeding Plovers in the San Francisco Bay. Under either Alternatives C or D, we would recommend continued monitoring of the newly enhanced ponds, along with the rest of Eden Landing. This will allow us to collect the necessary data to determine how recent project actions have affected the recovery of breeding Plovers and other pond dependent species, thus greatly informing future project actions.

Thank you very much for considering my comments.

Regards,

Benjamin Pearl, Plover Program Director
San Francisco Bay Bird Observatory

Response to San Francisco Bay Bird Observatory (O-SFBBO)

O-SFBBO-1

As described in MCR 1, Selection of the Preferred Alternative, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. The adjacent Inland Ponds (E5 and E6) would also remain managed ponds during the first phase of restoration; however, if monitoring and implementation of the Adaptive Management Plan determines that tidal restoration of Ponds E6 and E5 is most beneficial, then Ponds E5 and E6 would be open to muted tidal flow. Conversely, the Southern Ponds would be opened to muted tidal flows through a culvert system during the first phase of restoration; however, those ponds could be operated more as true managed ponds and not left open to constant muted tidal flows if ongoing monitoring shows that more managed ponds are needed for bird habitat.

O-SFBBO-2

With the Preferred Alternative, additional water control structures would be constructed in the Inland and Southern Ponds and some of the existing structures would be repaired. These improved water control structures would allow increased operational flexibility (relative to existing conditions) to manage water depth in managed ponds. Monitoring of western snowy plover would continue as per the Adaptive Management Plan.

Trout Unlimited, John Muir Chapter (O-JMTU)

TROUT UNLIMITED

May 8, 2018

Brenda Buxton, Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612

Re: Phase 2 South Bay Salt Pond Restoration Project Draft EIR

Dear Ms Buxton:

O-JMTU-1 The John Muir Chapter of Trout Unlimited (JMTU) welcomes the opportunity to comment on the State Coastal Conservancy's South Bay Salt Pond Restoration Project Draft EIR. JMTU has 900 members in the Alameda and Contra Costa Counties. We are dedicated to conserving, protecting, and restoring cold water fisheries and their watersheds. In keeping with our mission, JMTU supports the various districts and non-profit organizations working to restore steelhead to Alameda Creek.

JMTU supports Alternative B, restoration of all 11 southern Eden Landing Phase 2 salt ponds to full tidal marsh, in one stage; this alternative has the greatest potential to provide critical estuarine rearing habitat for out-migrating smolts. We also support multiple points of access between Alameda Creek and restored tidal marshes, in order to increase connectivity between fish habitats and reduce predation risk to steelhead. JMTU strongly support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

More specifically, JMTU supports the proposed raising and improvement of approximately 2 mile of the the existing Bay-facing levees along Ponds E! and E2 (formerly known at the land mass concept). This would prevent wave overtopping and subsequent scour and erosion of the restored marsh behind the levee; provide for a habitat transition zone; and allow for more breaches of the interior levees to improve

O-JMTU-1 (cont.)

fish movement. We also support all feasible lowering of interior levees that does not increase flood risk, to again increase the hydraulic and fish connectivity between channels and marshes.

Lastly, we support connections to Union Sanitary District treated water and the Alameda County Water District Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water quality and habitat transition zones beneficial to fish.

Thank you for this opportunity to comment on the DEIR, please do not hesitate to contact me if you have any questions regarding the above comments.

Sincerely,

Peter Mangarella

Peter Mangarella
President
John Muir East Bay Chapter of Trout Unlimited
510 289 8163 (m)
info@JohnMuirTU.org

Response to Trout Unlimited, John Muir Chapter (O-JMTU)

O-JMTU-1

See MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative for implementation as part of the Phase 2 project at Eden Landing. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes two connections to the Bay Ponds and one to the Southern Ponds. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. The Bay Ponds would be opened to tidal flows from several breaches on the northern border with OAC and from two locations along the southern border with the ACFCC and there would be interior breaches to connect the four Bay Ponds to each other. The Southern Ponds would be opened to muted tidal flows through a culvert system, making them accessible to salmonids as well. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative.

The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals unless monitoring and implementation of the Adaptive Management Plan provide a basis for determining that tidal restoration of Ponds E6 and E5 is most beneficial. Similarly, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Trout Unlimited (O-TU)

May 11th, 2018

Brenda Buxton, Deputy Program
Manager State Coastal Conservancy
1515 Clay Street, 10th
Floor Oakland, CA 94612

Re: **Phase 2 South Bay Salt Pond Restoration Project Draft EIR**

Dear Ms Buxton:

O-TU-1

Thank you for the opportunity to comment on the DEIS for the Eden Landing Phase 2 Project. Trout Unlimited (TU) is a national coldwater fisheries conservation organization with over 150,000 members nationwide (over 10,000 in California) and over 200 professional staff nationwide (17 in California) dedicated to conserving, protecting, and restoring North America's trout and salmon fisheries and their watersheds for the next generation. TU was established in 1959 and has a long history of successful restoration work and cooperative projects throughout the United States, in California, and especially around the Bay Area A simple yet effective framework guides our work: Where rivers are intact, we protect them. Where they are fragmented by dams or dewatering, we reconnect them. Where they are degraded, we restore them. And to sustain these efforts into the future, we invest in youth education and outreach, creating a new generation of stream champions to continue our work.

TU, in collaboration with McBain Associates, conducted an extensive literature review and got the opinions on experts on the use of coastal estuaries by juvenile *Oncorhynchus mykiss*, with a focus on systems from California, to inform and support the design of the Phase 2 South Bay Salt Pond Restoration Project. We submitted our comments to the Alameda Creek Alliance in June, 2017.

While we like the design components of Alternative Eden B, we believe a phased approach will allow the implementation of an adaptive management plan that can incorporate lessons learned along the way and inform uncertainties associated with a large-scale and complicated project like this one. Thus, **we support Alternative Eden D**.

Trout Unlimited
4221 Hollis St. Emeryville, CA

O-TU-1 (cont.)

The phased approach is important because we do not know much about how native fishes, specifically *O. mykiss*, will react to this restoration project. Given their small number, it is crucial that the project limit impact and maximize benefit of native fish. For example, multiple breaches will spread out the predation pressure (by striped bass on juvenile *O. mykiss*, for example) beyond a single location. Monitoring predator use could also be done in initial phases to better understand the risk of predation and help inform subsequent phases. Increased connectivity will better allow native fish to move around to find suitable habitat and food and avoid poor water quality (high salinity, low dissolved oxygen, or high temperature).). To address concerns related to water quality and native fish, we suggest water quality monitoring and/or water quality modeling to determine the sub-daily levels of dissolved oxygen and temperatures that would occur in the project area. To maximize benefit, incorporating some of the pilot channels for fish habitat connectivity that are currently lacking in Alternative Eden D would be beneficial for native fish. These channels should incorporate large woody material to provide habitat heterogeneity, refuge from predators, and cover. We suggest that large wood structures be placed adjacent to flowing water to encourage scouring that will create small that can provide suitable refuge for *O. mykiss*. Wood structures should be sized so they do not wash away in the course of regular tidal cycles or storms.

O-TU-2

O-TU-3

O-TU-4

O-TU-5

Given the limited knowledge of native fish in the area of the proposed project, we suggest incorporating monitoring of native fish utilization of different habitat types throughout the life of the project, and after its completion. Such information will be useful in the phased approach of Alternative Eden D and will inform bay tidelands and estuary restoration in the future.

Thank you for your consideration and for the opportunity to comment on the project.

Respectfully,

Natalie J Stauffer

Natalie Stauffer-Olsen, PhD
Staff Scientist
Trout Unlimited

Trout Unlimited
4221 Hollis St. Emeryville, CA

Response to Trout Unlimited (O-TU2)

O-TU-1

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative uses a phased approach for tidal restoration. Tidal flows would be restored to the Bay Ponds and the Southern Ponds would be opened to muted tidal flows through culverts. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes two connections to the Bay Ponds and one to the Southern Ponds with the associated pilot channels. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. Because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

O-TU-2

As per the Adaptive Management Plan, estuarine fish would be monitored in foraging and rearing habitats within the project. Water quality parameters such as dissolved oxygen would also be monitored. Note that salinity and water temperature would be set by ambient conditions: the estuarine environment would reflect the combined mixture of fluvial flows and water from the Bay that passes through breaches and culverts, and the interior of the ponds are generally expected to be well mixed due to tidal exchange. This expectation of a well-mixed environment is supported by the results of the two dimensional hydrodynamic modeling conducted for the preliminary design (see Appendix D, Attachment 1). As discussed in Section 3.3.3 of the EIR, dissolved oxygen concentrations are correlated with hydraulic residence time and when mixing is high, hydraulic residence times are typically short and dissolved oxygen concentrations remain high.

O-TU-3

As discussed in response to comment O-TU-1 and MCR 5, Fish Habitat Restoration, ACFCC would have two connections to the Bay Ponds and one to the Southern Ponds in the Preferred Alternative. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. These connections also include the associated pilot channels.

O-TU-4

The addition of large woody debris at the pilot channels will be considered during detailed design. As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate.

O-TU-5

Steelhead, salmonids, and estuarine fish would be monitored in the restored areas as per the Adaptive Management Plan.

Haley & Aldrich, Inc. on behalf of Pacific Gas and Electric Company (B-HA)

HALEY ALDRICH

HALEY & ALDRICH, INC.
1956 Webster Street
Suite 300
Oakland, CA 94612
510.879.4544

5 June 2018
File No. 131132

State Coastal Conservancy
1515 Clay St., 10th Floor
Oakland, CA 94612

Attention: Brenda Bruxton
Deputy Program Manager

Subject: Comments Regarding Eden Landing Phase 2 Draft Environmental Impact Report

Dear Ms. Buxton:

B-HA-1 On behalf of Pacific Gas and Electric Company (PG&E), Haley & Aldrich, Inc. has reviewed the Draft Environmental Impact Statement/Report, Phase 2, Eden Landing Ecological Reserve (DEIR; April 2018) and has assembled the following comments for consideration:

1. The Draft EIR states that the average annual rate of dredged sediment delivery to the Bay and Inland Ponds is expected to range from 0.9 to 1.8 MCY per year. This volume represents approximately 25 to 50% of the average annual volume of sediment dredged for navigation purposes in the Bay. If that import rate cannot be achieved, how will it affect project design plans and construction schedule?

B-HA-2

2. As stated in the 2nd paragraph of the Dredge Material Import and Placement sub-section of Section 2.2.4 (and elsewhere in the draft EIR), only material meeting the San Francisco Bay Regional Water Quality Control Board's (RWQCB) wetland cover suitability criteria would be accepted. These criteria are established in the RWQCB's Draft Report: *Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines,* which specifies that cover suitability determinations will be based on best professional judgment, using a preponderance of evidence approach. However, the RWQCB has issued site-specific Waste Discharge Requirements for current wetlands restoration projects that typically prohibit use of sediments if they exhibit contaminant concentrations that exceed what are considered to be ambient in San Francisco Bay sediments. Will there be any consideration given to working with the RWQCB to develop criteria using effects-based data or a preponderance of ecological evidence approach that would include biological testing or other tools available to predict bioavailability? This approach would increase the volume of material available for beneficial reuse while ensuring the material posed no adverse ecological threat in the wetlands environment.

B-HA-3

3. In the second paragraph of the Dredge Material Import and Placement sub-section of Section 2.2.4 (and elsewhere), the Draft EIR states that San Francisco Bay dredging projects typically provide a range of fine and coarse material. Is it anticipated that a portion of the Eden Landing

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State Coastal Conservancy
5 June 2018
Page 2

B-HA-3 (cont.)

project will specifically require coarse-grained sediments? If so, is there an estimate for the quantity needed?

B-HA-4

4. According to Appendix E (Preliminary Design Memorandum of Dredged Material Placement at Southern Eden Landing), the current bottom elevations of the Inland and Bay Ponds range from 4.8 to 5.6 ft. NAVD88, and target average elevation to be achieved by importing dredged material is 6.0 or 6.5 ft. NAVD88. With this objective, the increase in pond elevation ranges from 0.4 to 1.7 ft. NAVD88. If this is correct, does it preclude any consideration for accepting dredged material determined to be *non-cover* quality since non-cover material beneficially reused for wetlands restoration must typically be topped by two to three feet of acceptable cover material?

5. In the second paragraph of the Dredge Material Import and Placement sub-section of Section 2.2.4 (and elsewhere), the Draft EIR states: *"Dredging projects wishing to dispose of material at the southern Eden Landing ponds would obtain separate environmental review and permits to dredge and to transport their material to a deep-water transfer point located in the Bay. Only material meeting the San Francisco Bay Regional Water Quality Control Board's (RWQCB) wetland cover suitability criteria would be accepted."* It was indicated at the public meeting on May 8, 2018, that foundation (non-cover) quality material would be accepted as well. Like the figures provided in Appendix E (see previous comment), this wording appears to limit all accepted material to cover quality material.

Please contact Scott Bodensteiner at sbodensteiner@haleyaldrich.com or 925.949.1026 with any requests for clarification.

Sincerely yours,
HALEY & ALDRICH, INC.

Scott Bodensteiner
Client Leader

Document1

Response to Haley & Aldrich, Inc on behalf of Pacific Gas and Electric Company (B-HA)

B-HA-1

As discussed in MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material.

B-HA-2

Site-specific waste discharge requirements are expected to be obtained prior to dredge material activities and the quality of the dredge materials would be required to meet permit requirements. This is clarified in Section 2.2 and Section 3.3 of the EIR. Development of a permitting approach would occur during later stages of design and permitting.

B-HA-3

There are no specific estimates for a need of coarse vs fine grain materials at this time.

B-HA-4

The Southern Eden Landing Preliminary Design Memorandum (Appendix E; Figure 3.1) provides a cumulative frequency plot of the bottom elevations in the ponds. Although a small portion of the Bay and Inland Ponds are depths greater than two feet below target elevations, these areas are small, and therefore we generally expect that the need would be (almost exclusively) for wetland cover material.

McBain Associates (B-MBA)

McBain Associates
APPLIED RIVER SCIENCES
980 7th Street, Arcata, CA 95521 · PO Box 663, Arcata, CA 95518 · ph (707) 826-7794 · fax (707)826-7795

June 4, 2017

Brenda Buxton,
Deputy Program Manager
State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, CA 94612

RE: Comments on South Bay Salt Pond Restoration Project Drat EIS

Dear Ms Buxton:

B-MBA-1

Thank you for providing the opportunity to review and provide comments on the Draft Environmental Impact Statement for Eden Landing Phase 2.

McBain Associates, in collaboration with Trout Unlimited, conducted and extensive literature review and interviewed experts with intent of developing an informed opinion on how to best design the restoration for the benefits of anadromous *Oncorhynchus mykiss*. Our review focused on the current studies of juvenile salmonid use in estuary environments that have been published and interviews with lead authors from those papers. We developed a formal comment on behalf of the Alameda Creek Alliance for the design of the Phase 2 South Bay Restoration Project, for the Eden Landing location, which we finished in June 2017.

Based on our review, we support Alternatives Eden B and D, full tidal restoration either in phased or a non-phased implementation. Alternative D would better allow the implementation of an adaptive management plan that can incorporate data and experiences found at each stage of implementation.

We feel that full tidal restoration would provide the most amount habitat for juvenile salmonids. Tidal and estuary zones are highly productive and have been shown to be important rearing habitats for juvenile salmonids in other systems. However, predation and poor water quality have also been shown to adversely affect salmonids in these systems. Given these risks we recommend the following:

B-MBA-2

1. The incorporation of multiple breach points to avoid predator congregation at break points, effectively reduced risk of predation to juvenile salmonids. Multiple breach points will also reduce risk of entrainment to anadromous salmonids in the event of poor water quality.

2. The construction of pilot channels to increase connectivity between Alameda Creek and Bay Ponds E2 and E4. We also support a breach of the levee instead of a water control structure to improve fish access to and from the restored marsh. These channels should incorporate structure for fish habitat, such as large woody debris, to create habitat complexity for salmonids and to provide deep water refuge under poor habitat conditions.

B-MBA-3

3. We support water quality, food availability and fish use monitoring in the restored area before, during and after project implementation. These data will be valuable to determine the risk of fish to adverse conditions and how beneficial the restored habitat is for salmonids. Additionally, this data will be useful for other similar projects.

We feel that the incorporation of these features and monitoring protocols would maximize the benefit and minimize the risk to anadromous *O. mykiss* in the restored area.

Thank you for again for the opportunity to review and comment on the project, we look forward to seeing it move forward.

Sincerely yours,

Timothy Caldwell
Fisheries Biologist

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Response to McBain Associates (B-MBA)

B-MBA-1

As discussed in MCR 5, Fish Habitat Restoration, the Preferred Alternative uses a phased approach for tidal restoration. Tidal flows would be restored to the Bay Ponds and the Southern Ponds would be opened to muted tidal flows through culverts. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes two connections to the Bay Ponds and one to the Southern Ponds with the associated pilot channels. One of the connections between the Bay Ponds and the ACFCC will no longer be through large culverts, as initially described, but instead through a full breach. The other two connections would be through culverts. Because the Southern Ponds would have a single connection which can have higher predation rates than multiple connections, the SBSP Restoration Project team intends to operate the water control structure there under careful monitoring in the early years to evaluate whether this dynamic occurs. If adverse conditions develop, the Southern Ponds could be operated more as managed ponds and not left open to constant muted tidal flows, consistent with an adaptive management approach to the phased restoration by the SBSP Restoration Project.

B-MBA-2

See response to comment B-MBA-1 regarding incorporation of a breach in the ACFCC and the inclusion of pilot channels at each opening to the ACFCC. The addition of pools and structural cover will be considered during detailed design. As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate.

B-MBA-3

The SBSP Restoration Project proponents support adaptive management and science-based monitoring. As per the Adaptive Management Plan, estuarine fish would be monitored in foraging and rearing habitats within the project. Water quality parameters such as dissolved oxygen would also be monitored. Monitoring of high food production habitat can be considered.

Staten Solar (B-SS)

From: utility@sfei.org
To: SBSP Question
Subject: An SBSP question or comment
Date: Tuesday, May 01, 2018 2:15:23 PM

First Name : Steve
Last Name : Stout
Organization : Staten Solar
Street Address : 1627 South Main Street
Street Address2 :
City : Milpitas
State : CA
Zip Code : 95035
Email : steve@statensolar.com

This is regarding:
Other

B-SS-1

Question or comment:
Wetland restoration is not the only way salt ponds can benefit the local environment. A small portion of this area could be set aside for a floating solar farm. Here are some reasons for going this route:

1.) no land purchase or allocation, saving land for other purposes;
2.) no need to clear, contour and maintain the land;
3.) no steel/aluminum mounts and their associated install costs;
4.) reduces water weeds, algae, bacteria and other unwanted growth through shading;
5.) reduces water evaporation in drought prone areas;
6.) a cooler/less dusty environment makes solar panels more efficient, while reducing maintenance;
7.) easier relocation, if the need arises;
8.) works at wastewater treatment plants and similar locations unsuited for wildlife;
9.) can sit on ground prone to flooding.

Staten Solar is one of few companies in the USA who install floating solar.

Response to Staten Solar (B-SS)

B-SS-1

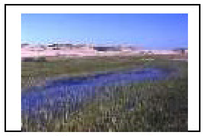
Section 1.2 of the EIR describes the overarching goal and objectives for the SBSP Restoration Project and Phase 2 actions at ELER. Setting aside a portion of the ponds to develop a floating solar farm would not meet purpose and need for the project.

2.2.5 Individuals

Comments from individuals and the responses to those comments are presented in this section.

Baye, Peter (I-PB1)

Peter R. Baye, Ph.D.
Coastal Ecologist, Botanist
33660 Annapolis Road
Annapolis, California 95412



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Brenda Buxton,
Deputy Program Manager, State Coastal Conservancy,
1515 Clay St., 10th Floor, Oakland, CA 94612.
phase2comments@southbayrestoration.org
brenda.buxton@scc.ca.gov

Subject: Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for Phase 2 of the South Bay Salt Pond Restoration Project at the Eden Landing Ecological Reserve; NEPA comments submitted on behalf of Citizen's Committee to Complete the Refuge.

May 21, 2018

Dear Ms. Buxton:

I-PB1-1

I would like to submit the following comments on selected aspects of the subject EIS/R. My comments are submitted on behalf of the Citizen's Committee to Complete the Refuge, Palo Alto, but they reflect my independent best professional and scientific judgment in tidal marsh restoration ecology. These comments are provided with the intention of supporting the project as a whole by identifying both problems and solutions that resolve issues regarding specific design alternatives, impacts, and project descriptions. Comments are focused on tidal marsh habitat restoration features, and related flood control features, that differ among alternatives.

Alternatives

The EIR/S volume I explicitly incorporates by reference (p. 2-1) the "details" of project alternative descriptions in Appendices B, C, and D in Volume II. Appendix B (preliminary alternatives analysis report) provides accounts (p. 6 et seq., and p. 27-28) of a "land mass" as a "high and wide earthen feature" designed to preclude catastrophic failure of traditional levees. Yet a word search for "land mass" in the pdf document of volume I of the EIR/S confirms that it is not explicitly addressed in any alternative, nor explicitly excluded or rejected from any alternative. Moreover, this design objective is expressly inconsistent with Appendix D, Preliminary Design Report description of the Bay Levee purpose in context of alternatives C and D (p. 21):

I-PB1-1 (cont.)

> The Bay Levee will be raised for habitat enhancement, not flood protection. Hydrodynamic modeling results …show that tide waters will enter southern Eden Landing through the OAC breaches and lowered levees, and therefore increasing the height of the Bay levee will not reduce the water surface elevation within the Bay and Inland Ponds. Raising this Bay levee may reduce wave overtopping…

This is an apparent inconsistency between the EIR volumes (main text and supporting documents) that is unresolved, and results in an incomplete project description and comparison of alternatives. It is ambiguous whether the very broad description of bay levee "improvements" described for Alternative D (p. 2-43) include, may include, or preclude a "land mass". This is highly significant, because the potential impacts and restoration feasibility and compatibility issues of the "land mass" are indeed massive. The HTZ outline of the bay levee in Alternative D is similar to the vague "land mass" proposal, but the description of Alternative D does not explain whether the "land mass" it is encompassed in it or not.

I-PB1-2

A further problem with the status of the "land mass" in the alternatives analysis and project description is the statement that geotechnical analysis specific to the site – including the analysis of whether the bay muds in the footprint of the "land mass" are even feasible and ripe for comparison with alternatives that are feasible. Appendix D, pp. 14-15, affirms that no site-specific geotechnical analysis has yet been performed for the EIR/S. The geotechnical attachment (Attachment 2, p. 4) indicates that some levee segments cannot even be built to the 12 foot elevation standard without failing stability standards for safety at end of construction. This begs the question of how an vastly larger land mass could be placed without inducing intensive subsidence of low-strength bay mud, and mudwaves that could destabilize salt marsh restoration.

I-PB1-3

Appendix B (p. 27) indicates that the concept of the "land mass" is "much like a barrier island". There is ample evidence that natural marsh-fringing barrier beaches did indeed occur near the project site (e.g. U.S. Coast Survey T-sheet 481 North, 1855, multiple-ridge recurved spit at the end of Alameda Island, near modern Otis Drive; width ranging from approximately 90 – 270 ft at widest; T-591, Fleming Point barrier beach, south of modern Golden Gate Fields, Berkeley, a single dune ridge barrier approximately 40-70 ft wide). Modern analogs of historical barrier beaches that meet or exceed elevation targets for the Bay levee have spontaneously regenerated at Radio Beach (Oakland Bay Bridge toll plaza north shore; 50-60 ft wide beachface, 70-90 ft wide foredune with crest over 5 ft above MHHW), and a wide sand barrier spit with limited sand supply persists even closer at Roberts Landing, San Leandro. The Radio Beach dune also has a double-ridge profile that encloses a non-tidal lagoon – a profile type that would provide even greater flood protection (overwash detention) at Eden Landing than a single dune ridge.

These reference San Francisco Bay barrier beaches have demonstrated habitat value for terns (roosts at Radio Beach north end spit), western snowy plovers (vagrants at Roberts Landing), and potential suitable habitat for endangered California sea-blite (USFWS pilot

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I-PB1-3 (cont.)

reintroduction project at Roberts Landing, terminated due to unfortunate timing of extreme storm erosion ten years ago). Barrier beaches, especially those with gravel berms, "self-seal" rather than fail and tidally breach during storm erosion events, as artificial bay levees do. Barrier beaches with sufficient sediment supply retreat landward while building vertically (foredune accretion) and retaining geomorphic integrity (profile migration landward by "barrier rollover" – dune and washover migration), instead of eroding in place and leaving a lag of immobile residual rocky fill (land mass failure legacy). In relation to restoration and flood control objectives, a barrier beach restoration would provide an environmentally superior alternative to an earthen "land mass", and require less fill. Like Aramburu Island beach, the beach could be designed to "self-construct" by wave and wind action following profile nourishment (hydraulic placement in the foreshore), rather than engineered fill placement. Alternatively, it could be placed hydraulically behind the existing levee, which could be allowed to fail and "activate" wave and wind processes that would mobilize beach sediment and form the barrier beach after the Bay levee erodes and fails – eliminating a major cost and impact of bay levee reconstruction. The potential coarse sediment supplies – Port of Oakland and Alameda Flood Control Channel dredging – are the same as for other alternatives described. The "root wad" design of Alternative B actually requires a barrier beach in order to function.

Therefore, the final EIR should explicitly reject the poorly defined "land mass" concept and replace it with an actual barrier beach restoration with multiple ecological benefits (tern, shorebird, western snowy plover, California sea-blite), recreational benefits (limited public access and recreation for some segments) and flood control benefits (reduction of breach risk, wave runup, and dynamic, sustainable increase in wave attenuation).

I-PB1-4

Habitat Transition Zones ("Upland Transition Zones"; HTZ, UTZ). HTZ are broadly defined in Appendix B (p. 7) as "another enhancement" to increase flood protection, buffer sea level rise, and "add diversity". Appendix D (p. 28) describes habitat transition zones as

> …areas with a wide transition in elevation from upland zones to tidal marsh zones. Low marsh, high marsh, tidal fringe, and upland habitats will develop over a habitat transition zone. The design goal of habitat transition zones is to provide areas varying in elevation to increase habitat diversity and complexity.

The EIR/S defines HTZ on p. 2-15 as "A habitat transition zone is a constructed feature with a relatively gentle slope (up to 30:1 [horizontal:vertical]) intended to provide a natural and ecologically beneficial connection between uplands or levees and the adjacent pond bottom" without reference to flood protection or sea level rise buffering. Because this is a critical feature of the project design and objectives, the HTZ and its design goals need to be consistently and comprehensively defined so alternatives can be compared accurately in relation to project objectives. Incomplete definitions and objectives may

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I-PB1-4 (cont.) cause or contribute to imbalanced comparisons of alternatives among HTZs located in variously at back-side, interior pond ("mid-complex") levee, and bay levee positions.

The EIR/S's broad-brush description of terrestrial HTZs as a project "enhancement" does not accurately reflect the fundamental, essential role that broad, gently sloping supratidal-high intertidal gradients must provide for stability and ecological function of the restoration of tidal marsh during accelerated sea level rise. They are not optional amenities or enhancements of a tidal restoration project that has objectives for long-term endangered species habitat support during accelerated sea level rise. Properly located and distributed HTZs are arguably *more* essential than raising intertidal fill platforms to Mean Sea Level to Mean Higher High Water, because unlike intertidal marsh platforms, there are no natural, passive processes that could possibly form them, and all long-term tidal marsh restoration objectives would fail without them. Yet the EIR/S dedicates a higher priority to dredge material engineering and placement (a full appendix), while leaving ecological and geomorphic functional assessment of HTZs as a generic and subordinate feature of alternatives.

Essential HTZ ecological design features, such as soil and vegetation criteria related to the stated objectives (habitat diversity, high tide refuge, sea level rise transgression space), are left without sufficient detail to meaningfully compare alternatives. Alternatives variously place terrestrial HTZs at the bay edge and interior of the Eden Landing complex (island-like artificial locations incongruent with sea level rise adaptation or natural tidal marshes) with those at the "back side" (landward edge; natural position and congruent with sea level rise adaptation). Distinguishing HTZ and "island" high tide refuges functions properly (see discussion below) allows for accurate weighting of HTZ flood control and habitat benefits at different landscape positions in the project area, and thus allows for valid comparison of alternatives. The erratic, artificial "bay levee" and "mid-complex" HTZ positions are poorly justified by habitat functions, especially where they are disengaged from potential treated wastewater or well water irrigation.

I-PB1-5 **Habitat Transition Zone vegetation establishment**. Appendix D (p. 29) states that hydroseeding with native seed mix and/or a planting schema will speed establishment of a range of vegetation, transiting from tidal marsh to upland vegetation, for slope protection. A native annual cover crop composed of a mix of summer and winter annuals with high competitive ability should be hydroseeded (or otherwise broadcast seeded) on all newly graded slopes in fall. Revegetation performed solely by hydroseeding a generic "native seed mix" would predictably result in a transient 1-2 years of target seeded species emergence, followed by rapid succession to weed dominance. This sequence was evident in the first hydroseeding of tidal marsh restoration site levees at Sonoma Baylands, and continues to occur in the Estuary today.

The timing of native annual cover crop sowing should either be prior to germinating rains, or after tillage of rain-germinated weeds from seed banks, depending on the

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I-PB1-5 (cont.)

severity of existing weed seed banks or invasions. The dominant native perennial plant species of the transition zone, however, are poorly adapted to establishment by direct seeding. Native perennials and shrub seedlings are subject to high mortality, and survivors would be inherently slow-growing and vulnerable to competition by fast-growing weeds. Vegetative propagules and methods should be used to establish native perennial forbs, grasses and grass-like plants, subshrubs, and shrubs. Most importantly, as explained below, HTZ vegetation design and ecological functions depend on matching compatible substrate (edaphic conditions; soil-vegetation relationships) with ecological objectives. HTZ vegetation designs should include variations matched to both soil and hydrology options ("dry" levee and treated wastewater/well water subirrigation options, different soil texture contingencies). Without matching vegetation design to soil and hydrology, habitat deficiencies or failure (and hence restoration objective deficits) would likely result.

I-PB1-6

HTZ substrate ecological criteria for terrestrial, on-site, and imported estuarine sediments. Appendix D (p. 28) states Appendix D states "Habitat transition zones will be constructed of material generated on-site from excavations of pilot channels, levee breaches, and lowered levees", and that "upland fill material may also be used if available from off-site construction projects, assuming it meets suitability requirements", but it does not state what "suitability requirements" are, or whether they are ecological (based restoration objectives), or merely bulk fill engineering and water quality criteria for contaminants and geotechnical needs unrelated to ecological restoration objectives. Little HTZ substrate information is provided on EIR/S p. 2-43, regarding only compaction and hydroseeding, but no physical soil criteria. The most detailed description of imported terrestrial fill suitability is (inappropriately) in discussion of traffic impacts on EIR/S volume 1 p. 2-60:

> Finding source projects with sufficient quantities of upland fill material is difficult for several reasons. The excavation must occur in a year and season when the SBSP Restoration Project can accept it. Stockpiling material or moving it more than once is cost prohibitive and would increase environmental impacts. Then, to be used in a restoration project, the material must pass a screening to demonstrate its lack of contamination. The source project should also be located close enough to the restoration project that bringing it there would both have fewer environmental impacts and be less expensive than bringing to a landfill or other destination.

The EIR/S contains insufficient description of upland fill, fill sources, or criteria required for a meaningful assessment of impacts or alternatives. This is not a minor detail to be deferred or left to "dirt brokers" with no understanding of tidal marsh restoration. The lack of explicit substrate source and ecological suitability criteria for HTZ is a major omission with potential significant impacts for restoration. The ecological restoration outcomes and impacts of HTZ design are likely to differ significant depending on the source of fill and method of construction. As described, the project could allow fill in the

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I-PB1-6 (cont.)

upper HTZ soil profile that would irreversibly defeat its basic objectives for vegetation and habitat.

I-PB1-7

Terrestrial (upland) fill sources for HTZ. Imported terrestrial substrate suitability criteria for HTZs should be defined ecologically for each alternative, in terms of soil texture, bulk density, and chemistry matched to the target native plant assemblage, and not merely in terms of engineering suitability as bulk fill. Clay loams (clay, sandy clay, silty clay) are appropriate for the top 1.5 ft of all habitat transition zone slopes. Drained bay mud is usually suitable for this purpose. Adverse soil conditions due to use of stony terrestrial subsoils, especially unweathered horizons with high content of cobble or large gravel (such as some newly constructed Bair Island constructed levees), can pose almost insurmountable constraints for growth of suitable vegetation types supporting essential ecological objectives in salt marsh transition zones. Stony subsoils favor effectively irreversible and unmanageable dominance by many annual non-native Mediterranean weeds. Superficial soil amendments could not offset the root zone impacts of stony soils with compacted clay, or sandy soils with high pore volume.

Mitigation for potential significant long-term impacts (and restoration feasibility impairments) of importing ecologically incompatible upland fill for HTZs should include a requirement for a minimum 1 ft (objective: 1.5 ft) cap of either dewatered fine-grained (silt to clay) dredge sediment, low-sulfate on-site bay mud, or comparable silty clay loam as a cover layer on HTZs.

Dredged material sources for HTZ construction. Appendix E states that one potential dredge sediment source, Oakland Inner & Outer Harbor, may contain up to 40% sand. Sand and bay mud are not ecologically equivalent as fill platforms for tidal marsh restoration. Sandy dredged material, especially batches with very high percentage Merritt Sand (Pleistocene beach, dune and shallow lagoon sands, similar to Ocean Beach sand texture) should not be used as bulk fill for tidal marsh platforms or HTZs at Eden Landing. High concentration of Merritt Sand in the upper marsh soil horizons is likely to result in prostrate pickleweed growth habit, and formation of persistent playa-like high salt marsh pans (nearly barren flats, similar to some salt pond flats) in the high salt marsh ecotone, as at Hamilton Wetlands Restoration. This is due to sand's naturally low nutrient retention capacity, low moisture content, and high potential for capillary concentration of salt at the surface. Well-planned high marsh transition habitat design may well include such playa-like sandy flats and high marsh pans, but sandy sediments should not be treated indiscriminately as inert bulk fill, equivalent to bay mud. Sand-dominated dredged material should be prioritized for estuarine beach nourishment at the bay shore of the Bay Ponds, as part of a multi-purpose estuarine barrier beach restoration design component.

I-PB1-8

Appendix E (p. 12) states that dredged material may be also used to construct HTZs, but it does not explain whether this would occur through direct placement of dredged material in cells, or earthmoving of dewatered dredged material after placement.

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I-PB1-8 (cont.)

Appendix E and the EIR/S provide no alternatives including hydraulic placement of sediment for HTZ construction, with deliberate "mounding" (sediment splays, fans) at sediment slurry discharge points. The hydraulic construction of HTZs (dredge pipe mounding) had demonstrated the feasibility of developing beneficial high salt marsh-terrestrial gradients, as well as back-marsh pool habitats. Complex sediment splays, fans and mounds are commonly formed unintentionally at dredge material placement cells for tidal restoration (e.g. Montezuma Wetlands, Sonoma Baylands). At Sonoma Baylands, they formed the earliest and most extensive high marsh habitats at the project site, ahead of all dredge material fill platform areas, which remain predominantly middle to low marsh plain over 20 years after construction. HTZ construction in alternatives using dredge material should incorporate dredge sediment mounding, by timing movement of the dredge discharge pipe points to develop a series of sediment splays or fans, distributary channels, and discharge point scour pools.

I-PB1-9

On-site HTZ substrate sources. If HTZs are constructed from on-site excavated bay mud from ancient salt marsh soils that have been converted to salt pond beds, substrate suitability criteria must include testing for acid sulfate or sulfide content. Unlike freshly dredged bay mud dominated by mineral sediments, bay mud from old salt marsh soils in diked baylands may have high organic matter content, and past exposure to alternating prolonged flooding and drawdown. Under these conditions, old salt marsh soils may likely form horizons of highly elevated acid sulfates that can be toxic to vegetation. Acid sulfate soils in levee slopes designed as transition zones may cause persistent inhibition of vegetation and even barren zones, supporting sparse cover of a few acid-tolerant, mostly weedy species, until acid sulfates are neutralized (a process that may take up to five years or more). Recent examples of severe localized inhibition of vegetation by acid sulfates, lasting over five years, occurred at the Petaluma Marsh Expansion Project and one portion of the Bahia Wetland Restoration Projects (Novato, Marin County). Less severe but significant examples also occurred more recently at Sears Point and Cullinan Ranch tidal marsh restoration projects, resulting in persistent large local barren areas, weed prevalence, and delayed colonization by most target native species. Feasible mitigation for potential impacts of acid sulfate soil would include testing soils from potential on-site borrow areas, and segregating acid sulfate soils for placement as foundation fill below the surface of HTZ root depth (1-1.5 ft), avoiding near-surface placement.

I-PB1-10

Dredged material fill impacts and mitigation for restoration of tidal drainage patterning. The legacy of preserved prehistoric tidal creek patterns in salt pond beds (diked salt marsh tidal drainage patterns) is a highly valuable asset for tidal marsh restoration: it imprints a tidal creek template on the marsh platform that preserves high sinuosity and density of mature prehistoric tidal marsh at time of diking in 19th c. Slurry is likely to fill and level. Differential settlement (auto-compaction; thicker layer slurry in slough beds; more settlement) of slurried dredge material is likely to revive tidal channel drainage patterns unless cell berm layout cuts them off and consolidates dredge sediment in confined cells. If confinement berms are used for engineered placement of dredged

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I-PB1-10 (cont.)

sediments, they should be aligned to run between tidal drainage networks, like "tidal watersheds" to preserve high drainage density, channel sinuosity of mature ancient tidal marsh. Borrow ditch blocks, and breaches of interior salt pond levees, should be combined with to prevent borrow ditches from dominating tidal flow patterns, and reconnect ancient tidal drainage networks as much as possible. This is not described in preliminary design for any alternatives; all alternatives appear to imply a high risk of burying and erasing major portions of antecedent tidal channel patterns.

I-PB1-11

Dredged material fill elevation targets and fill stabilization with vegetation. The target elevation range between MSL and MHW is appropriate, to ensure rapid vegetative stabilization and retention of placed sediment, minimizing the risk of reworking (resuspension by tidal current and wind-wave turbulence) and net loss during strong spring ebb tides or storm events. However, the limiting habitat in coming decades of accelerated SLR will likely be high salt marsh (approx. MHHW to mean perigee spring high tide elevation, so the EIR/S should specify of dredged sediment volumes (percent) of dredged material allocation to wide HTZ ramps (platforms for higher high salt marsh zones over 20-50 years of sea level rise), and flat intertidal marsh platforms below MHW elevation.

I-PB1-12

Imported dredged material and project timing. There is trade-off in committing to use of dredged material with the intention of accelerating tidal marsh restoration or correcting subsidence, to reach low or middle salt marsh elevation range. The trade-off is between time opportunity for potential tidal sediment accretion (direct breach with no dredge material import), and the equivalent elevation gain from dredge material placement, within a finite amount of time, as the risks of sea level rise acceleration and declining estuarine sediment deficits increase. If the added delay relative to direct breaching and passive tidal sedimentation is short, and tidal suspended sediment concentrations (SSC) are relatively low, the delay in restoration caused by dredged material engineered placement provides a net advantage for tidal restoration. But where SSC is high, and dredge material wait time (tidal restoration/breach delay) is long, dredged material dependence for tidal restoration can become disadvantageous. Very long delays in project scheduling and sediment delivery, such as at Montezuma Wetlands (over decades), have resulted in significant net delay of tidal restoration relative to prompt tidal breaching. As the sea level rise curve steepens, this potential deficit may become more severe. The EIR/S should mitigate this risk by setting a threshold schedule to implement tidal breaching in case of excessive delay in dredged material placement at Eden Landing ponds, if dredged material options are taken. Tidal restoration should not be delayed indefinitely because of a project commitment to accept dredged material; a cut-off is needed to proceed with tidal restoration if dredged material delivery is excessively delayed. Alternative beneficial re-use options for dredged material exist at some Alviso-Mountain View ponds, which are more severely subsided, may be a better alternative site for dredged material in case of Eden Landing project delay.

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I-PB1-13 **Imported Alameda Flood Control Channel sediment placement**. The EIR/S covers dredged material offloading and placement (Appendix E) in detail. It also proposes and evaluates details for pipeline connections for delivering brackish groundwater from wells, and tertiary treated wastewater from Union Sanitary District, to support restoration construction and maintenance activities. These are appropriate and informative for the project description and alternatives. But there appears to be no alternative or module, however, for long-term infrastructure (pipeline and booster pump delivery) of Alameda Flood Control Channel excavated sediment, which is a highly significant long-term, recurrent source of both coarse and fine sediment nourishment for bay shorelines, marshes, and habitat transition zones. Flood control sediment should be integrated into the project design just as dredge sediment and water sources are.

San Francisco Estuary Institute (SFEI 2017) provided data on the highly variable annual sediment load of Alameda Creek, which averages approximately 100,000 tons/year. The bed sediments that are actively excavated are richer in coarse sand and gravel than the total sediment load, with the proportion of gravel increasing upstream above the Niles Canyon gauge (about 40% gravel, 25% coarse silt and sand; SFEI 2017). Most channel maintenance sediment removed is in tidal reaches, close to the project site, where the proportion of silt and clay is about 60%. All these sediment classes, volumes and the cyclic nature of supply are extraordinarily important assets for tidal restoration and long-term adaptation (management, maintenance) to sea level rise, and no less important than single-event construction fill import sources (Goals Project 2015, SFEI 2017).

The EIR/S should include this highly significant marsh and shoreline sediment nourishment resource as a part of the restoration infrastructure. Sediment dredged from Alameda Creek should be piped to the site with a system of booster pumps (as proposed for offshore import and delivery of dredged material) and delivered for restoration construction, and for long-term "thin-lift" slurry deposits along habitat transition zones, high marsh zones, and especially bay shorelines (for gravel and sand-dominated sediment batches). The long-term restoration and marsh maintenance value of this permanent watershed sediment supply would be greater than one-time dredged sediment subsidies during project construction, especially when sea level rise rates accelerate. The ongoing channel maintenance activities of Alameda Flood Control channel should be integrated with the restoration design and infrastructure in at least one alternative, even if not to a level of detail comparable with Appendix E.

I-PB1-14 **Habitat Islands and sand and shell capping for special-status wildlife habitat enhancement.** "Habitat islands" are proposed as either shorebird roost or high tide salt marsh refuge features. Shorebird islands suitable for terns and plovers are proposed to be kept suitably barren by substrate design:

> A select group of islands will be treated to create nesting habitat for western snowy plover, California least tern, or other bird species. The top surface of the islands will be treated with a 12-inch thick sand layer underlain by a 6-inch thick

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I-PB1-14 (cont.)

> crushed rock to minimize weed establishment. The sand layer will include oyster shells or other materials to provide a primarily unvegetated, diverse landscape that is typically preferred by nesting birds. (Appendix D, p. 31)

The capping of islands with sand, shell, and impermeable layers would preclude subsequent conversion to high salt marsh vegetation capable of providing dense cover of tall vegetation that functions as high tide refuge for wildlife during extreme high tide marsh submergence events. Sand surface layers naturally promote cover of relatively low, prostrate salt marsh vegetation (mats of pickleweed, saltgrass, alkali-heath; stunted gumplant or none; see Hamilton Wetlands Restoration example below). Habitat islands constructed with sand and shell for shorebird roosts, even if feasible and sustainable (which is not the case), would require reconstruction and conversion to high salt marsh features with a different substrate if they were to function as high tide refuge cover in a salt marsh.

Capping emergent islands with sand and shell as habitat enhancement feature for terns and plovers habitat is very likely to be infeasible and counter-productive in the long term, and even short-term (> 2 yr); it would fail to meet objectives to "enhance" islands or "land mass" to become surrogate habitats for high-albedo unvegetated habitats in salt ponds, levees, or beaches. This is a potential significant impact if these features are proposed to compensate for restoration project-induced habitat loss of special-status species such as western snowy plovers, least terns, or important high tide roosts for shorebirds. The EIR/S appears to mistake the ecological processes that maintain barren sand and shell substrates in the Estuary, and assumes that substrate design alone will provide suitable habitat conditions.

In the absence of wave action, physically stable sand or shell deposits 12" thick, even with road base/crushed rock below, would predictably become rapidly colonized by annual weeds at high density and cover, which would persist indefinitely or undergo succession to dominant weedy perennials or scrub. Bare sand or shell habitats capable of attracting and supporting snowy plovers, or shorebird roosts, are formed and maintained by recurrent disturbance or stress sufficient to preclude colonization and persistence of vegetation. The prevailing natural disturbances and physiological stresses that maintain barren sand, shell, or pan beds are either (a) daily high tide wave action (beaches), or (b) alternation between prolonged seasonal alternation of flooding and desiccation in saline depressions and flats (pan or playa in salt ponds or high salt marsh edges).

Positively drained, convex sandy or shelly topographic features (mounds or berms with no hypersaline salt accumulation, seasonal hypersaline desiccation, or seasonal flooding) in either salt marshes or managed non-hypersaline lagoons/ponds inevitably become colonized and dominated by thick cover of annual weeds (and a few native plants) that are adapted to sand substrates. The colonization and accumulation of weed seed banks occurs rapidly, within 1-2 years. Barren high-albedo sand or shell surfaces would need chronic high maintenance, which is not feasible in the long term or consistent with

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I-PB1-14 (cont.)

"restoration". Sand and shell surfaces within hypersaline basins, or wave-exposed shorelines, maintain dynamic barren high-albedo surfaces. On levee roads, routine vehicle use and compaction of hypersaline sediments maintain barrens. In the absence of vegetation suppressing dynamic influences like these, sand and shell barrens are unstable and become vegetated landforms.

Outstanding examples of permanently vegetated well-drained stabilized sand and shell berms (relict beach ridges cut off from wave action) and mounds, and their rapid formation after stabilization, are evident around Foster City, Point Pinole, Brisbane, Oakland, and elsewhere. In context of dredged material placement, Port of Oakland Merritt Sand deposited at Montezuma Wetlands initially formed barren active deflation plains and dunes that attracted western snowy plovers beyond their historical range. The Montezuma sands, which were placed over relatively impermeable and hypersaline bay mud (root barrier to terrestrial weeds, analogous with an impermeable road base layer) subsequently became colonized by vegetation that caused the site to be abandoned by plovers and terns, despite intensive short-lived unsustainable efforts to suppress vegetation and maintain artificial sandy barrens.

The target tidal elevations of habitat islands in salt marsh restoration areas should not exceed the highest spring tide elevations because perennial vegetation canopy cover above the substrate surface, not the substrate surface itself, provides wildlife emergent high tide cover during extreme high tides. Island elevations and substrates should have objectives to maintain tall, dense perennial native vegetation cover above the extreme high tide water surface, distributed near tidal channels. Conversion of islands to supratidal, terrestrial substrate elevations may result in dominance of annual weeds above the high tide line, which would provide inferior cover during winter high tides. Similarly, if supratidal elevations target terrestrial shrubs as cover, these would likely be subject to mass mortality (dieback and degeneration of cover) after extreme high tides saline soils when sea level rises, shifting cover back to weedy annuals until high salt marsh succession occurs. Habitat islands dedicated to provide high tide salt marsh wildlife cover should set design substrate and elevation objectives to produce tall, dense, semi-evergreen gumplant canopies would remain above the extreme high tide water surface (i.e., separate but related tidal elevation objectives for substrate and vegetation canopy cover). High tide flood refuge cover could be supplemented by installation of large woody debris that can trap smaller floating debris, and provide dynamic refuges independent of vegetation canopy structure and elevation.

I-PB1-15

Habitat Transition Zones and "Islands" as high tide refuge. The EIR/S does not explicitly compare the critical high tide refuge habitat designs among alternatives, or the configuration and relative contribution of high tide refuge functions provided by HTZs and "islands". The two constructed features differ significantly in relation to high tide movements of endangered California Ridgway's rails and salt marsh harvest mice during extreme high tides.

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I-PB1-15 (cont.)

When flooded out of tallest available salt marsh vegetation cover during high tides, SMHM move vertically to the nearest emergent cover within their home ranges, or are forced to swim to floating or emergent cover, which exposes them to risk of avian predation or drowning (wind-wave turbulence). Ridgway's rails move through tidal creeks and take cover in the tallest vegetation in home ranges, which is normally creek-bank gumplant directly connected to primary creek travel corridors. Cross-marsh movements during marsh submergence to alternative "upland" (landward edge) transition zones is a last resort when no other cover is available within or near home range, which is a characteristic trait of degraded, narrow salt marshes bordered by levees – not restored extensive tidal marsh plains. There is no basis to assign primary high tide refuge functions to HTZs; they are catastrophic alternative flood refuge habitats, back-up refuges of last resort when internal home-range refugia are submerged. In a restoration design, primary high tide refugia should be well-distributed within home ranges of sensitive wildlife, in relation to tidal creek bank patterns - where the tallest vegetation naturally occurs. Well-distributed, extensive high intertidal salt marsh "islands" (emergent high marsh mounds or berms) should be interpreted and designed as the first line of normal high tide refuge habitat (perigee spring high tides, storm high tides, with HTZs as infrequent "worst case" flood refuge (storm, perigee high spring tide, and warm Pacific sea level anomalies or extreme ENSO events).

The environmentally superior/preferable alternative should provide the maximum creek-parallel distribution of effective high tide refuge habitat (tall high intertidal marsh vegetation) in restored tidal marsh. Alternatives should not excessively weigh benefits of peripheral HTZs as high tide refuge habitat over internal high tide refuge habitat of the salt marsh plain.

If high tide refuge designs internal to the restored tidal marsh are adequate, the flood protection designs of the alternatives (B, C, D) are largely and properly decoupled from the different alignments of HTZs at artificial "mid-complex" and "bay levee" locations. The alternative, unnatural HTZ locations at the bay levee and mid-complex (Alternative D) are unjustified by habitat benefits, and become essentially flood control primary-purpose designs, if the alternatives properly rely primarily on internal marsh "island" high tide refuge designs.

I-PB1-16

Tree root wads as shoreline enhancements: incomplete or infeasible design
The DEIR and Appendix D propose to use "root wads" of trees as bay shoreline treatment (alternative B), but without incorporating placement of coarse sediment (sand, gravel). The stated purpose (Alternative B) for tree root wads on the Bay levee was "to help create high tide refuge and help protect the levee from wave erosion. Tree "rootwads" are a natural slope stabilization technique often used in stream restoration design". This is an error of interpretation out of context. Root wads of trees are ordinarily used as scour objects in stream restoration to create erosional pool habitats where turbulent streamflow is concentrated, as well as components of bank stabilization when combined with other stabilization features.

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I-PB1-16 (cont.)

Without coarse sediment to trap and buffer the logs and root wads, wave action at the bay shore would be reflected and concentrated, intensifying storm wave erosion. In order to function as a protective shoreline features, log or rootwad groins would need to be combined with a source of coarse sediment to trap. This was the basis of log groins at Aramburu Island habitat restoration project, which placed groins to check longshore drift of gravel. Most of the log groins there continue to perform this function six years after construction. Log groins on the exposed bay shoreline, subject to intensive wave action at high tide during storms, do not themselves provide "high tide refuge" for shorebirds or salt marsh wildlife. Unless large woody debris is embedded in the banks of tidal creeks within the salt marsh, where it may trap other debris or provides a foundation to elevate the vegetation canopy of climbing pickleweed, alkali-heath, or saltgrass, it will not act as any meaningful tidal flooding refuge.

Thank you for your attention to these comments, and for your laudable long-term efforts at managing the unprecedented regional tidal wetlands restoration project, of which Eden Landing is one part. I will provide a supplemental illustrated version of this comment letter to clarify major points, before close of CEQA comment deadline, after this letter is submitted within posted NEPA deadlines.

Respectfully submitted,

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Cc: Citizen's Committee to Complete the Refuge

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Response to Baye, Peter (I-PB1)

I-PB1-1

As described in Section 2 of the EIR, the Preliminary Alternatives Analysis Report (Appendix B) contains the full description of the initial alternatives, the screening criteria, the selection of alternatives carried over into the Draft EIS/R, and the alternatives considered but eliminated from detailed study. Because it is a report that describes the development of the project alternatives, elements that were eliminated and did not move forward into the environmental alternatives analysis are also described therein.

Chapter 2 of the EIR describes each of the project alternatives and the project elements. Alternative Eden D includes a habitat transition zone on the eastern side of the outboard levee. It does not include a "land mass" or barrier island on the outboard side of the levee.

I-PB1-2

As discussed in response to comment I-PB1-1, Alternative Eden D does not include a "land mass" or barrier island on the outboard side of the Bay Ponds to provide coastal flood risk protection. Instead, a habitat transition zone would be built on the eastern side of Pond E2's outboard levee.

The Eden Landing Geotechnical Investigation and Analyses (Appendix D, Attachment 2) provides the results of the site-specific geotechnical analyses. The analyses indicates that if a specific levee section were to be overbuilt to a 15 feet elevation, a 5 to 1 (horizontal to vertical) slope would be needed. Alternatively, staged construction to an elevation of 12 feet followed by periodic maintenance may be needed.

During future design phases, this geotechnical data will be used to assess the existing levees' ability to support construction equipment, to perform seepage and slope stability analysis for raised levees, to evaluate the potential magnitude of consolidation settlement induced by placement of additional levee fill, and to design foundation elements for water control structures, bridge abutments, and boardwalks. Consolidation settlement will also be evaluated in areas designated for habitat transition zone fill; placement of additional fill may be required to account for settlement and achieve the proposed finished grade. For the preliminary design, conservative assumptions were made for proposed slopes and bulking factors. Later design phases will be based off the geotechnical investigation results.

I-PB1-3

See response to comment I-PB1-1 regarding purpose of the Preliminary Alternatives Analysis Report (Appendix B), its relationship to the Draft EIS/R, and the lack of a "land mass" in the action alternatives. Alternative Eden B does include placement of rootwads and logs outside of Pond E2 to help trap sediment and form beach-like areas as a habitat enhancement while providing some erosion protection. The Preferred Alternative includes rootwads and other enhancement features on the western side of Pond E2's outboard levee. Gravels would be placed at or near the rootwads along approximately 300 linear feet at the toe of the bay-facing levee to form a small, pilot-scale gravel beach. Although an extensive barrier beach is not included, the Preferred Alternative does not exclude the possibility of development of a larger-scale barrier beach at a future date.

I-PB1-4

See response to comment I-PB1-1 regarding purpose of the Preliminary Alternatives Analysis Report (Appendix B), its relationship to the Draft EIS/R, and how certain elements in Appendix B have not been brought forward into the Draft EIS/R. Section 2.2 of the EIR describes the primarily purpose of the habitat transition zone as it relates to habitat diversity and complexity. Secondary effects may include the de facto enhancement of flood risk management and habitat resiliency in the face of sea-level rise. See MCR 3, Sea-Level Rise, regarding estimates of future sea-level rise and climate change impacts on marsh restoration, and regarding sea-level rise and habitat restoration planning.

See also MCR 2, Details of Designs, regarding the level of detail required under CEQA and NEPA for analysis of the environmental impacts of the project. Both NEPA and CEQA require the development and analysis of a range of alternatives. The comparison of alternatives is not required by NEPA or CEQA so that the “best” alternative for assuring the project's “success” can be identified, but rather so that the adverse impacts from different alternatives can be identified and compared. Note that the Preferred Alternative includes three habitat transition zones, each of which can provide various benefits depending on landscape position.

Habitat transition zone could be built from onsite materials, dredge materials, or from the import of upland fill materials. As such, the construction impacts associated with dredge material placement is also relevant to this feature. Soil and vegetation criteria for the habitat transition zones will be developed during later stages of design.

I-PB1-5

The suggested seed mix and the timing for its sowing, as well as suggestions for planting propagules and development of wet and dry planting plans, will be considered during detailed design. Suggestions regarding how to make the outcome of the project better, such as how to increase the chance of getting favorable types of vegetation communities, are not about adverse impacts on the existing environment. Therefore, while the SBSP Restoration Project proponents appreciate these inputs and points and will consider them in the next step of the design process, they are not impacts to address in a NEPA/CEQA document.

As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. As designs proceed, many of the suggested refinements will be incorporated into the design where feasible and appropriate.

I-PB1-6

Section 2.2 of the EIR indicates that the suitability criteria for dredge materials would be based on the Regional Water Quality Control Board’s screening guidelines for wetland cover material and Section 3.3 of the EIR describes these criteria in detail. Sediment quality in inundation areas is expected to meet the wetland cover suitability criteria and/or site-specific waste discharge requirements regardless of alternative or location for the habitat transition zone. The Regional Water Quality Control Board also has quality guidelines for foundation materials that may be applicable for dredge materials placed below wetland cover materials, depending on future permit requirements. The quality of upland fill materials is also expected to meet permit requirements. Sources for upland fill materials need not be identified at this time.

I-PB1-7

Physical soil properties and vegetation criteria for the habitat transition zones will be developed during later stages of design. Suggestions regarding the exclusion of stony terrestrial subsoil and materials with high sand content within the top layer (1.5 feet) of the habitat transition zones will be considered during detailed design.

I-PB1-8

The Preliminary Design Memorandum of Dredged Material Placement at Southern Eden Landing (Appendix E) describes how the secondary pipelines could be used to allow for mounding along the proposed habitat transition zone locations. Suggestions regarding timing movement of the dredge discharge pipe points to develop a series of sediment splays or fans, distributary channels, and discharge point scour pools will be considered during detailed design.

I-PB1-9

Suggestions regarding the testing and exclusion of materials with high sulfate/sulfide content within the top layer (1.5 feet) of the habitat transition zones will be considered during detailed design.

I-PB1-10

Suggestions regarding the placement of cell berm layouts (if used) will be considered during detailed design. Note that some historical oxbows would be re-connected where feasible, but in general, the relatively linear OAC and ACFCC levees and the internal pond levees have disconnected many of the historic channels.

I-PB1-11

The suggested allocation of the dredge material for habitat transition zones vs. pond bottoms (as a percentage) will be considered during detailed design.

I-PB1-12

As noted in MCR 4, Beneficial Reuse of Dredge Material, including Placement Locations, Purpose, Timing, and Impacts, the SBSP Restoration Project proponents intend to accept dredge material for the beneficial reuse in project restoration actions if materials are available in the time frame needed for successful project implementation. As such, the project was developed such that if dredge materials were not available in an appropriate time frame, project implementation can proceed without such material. The project would benefit from the incorporation of dredge material but does not depend on it. The inclusion of beneficial reuse of dredge material in the Phase 2 Preferred Alternative at Eden Landing should not be interpreted as a commitment to wait indefinitely for that material to be supplied to the project site.

I-PB1-13

Although the transport of dredge materials originating in upstream areas of the ACFCC (via a slurry pipeline) is not incorporated into the project design, such materials can be accepted at the site and placed with other dredge materials in the Bay (and possibly Inland) Ponds. These materials would need to meet project requirements for cleanliness and the source project would need to cover the NEPA/CEQA, and regulatory concerns of generating the slurry material and transporting it to the site. Also note that some sediment in Alameda Creek is expected to be transported via natural processes through the connection between the ACFCC and the Bay Ponds.

I-PB1-14

Suggestions regarding target elevations and the exclusion of unvegetated habitat islands will be considered during detailed design.

I-PB1-15

Refuge habitat has been incorporated in the preliminary design at internal levees. The Preferred Alternative (and each of the action alternatives) includes both habitat islands and habitat transition zones; therefore, an explicit comparison that weighs the benefits of how each type of feature would function as high tide refugia is not needed. See also MCR 2, Details of Designs, regarding the comparison of alternatives under CEQA and NEPA.

I-PB1-16

Rootwads are intended to create drag, allowing an opportunity for suspended sediment to settle out of the water column. Rootwads would be anchored in place and coarse sediment would be used as backfill areas near the structure. Additional debris and coarse material is expected to collect near the structure and form beach-like areas as a habitat enhancement while providing some erosion protection. This clarifying information as included in Section 2.2.2 of the Final EIR. As further discussed in Chapter 6 of the Final EIR, gravels would be placed at or near the rootwads along approximately 300 linear feet at the toe of the bay-facing levee to form a small, pilot-scale gravel beach in the Preferred Alternative. Although, an extensive barrier beach is not included, the Preferred Alternative does not exclude the possibility of development of a larger-scale barrier beach at a future date.

See also response to comment I-PB1-4 and MCR 2, Details of Designs, regarding the level of detail required under CEQA and NEPA for analysis of the environmental impacts of the project.

Baye, Peter (I-PB2)

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Subject: Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for Phase 2 of the South Bay Salt Pond Restoration Project at the Eden Landing Ecological Reserve; CEQA comments submitted on behalf of Citizen's Committee to Complete the Refuge.

May 30, 2018

Dear Ms. Buxton:

I-PB2-1

I would like to submit the following comments on selected aspects of the subject EIS/R. My comments are submitted on behalf of the Citizen's Committee to Complete the Refuge, Palo Alto, but they reflect my independent best professional and scientific judgment in tidal marsh restoration ecology. These comments are provided with the intention of improving the project as a whole by identifying both problems and solutions that resolve issues regarding specific design alternatives, impacts, and project descriptions. Comments are focused on tidal marsh habitat restoration features, and related flood control features, that differ among alternatives.

An earlier text-only version of this comment letter was submitted for the separate EIS (NEPA) comment deadline schedule. This CEQA (EIR) comment version is completed with figures and captions, including relevant additional "text box" discussion. The two versions are substantially the same, with minor additional corrections.

Alternatives

The EIR/S volume I explicitly incorporates by reference (p. 2-1) the "details" of project alternative descriptions in Appendices B, C, and D in Volume II. Appendix B (preliminary alternatives analysis report) provides accounts (p. 6 *et seq*., and p. 27-28) of a "land mass" as a "high and wide earthen feature" designed to preclude catastrophic failure of traditional levees. Yet a word search for "land mass" in the pdf document of volume I of the EIR/S confirms that it is not explicitly addressed in any alternative, nor

I-PB2-1 (cont.)

explicitly excluded or rejected from any alternative. Moreover, this design objective is expressly inconsistent with Appendix D, Preliminary Design Report description of the Bay Levee purpose in context of alternatives C and D (p. 21):

> The Bay Levee will be raised for habitat enhancement, not flood protection. Hydrodynamic modeling results …show that tide waters will enter southern Eden Landing through the OAC breaches and lowered levees, and therefore increasing the height of the Bay levee will not reduce the water surface elevation within the Bay and Inland Ponds. Raising this Bay levee may reduce wave overtopping…

This is an apparent inconsistency between the EIR volumes (main text and supporting documents) that is unresolved, and results in an incomplete project description and comparison of alternatives. It is ambiguous whether the very broad description of bay levee "improvements" described for Alternative D (p. 2-43) include, may include, or preclude a "land mass". This is highly significant, because the potential impacts and restoration feasibility and compatibility issues of the "land mass" are indeed massive. The HTZ outline of the bay levee in Alternative D is similar to the vague "land mass" proposal, but the description of Alternative D does not explain whether the "land mass" it is encompassed in it or not.

I-PB2-2

A further problem with the status of the "land mass" in the alternatives analysis and project description is the statement that geotechnical analysis specific to the site – including the analysis of whether the bay muds in the footprint of the "land mass" are even feasible and ripe for comparison with alternatives that are feasible. Appendix D, pp. 14-15, affirms that no site-specific geotechnical analysis has yet been performed for the EIR/S. The geotechnical attachment (Attachment 2, p. 4) indicates that some levee segments cannot even be built to the 12 foot elevation standard without failing stability standards for safety at end of construction. This begs the question of how a vastly larger land mass could be placed without inducing intensive subsidence of low-strength bay mud, and mudwaves that could destabilize salt marsh restoration.

Small mud waves (left) leave uplifted, tilted mudflat "crusts" in the wake of onshore-migrating small, light barrier shell beaches at Foster City, 2010. In contrast, heavy loads of high dunes migrating in rapid pulses

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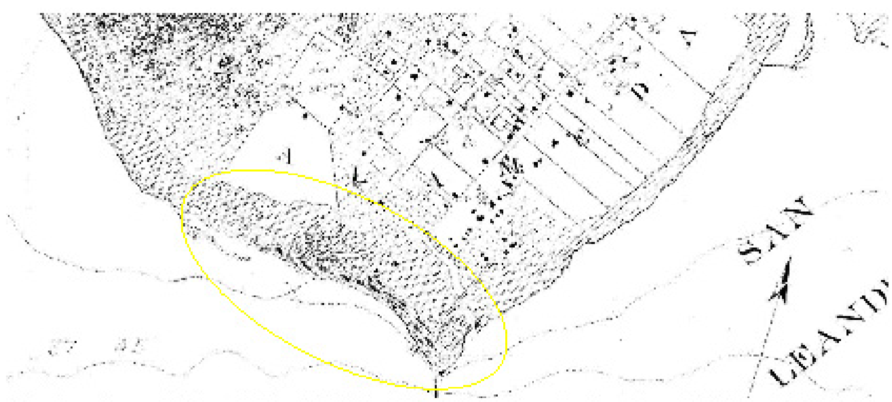
I-PB2-2 over salt marsh at Morro Bay, Shark Inlet (right, 2018), cause more massive uplift, heaving, and drying of salt marsh blocks, and extrusion of underlying soft, low strength estuarine muds. Rapid placement of high earthen fill "land masses" over bay mud would require geotechnical analysis to assess the risk and magnitude of mudwave instability of adjacent restored marsh.

I-PB2-3 Appendix B (p. 27) indicates that the *concept* of the "land mass" is "much like a barrier island". There is ample evidence that actual, natural marsh-fringing barrier beaches did indeed occur near the project site: for example,

- U.S. Coast Survey T-sheet 481 North, 1855, multiple-ridge recurved spit at the end of Alameda Island, near modern Otis Drive; width ranging from approximately 90 – 270 ft at widest; T-591,
- Fleming Point barrier beach, south of modern Golden Gate Fields, Berkeley, a single dune ridge barrier approximately 40-70 ft wide).

Modern analogs of historical barrier beaches that meet or exceed elevation targets for the Bay levee have spontaneously regenerated at Radio Beach (Oakland Bay Bridge toll plaza north shore; 50-60 ft wide beachface, 70-90 ft wide foredune with crest over 5 ft above MHHW). A wide, low sand barrier spit, with limited sand supply persists even closer to Eden Landing at Roberts Landing, San Leandro, north of the San Lorenzo Creek mouth. The Radio Beach dune also has a double-ridge profile that encloses a non-tidal lagoon – a profile type that would provide even greater flood protection (overwash detention) at Eden Landing than a single dune ridge. These examples of historical and modern SF Bay barrier beaches are shown below. These are presented as models of environmentally superior alternative constructed (or "self-constructed", sediment-nourished) types of shore landforms that would provide functional equivalence of an earthen fill "land mass", in habitat transition zones at the Bay Pond levee shoreline position.



U.S. Coast Survey T-sheet 481 North, 1855, multiple-ridge recurved spit at the end of Alameda Island, near modern Otis Drive. This is an historical reference analog for a barrier beach with dimensions and flood attenuation functions similar to an artificial earthen fill "land mass", but with high potential habitat value, and dynamic geomorphic processes that allow self-maintenance and self-construction with nourishment of suitable sediment size range (sand and gravel).

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(cont.)

U.S. Coast Survey T-sheet 591 (1856), Fleming Point barrier beach, south of modern Golden Gate Fields, Berkeley, a linear single dune ridge barrier beach (tombolo; barrier beach connected to an upland island) sheltering a tidal salt marsh.

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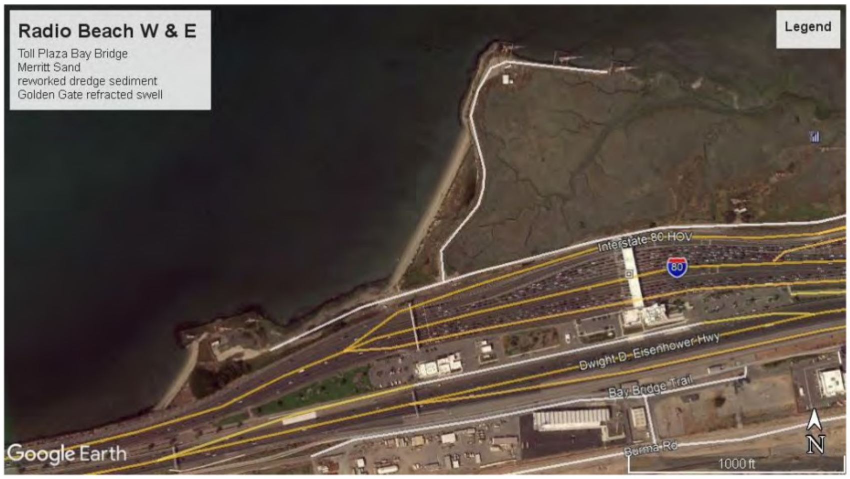

Radio Beach, estuarine barrier beach reference site, north shore of Oakland Bay Bridge toll plaza. Medium sand beach with dynamically stable, gradually retreating foredune, variably 3-6 ft above the high tide line. The vegetated foredune retreats over a small backbarrier lagoon and salt marsh. The barrier beach functions as a dynamic self-repairing natural "levee" that reduces wave runup and overwash if its sediment budget is maintained.

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Radio Beach, north end: short-term beach erosion exposes a "core" of gravel and cobble berm over which the sand berm and foredune is deposited. The gravel-cobble berm is a storm deposit that resists beach erosion and buffers foredune undercutting and retreat in response to wave action.

Radio Beach, backbarrier non-tidal lagoon and salt marsh. This swale depressional wetland formed between the foredune and a remnant levee seaward of the tidal salt marsh. The wide swale functions as a basin that detains storm overwash. This feature is a potential flood attenuation design feature that does not require fill across the entire profile, and may be applicable to the Eden Landing shoreline.

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(cont.)

The north sand spit of Radio Beach has provided an attractive roosting habitat for elegant and Caspian terns. Wave action and sand mobility maintain barren substrate attractive to terns and shorebirds.

These and other San Francisco Bay barrier beaches provide reference conditions demonstrating habitat value for terns (roosts at Radio Beach north end spit), western snowy plovers (vagrants at Roberts Landing), and potential suitable habitat for endangered California sea-blite. A USFWS pilot reintroduction project in 2008 included Roberts Landing, but was terminated due to unfortunate timing of extreme storm erosion after transplanting. Barrier beaches, especially those with gravel berms, "self-seal" rather than fail and tidally breach during storm erosion events, as artificial bay levees do. Barrier beaches with sufficient sediment supply retreat landward while building vertically (foredune accretion) and retaining geomorphic integrity (profile migration landward by "barrier rollover" – dune and washover migration), instead of eroding in place and leaving a lag of immobile residual rocky fill (land mass failure legacy). In relation to restoration and flood control objectives, a barrier beach restoration would provide an environmentally superior alternative to an earthen "land mass" of imported upland fill. Beach restoration would provide multiple benefits naturally compatible with the restored tidal marsh platform, and would require less fill. Like Aramburu Island beach, the beach could be designed to "self-construct" by wave and wind action following profile

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(cont.)

nourishment (hydraulic placement in the foreshore), rather than engineered fill placement. Alternatively, it could be placed hydraulically behind the existing levee, which could be allowed to fail and "activate" wave and wind processes that would mobilize beach sediment and form the barrier beach after the Bay levee erodes, replacing it, while eliminating a major cost and impact of bay levee reconstruction. The potential coarse sediment supplies – Port of Oakland and Alameda Flood Control Channel dredging – are the same as for other alternatives described. The "root wad" design of Alternative B actually requires a barrier beach in order to function.

Roberts Landing barrier beach is composed of a washover terrace capped with low foredunes. In the 1970s, prior to degradation by off-road vehicles, it supported vegetated dunes up to about 6 ft high, according to the late Janice and Frank Delfino of CCCR.

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Roberts Landing barrier beach, north end, exhibits gradual landward migration over the salt marsh behind it, through dune migration and storm overwash linked to beach shoreline retreat. The barrier prevents direct wave erosion of the salt marsh.

Roberts Landing barrier beach is visited by western snowy plovers, and is a high tide roost for shorebirds that forage on adjacent mudflats during most of the tidal cycle.

Estuarine barrier beach transition drift-lines and salt marsh borders are the primary habitat for recovery of endangered California sea-blite (*Suaeda californica*). USFWS initiated pilot reintroductions at Roberts Landing (above) and an Emeryville site near Radio Beach in March

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2008. Storm erosion eliminated the small immature colony at Roberts Landing, but the Emeryville population was successful. A large restored barrier beach at Eden Landing would contribute the largest potential habitat for re-establishment of California sea-blite in the San Francisco Bay recovery unit, consistent with the recovery plan for the species, and potential recovery funding. Valary Bloom (right) of USFWS is shown preparing transplant sites at Roberts Landing.

California sea-blite (*Suaeda californica*) beach transplant 6 months old at Roberts Landing (left), and a mature 13 yr old colony stabilizes a segment of the shoreline at Port of San Francisco Pier 94 (right). Prof. Katharine Boyer, San Francisco State University, is leading research on the ability of sea-blite to provide tall emergent high tide cover for salt marsh wildlife.

Janice Delfino (left, 2006) at Roberts Landing sand spit, recalled history of the barrier beach as a shorebird high tide roost and post-breeding habitat for terns (training juveniles to forage). Citizen's Committee to Complete the Refuge and partner organizations, including Ohlone Audubon, have a long history of habitat conservation for Hayward Shoreline wetlands and beaches, which continues today, and continue to advocate for restoration of sustainable natural shorebird habitats, in addition to intensively managed habitats. Isolated, undisturbed sand spits and beaches still serve as high tide roosts for shorebirds and tern, but such habitats, like Foster City sand and shell spits (right) are now rare because of shoreline stabilization by artificial levees and rip-rap.

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I-PB2-3 (cont.)

Therefore, the final EIR should explicitly reject the poorly defined "land mass" concept and replace it with an actual barrier beach restoration with multiple ecological benefits (tern, shorebird, western snowy plover, California sea-blite), recreational benefits (limited public access and recreation for some segments) and flood control benefits (reduction of breach risk, wave runup, and dynamic, sustainable increase in wave attenuation).

I-PB2-4

Habitat Transition Zones ("Upland Transition Zones"; HTZ, UTZ). HTZ are broadly defined in Appendix B (p. 7) as "another enhancement" to increase flood protection, buffer sea level rise, and "add diversity". Appendix D (p. 28) describes habitat transition zones as

> …areas with a wide transition in elevation from upland zones to tidal marsh zones. Low marsh, high marsh, tidal fringe, and upland habitats will develop over a habitat transition zone. The design goal of habitat transition zones is to provide areas varying in elevation to increase habitat diversity and complexity.

The EIR/S defines HTZ on p. 2-15 as "A habitat transition zone is a constructed feature with a relatively gentle slope (up to 30:1 [horizontal:vertical]) intended to provide a natural and ecologically beneficial connection between uplands or levees and the adjacent pond bottom", without reference to flood protection or sea level rise buffering. Because this is a critical feature of the project design and objectives, the HTZ and its design goals need to be consistently and comprehensively defined so alternatives can be compared accurately in relation to project objectives. Incomplete definitions and objectives may cause or contribute to imbalanced comparisons of alternatives among HTZs located in variously at back-side, interior pond ("mid-complex") levee, and bay levee positions. Potential habitat and flood control functions of HTZ designs vary significantly depending on tidal marsh landscape position (bay edge, marsh interior, landward edge, channel edge), not just engineering design.

The EIR/S's broad-brush description of terrestrial HTZs as a project "enhancement" does not accurately reflect the fundamental, essential role that broad, gently sloping supratidal-high intertidal gradients must provide for stability and ecological function of the restoration of tidal marsh during accelerated sea level rise. They are not optional amenities or enhancements of a tidal restoration project that has objectives for long-term endangered species habitat support during accelerated sea level rise. Properly located and distributed HTZs are arguably *more* essential than raising intertidal fill platforms to Mean Sea Level to Mean Higher High Water, because unlike intertidal marsh platforms, there are no natural, passive processes that could possibly form them, and all long-term tidal marsh restoration objectives would fail without them. Yet the EIR/S dedicates a higher priority to dredge material engineering and placement (a full appendix), while leaving ecological and geomorphic functional assessment of HTZs as a generic and subordinate feature of alternatives.

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I-PB2-4 (cont.)

Essential HTZ ecological design features, such as soil and vegetation criteria related to the stated objectives (habitat diversity, high tide refuge, sea level rise transgression space), are left without sufficient detail to meaningfully compare alternatives. Alternatives variously place terrestrial HTZs at the bay edge and interior of the Eden Landing complex (island-like artificial locations incongruent with sea level rise adaptation or natural tidal marshes) with those at the "back side" (landward edge; natural position and congruent with sea level rise adaptation). Distinguishing HTZ and "island" high tide refuges functions properly (see discussion below) allows for accurate weighting of HTZ flood control and habitat benefits at different landscape positions in the project area, and thus allows for valid comparison of alternatives. The erratic, artificial "bay levee" and "mid-complex" HTZ positions are poorly justified by habitat functions, especially where they are disengaged from potential treated wastewater or well water irrigation.

I-PB2-5

Habitat Transition Zone vegetation establishment. Appendix D (p. 29) states that hydroseeding with native seed mix and/or a planting schema will speed establishment of a range of vegetation, transiting from tidal marsh to upland vegetation, for slope protection. A native annual cover crop composed of a mix of summer and winter annuals with high competitive ability should be hydroseeded (or otherwise broadcast seeded) on all newly graded slopes in fall. Revegetation performed solely by hydroseeding a generic "native seed mix" would predictably result in a transient 1-2 years of target seeded species emergence, followed by rapid succession to weed dominance. This sequence was evident in the first hydroseeding of tidal marsh restoration site levees at Sonoma Baylands, and continues to occur in the Estuary today.

The timing of native annual cover crop sowing should either be prior to germinating rains, or after tillage of rain-germinated weeds from seed banks, depending on the severity of existing weed seed banks or invasions. The dominant native perennial plant species of the transition zone, however, are poorly adapted to establishment by direct seeding. Native perennials and shrub seedlings are subject to high mortality, and survivors would be inherently slow-growing and vulnerable to competition by fast-growing weeds. Vegetative propagules and methods should be used to establish native perennial forbs, grasses and grass-like plants, subshrubs, and shrubs. Most importantly, as explained below, HTZ vegetation design and ecological functions depend on matching compatible substrate (edaphic conditions; soil-vegetation relationships) with ecological objectives. HTZ vegetation designs should include variations matched to both soil and hydrology options ("dry" levee and treated wastewater/well water subirrigation options, different soil texture contingencies). Without matching vegetation design to soil and hydrology, habitat deficiencies or failure (and hence restoration objective deficits) would likely result.

I-PB2-6

HTZ substrate ecological criteria for terrestrial, on-site, and imported estuarine sediments. Appendix D (p. 28) states Appendix D states "Habitat transition zones will be constructed of material generated on-site from excavations of pilot channels, levee

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I-PB2-6 (cont.)

breaches, and lowered levees", and that "upland fill material may also be used if available from off-site construction projects, assuming it meets suitability requirements", but it does not state what "suitability requirements" are, or whether they are ecological (based restoration objectives), or merely bulk fill engineering and water quality criteria for contaminants and geotechnical needs unrelated to ecological restoration objectives. Little HTZ substrate information is provided on EIR/S p. 2-43, regarding only compaction and hydroseeding, but no physical soil criteria. The most detailed description of imported terrestrial fill suitability is (inappropriately) in discussion of traffic impacts on EIR/S volume 1 p. 2-60:

> Finding source projects with sufficient quantities of upland fill material is difficult for several reasons. The excavation must occur in a year and season when the SBSP Restoration Project can accept it. Stockpiling material or moving it more than once is cost prohibitive and would increase environmental impacts. Then, to be used in a restoration project, the material must pass a screening to demonstrate its lack of contamination. The source project should also be located close enough to the restoration project that bringing it there would both have fewer environmental impacts and be less expensive than bringing to a landfill or other destination.

The EIR/S contains insufficient description of upland fill, fill sources, or criteria required for a meaningful assessment of impacts or alternatives. This is not a minor detail to be deferred or left to "dirt brokers" with no understanding of tidal marsh restoration. The lack of explicit substrate source and ecological suitability criteria for HTZ is a major omission with potential significant impacts for restoration. The ecological restoration outcomes and impacts of HTZ design are likely to differ significant depending on the source of fill and method of construction. As described, the project could allow fill in the upper HTZ soil profile that would irreversibly defeat its basic objectives for vegetation and habitat.

I-PB2-7

Terrestrial (upland) fill sources for HTZ. Imported terrestrial substrate suitability criteria for HTZs should be defined ecologically for each alternative, in terms of soil texture, bulk density, and chemistry matched to the target native plant assemblage, and not merely in terms of engineering suitability as bulk fill. Clay loams (clay, sandy clay, silty clay) are appropriate for the top 1.5 ft of all habitat transition zone slopes. Drained bay mud is usually suitable for this purpose. Adverse soil conditions due to use of stony terrestrial subsoils, especially unweathered horizons with high content of cobble or large gravel (such as some newly constructed Bair Island constructed levees), can pose almost insurmountable constraints for growth of suitable vegetation types supporting essential ecological objectives in salt marsh transition zones. Stony subsoils favor effectively irreversible and unmanageable dominance by many annual non-native Mediterranean weeds – a significant long-term impact and management burden, inconsistent with project objectives. Superficial soil amendments could not offset the root zone impacts of stony soils with compacted clay, or sandy soils with high pore volume.

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I-PB2-7 (cont.)

Mitigation for potential significant long-term impacts (and restoration feasibility impairments) of importing ecologically incompatible upland fill for HTZs should include a requirement for a minimum 1 ft (objective: 1.5 ft) cap of either dewatered fine-grained (silt to clay) dredge sediment, low-sulfate on-site bay mud, or comparable silty clay loam as a cover layer on HTZs.

Dredged material sources for HTZ construction. Appendix E states that one potential dredge sediment source, Oakland Inner & Outer Harbor, may contain up to 40% sand. Sand and bay mud are not ecologically equivalent as fill platforms for tidal marsh restoration. Sandy dredged material, especially batches with very high percentage Merritt Sand (Pleistocene beach, dune and shallow lagoon sands, similar to Ocean Beach sand texture) should not be used as bulk fill for tidal marsh platforms or HTZs at Eden Landing. High concentration of Merritt Sand in the upper marsh soil horizons is likely to result in prostrate pickleweed growth habit, and formation of persistent playa-like high salt marsh pans (nearly barren flats, similar to some salt pond flats) in the high salt marsh ecotone, as at Hamilton Wetlands Restoration. This is due to sand's naturally low nutrient retention capacity, low moisture content, and high potential for capillary concentration of salt at the surface. Well-planned high marsh transition habitat design may well include such playa-like sandy flats and high marsh pans, but sandy sediments should not be treated indiscriminately as inert bulk fill, equivalent to bay mud. Sand-dominated dredged material should be prioritized for estuarine beach nourishment at the bay shore of the Bay Ponds, as part of a multi-purpose estuarine barrier beach restoration design component.

Hamilton Wetlands Restoration terrestrial transition zones constructed from Merritt formation sand, dredged from Port of Oakland, have formed persistent playa-like barren flats with capillary salt crusts (hypersaline, desiccated summer substrate conditions) and very sparse, prostrate salt marsh vegetation. This habitat is similar to dried salt pond beds.

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I-PB2-7 (cont.)

Hamilton Wetlands Restoration terrestrial transition zones constructed from Merritt formation sand, promote low, prostrate salt marsh vegetation in the uppermost intertidal zone. This does not support the high salt marsh transition zone habitat objectives (alternative high tide refuge) of Eden Landing.

I-PB2-8

Appendix E (p. 12) states that dredged material may be also used to construct HTZs, but it does not explain whether this would occur through direct placement of dredged material in cells, or earthmoving of dewatered dredged material after placement. Appendix E and the EIR/S provide no alternatives including hydraulic placement of sediment for HTZ construction, such as designs for deliberate "mounding" (sediment splays, fans) at sediment slurry discharge points. The hydraulic construction of HTZs by dredge sediment discharge point mounding has occurred in multiple tidal marsh restoration projects in the region. It has demonstrated the feasibility of developing beneficial high salt marsh-terrestrial gradients, as well as back-marsh pool habitats. Complex sediment splays, fans and mounds are commonly formed, albeit unintentionally, at dredge material placement cells for tidal restoration (e.g. Montezuma Wetlands, Sonoma Baylands). At Sonoma Baylands, they formed the earliest and most extensive high marsh habitats at the project site, well in advance of all dredge material fill platform zones, which remain predominantly middle to low marsh plain over 20 years after construction. HTZ construction in alternatives that involve dredge material placement should incorporate dredge sediment mounding methods, by timing movement of the dredge discharge pipe points to develop a series of sediment splays or fans, distributary channels, and discharge point scour pools.

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I-PB2-8 (cont.)

"Mounding" of hydraulic dredge sediment slurry forms splays or cone-like sediment fans around the point of discharge at Montezuma Wetlands (left, 2015) and Sonoma Baylands (right, 1996). The mounded sediment fans at Sonoma Baylands formed a transition zone gradient between the constructed levee and adjacent tidal flats, supporting the only rapid development of high salt marsh (less than three years after deposition).

Salt marsh pools formed in dredge discharge pipe locations, originating as scour pools in sediment fans, have persisted over decades at Sonoma Baylands. The hydraulic sediment slurry construction of these HTZ features were unplanned and accidental, but could be advantageously incorporated in Eden Landing tidal marsh restoration where dredge material is applied

I-PB2-9

On-site HTZ substrate sources. If HTZs are constructed from on-site excavated bay mud from ancient salt marsh soils that have been converted to salt pond beds, substrate suitability criteria must include testing for acid sulfate or sulfide content. Unlike freshly dredged bay mud dominated by mineral sediments, bay mud from old salt marsh soils in diked baylands may have high organic matter content, and past exposure to alternating prolonged flooding and drawdown. Under these conditions, old salt marsh soils may likely form horizons of highly elevated acid sulfates that can be toxic to vegetation. Acid sulfate soils in levee slopes designed as transition zones may cause persistent inhibition of vegetation and even barren zones, supporting sparse cover of a few acid-tolerant, mostly weedy species, until acid sulfates are neutralized (a process that may take up to five years or more). Recent examples of severe localized inhibition of vegetation by acid sulfates, lasting over five years, occurred at the Petaluma Marsh Expansion Project and one portion of the Bahia Wetland Restoration Projects (Novato, Marin County). Less severe but significant examples also occurred more recently at Sears Point and Cullinan Ranch tidal marsh restoration projects, resulting in persistent large local barren areas, weed prevalence, and delayed colonization by most target native species. Feasible

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I-PB2-9 (cont.) mitigation for potential impacts of acid sulfate soil would include testing soils from potential on-site borrow areas, and segregating acid sulfate soils for placement as foundation fill below the surface of HTZ root depth (1-1.5 ft), avoiding near-surface placement.

Persistent acid sulfate soil impacts on passive revegetation of the high salt marsh and transition zone at Bahia Wetland Restoration Project, San Pablo Bay, November 15, 2012, four years after construction. Left – transition zone constructed from diked salt marsh soils with high acid sulfate content remained mostly barren. Right – same age adjacent transition zone constructed with drained, decades-old dredged material from a former dredge disposal site was rapidly and fully vegetated with native species below the high tide line. The acid sulfate inhibition declined enough for vegetation establishment after 2016, a significant delay.

I-PB2-10 **Dredged material fill impacts and mitigation for restoration of tidal drainage patterning.** The legacy of preserved prehistoric tidal creek patterns in salt pond beds (diked salt marsh tidal drainage patterns) is a highly valuable asset for tidal marsh restoration: it imprints a tidal creek template on the marsh platform that preserves high sinuosity and density of mature prehistoric tidal marsh, preserved at the time of diking in the 19th century. Dredged sediment slurry is likely to fill and level relict tidal marsh drainage patterns. Differential settlement (auto-compaction; thicker layer slurry in slough beds; more settlement) of slurried dredge material, however, is likely to revive tidal channel drainage patterns unless cell berm layout cuts them off and consolidates dredge sediment in confined cells. This would be an adverse impact of construction design on project hydrologic and ecological objectives for restoration. If confinement berms are used for engineered placement of dredged sediments, they should be aligned to run between tidal drainage networks, like "tidal watersheds" to preserve high drainage density, channel sinuosity of mature ancient tidal marsh. Borrow ditch blocks, and breaches of interior salt pond levees, should be combined with to prevent borrow ditches from dominating tidal flow patterns, and reconnect ancient tidal drainage networks as much as possible. This is not described in preliminary design for any alternatives; all alternatives appear to imply a high risk of burying and erasing major portions of antecedent tidal channel patterns.

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I-PB2-11 **Dredged material fill elevation targets and fill stabilization with vegetation**. The target elevation range between MSL and MHW is appropriate, to ensure rapid vegetative stabilization and retention of placed sediment, minimizing the risk of reworking (resuspension by tidal current and wind-wave turbulence) and net loss during strong spring ebb tides or storm events. However, the limiting habitat in coming decades of accelerated sea level rise will likely be high salt marsh (approx. MHHW to mean perigean spring high tide elevation, so the EIR/S should specify of dredged sediment volumes (percent) of dredged material allocation to wide HTZ ramps (platforms for higher high salt marsh zones over 20-50 years of sea level rise), and flat intertidal marsh platforms below MHW elevation.

I-PB2-12 **Imported dredged material and project timing**. There is trade-off in committing to use of dredged material with the intention of accelerating tidal marsh restoration or correcting subsidence, to reach low or middle salt marsh elevation range. The trade-off is between time opportunity for potential tidal sediment accretion (direct breach with no dredge material import), and the equivalent elevation gain from dredge material placement, within a finite amount of time, as the risks of sea level rise acceleration and declining estuarine sediment deficits increase. If the added delay relative to direct breaching and passive tidal sedimentation is short, and tidal suspended sediment concentrations (SSC) are relatively low, the delay in restoration caused by dredged material engineered placement provides a net advantage for tidal restoration. But where SSC is high, and dredge material wait time (tidal restoration/breach delay) is long, dredged material dependence for tidal restoration can become disadvantageous. Very long delays in project scheduling and sediment delivery, such as at Montezuma Wetlands (over decades), have resulted in significant net delay of tidal restoration relative to prompt tidal breaching. As the sea level rise curve steepens, this potential deficit may become more severe. The EIR/S should mitigate this risk by setting a threshold schedule to implement tidal breaching in case of excessive delay in dredged material placement at Eden Landing ponds, if dredged material options are taken. Tidal restoration should not be delayed indefinitely because of a project commitment to accept dredged material; a cut-off is needed to proceed with tidal restoration if dredged material delivery is excessively delayed. Alternative beneficial re-use options for dredged material exist at some Alviso-Mountain View ponds, which are more severely subsided, may be a better alternative site for dredged material in case of Eden Landing project delay.

I-PB2-13 **Imported Alameda Flood Control Channel sediment placement**. The EIR/S covers dredged material offloading and placement (Appendix E) in detail. It also proposes and evaluates details for pipeline connections for delivering brackish groundwater from wells, and tertiary treated wastewater from Union Sanitary District, to support restoration construction and maintenance activities. These are appropriate and informative for the project description and alternatives. But there appears to be no alternative or module (sub-alternative), however, for long-term infrastructure (pipeline and booster pump delivery) of Alameda Flood Control Channel excavated sediment, which is a highly significant long-term, recurrent source of both coarse and fine sediment nourishment for

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I-PB2-13 (cont.)

bay shorelines, marshes, and habitat transition zones. Flood control sediment should be integrated into the project design just as dredge sediment and water sources are.

San Francisco Estuary Institute (SFEI 2017) provided data on the highly variable annual sediment load of Alameda Creek, which averages approximately 100,000 tons/year. The bed sediments that are actively excavated are richer in coarse sand and gravel than the total sediment load, with the proportion of gravel increasing upstream above the Niles Canyon gauge (about 40% gravel, 25% coarse silt and sand; SFEI 2017). Most channel maintenance sediment removed is in tidal reaches, close to the project site, where the proportion of silt and clay is about 60%. All these sediment classes, volumes and the cyclic nature of supply are extraordinarily important assets for tidal restoration and long-term adaptation (management, maintenance) to sea level rise, and no less important than single-event construction fill import sources (Goals Project 2015, SFEI 2017).

The EIR/S should include this highly significant marsh and shoreline sediment nourishment resource as a part of the restoration infrastructure. Sediment dredged from Alameda Creek should be piped to the site with a system of booster pumps (as proposed for offshore import and delivery of dredged material) and delivered for restoration construction, and for long-term "thin-lift" slurry deposits along habitat transition zones, high marsh zones, and especially bay shorelines (for gravel and sand-dominated sediment batches). The long-term restoration and marsh maintenance value of this permanent watershed sediment supply would be greater than one-time dredged sediment subsidies during project construction, especially when sea level rise rates accelerate. The ongoing channel maintenance activities of Alameda Flood Control channel should be integrated with the restoration design and infrastructure in at least one alternative, even if not to a level of detail comparable with Appendix E.

I-PB2-14

Habitat Islands and sand and shell capping for special-status wildlife habitat enhancement. "Habitat islands" are proposed as either shorebird roost or high tide salt marsh refuge features. Shorebird islands suitable for terns and plovers are proposed to be kept suitably barren by substrate design:

> A select group of islands will be treated to create nesting habitat for western snowy plover, California least tern, or other bird species. The top surface of the islands will be treated with a 12-inch thick sand layer underlain by a 6-inch thick crushed rock to minimize weed establishment. The sand layer will include oyster shells or other materials to provide a primarily unvegetated, diverse landscape that is typically preferred by nesting birds. (Appendix D, p. 31)

The capping of islands with sand, shell, and impermeable layers would preclude subsequent conversion to high salt marsh vegetation capable of providing dense cover of tall vegetation that functions as high tide refuge for wildlife during extreme high tide marsh submergence events. Sand surface layers naturally promote cover of relatively low, prostrate salt marsh vegetation (mats of pickleweed, saltgrass, alkali-heath; stunted

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I-PB2-14 (cont.)

gumplant or none; see Hamilton Wetlands Restoration example, p. 14-15, this letter). Habitat islands constructed with sand and shell for shorebird roosts, even if feasible and sustainable (which is not the case), would require reconstruction and conversion to high salt marsh features with a different substrate if they were to function as high tide refuge cover in a salt marsh.

Capping emergent islands with sand and shell as habitat enhancement feature for terns and plovers habitat is very likely to be infeasible and counter-productive in the long term, and even short-term (> 2 yr); it would fail to meet objectives to "enhance" islands or "land mass" to become surrogate habitats for high-albedo unvegetated habitats in salt ponds, levees, or beaches. This is a potential significant impact if these features are proposed to compensate for restoration project-induced habitat loss of special-status species such as western snowy plovers, least terns, or important high tide roosts for shorebirds. The EIR/S appears to mistake the ecological processes that maintain barren sand and shell substrates in the Estuary, and wrongly assumes that substrate design alone will provide suitable habitat conditions. This error could result in degraded habitat conditions for both tidal marsh and barren habitats used by shorebirds and terns.

In the absence of wave action, physically stable sand or shell deposits 12" thick, even with road base/crushed rock below, would predictably become rapidly colonized by annual weeds at high density and cover, which would persist indefinitely or undergo succession to dominant weedy perennials or scrub. Positively drained, convex sandy or shelly topographic features (mounds or berms with no hypersaline salt accumulation, seasonal hypersaline desiccation, or seasonal flooding) in either salt marshes or managed non-hypersaline lagoons/ponds inevitably become dominated by thick cover of annual weeds (and a few native plants) that are adapted to sand substrates. The colonization and accumulation of weed seed banks occurs rapidly, within 1-2 years.

Outstanding examples of permanently vegetated well-drained stabilized sand and shell berms (relict beach ridges cut off from wave action) and mounds, and their rapid formation after stabilization, are evident around Foster City, Point Pinole, Brisbane, Oakland, and elsewhere. In context of dredged material placement, Port of Oakland Merritt Sand deposited at Montezuma Wetlands initially formed barren active deflation plains and dunes that attracted western snowy plovers beyond their historical range. The Montezuma sands, which were placed over relatively impermeable and hypersaline bay mud (root barrier to terrestrial weeds, analogous with an impermeable road base layer) subsequently became colonized by vegetation that caused the site to be abandoned by plovers and terns, despite intensive short-lived unsustainable efforts to suppress vegetation and maintain artificial sandy barrens.

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I-PB2-14 (cont.)

Foster City shoreline supports a sequence of prograding (expanding bayward) oyster shell hash beach ridges with salt marsh swales between them. Relict, stabilized older ridges cut off from wave actions by younger ridges rapidly become colonized by gumplant, pickleweed, alkali-heath, and non-native halophytes.

Stable old oyster shell hash flats and berms rapidly become dominated by either invasive non-native halophytes, or high salt marsh plants, depending on location and seed rain. Massive infestations of invasive Algerian sea-lavender (*Limonium ramosissimum*) dominate shell flats at Foster City dredge disposal areas, and requires intensive management to control. Perennial vegetative cover of gumplant and pickleweed (right) dominate stabilized shell beach ridges at Foster City, with barren substrate restricted to trampled trails. Shell and sand deposits support shallow-rooted, drought-adapted and halophytic annual or perennial plants that grow in the wet season, even when deposits occur over impermeable substrate. Only periodic wave action, extreme hypersalinity, or seasonal ponding and desiccation, maintain dynamic barren sandy or shelly substrates suitable for tern and plover habitat.

Artificial barren high-albedo sand or shell surfaces in wave-sheltered wetland settings would need chronic high maintenance, which is not feasible in the long term or consistent with "restoration". Sand and shell surfaces within hypersaline basins, or wave-exposed

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I-PB2-14 (cont.)

shorelines, maintain dynamic barren high-albedo surfaces. On levee roads, routine vehicle use and compaction of hypersaline sediments maintain barrens. In the absence of vegetation suppressing dynamic influences like these, sand and shell barrens are unstable and become vegetated landforms.

Natural bare sand or shell habitats capable of attracting and supporting snowy plovers, or shorebird roosts, are formed and maintained by recurrent disturbance or stress sufficient to preclude colonization and persistence of vegetation. The prevailing natural disturbances and physiological stresses that maintain barren sand, shell, or pan beds are either (a) daily high tide wave action (beaches), or (b) alternation between prolonged seasonal alternation of flooding and desiccation in saline depressions and flats (pan or playa in salt ponds or high salt marsh edges).

The target tidal elevations of "habitat islands" (vegetated high tide refuge habitats) in salt marsh restoration areas should not exceed the highest spring tide elevations because perennial vegetation canopy cover above the substrate surface, not the substrate surface itself, provides wildlife emergent high tide cover during extreme high tides. See China Camp Marsh and upper Newark Slough ancient tidal marsh examples below, under discussion of HTZs. Island elevations and substrates should have objectives to maintain tall, dense perennial native vegetation cover above the extreme high tide water surface, distributed near tidal channels. Conversion of islands to supratidal, terrestrial substrate elevations may result in dominance of annual weeds above the high tide line, which would provide inferior cover during winter high tides. Similarly, if supratidal elevations target terrestrial shrubs as cover, these would likely be subject to mass mortality (dieback and degeneration of cover) after extreme high tides saline soils when sea level rises, shifting cover back to weedy annuals until high salt marsh succession occurs. Habitat islands dedicated to provide high tide salt marsh wildlife cover should set design substrate and elevation objectives to produce tall, dense, semi-evergreen gumplant canopies would remain above the extreme high tide water surface (i.e., separate but related tidal elevation objectives for substrate and vegetation canopy cover). High tide flood refuge cover could be supplemented by installation of large woody debris that can trap smaller floating debris, and provide dynamic refuges independent of vegetation canopy structure and elevation.

I-PB2-15

Habitat Transition Zones (HTZs) and "Islands" as high tide refuge. The EIR/S does not explicitly compare the critical high tide refuge habitat designs among alternatives, or the configuration and relative contribution of high tide refuge functions provided by HTZs and "islands". The two constructed features differ significantly in relation to high tide movements of endangered California Ridgway's rails and salt marsh harvest mice during extreme high tides. This restoration design is essential to the long-term success of all project alternatives.

When flooded out of tallest available salt marsh vegetation cover during high tides, SMHM move vertically to the nearest emergent cover within their home ranges, or are

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I-PB2-15 (cont.)

forced to swim to floating or emergent cover, which exposes them to risk of avian predation or drowning (wind-wave turbulence). Ridgway's rails move through tidal creeks and take cover in the tallest vegetation in home ranges during marsh submergence events. The tallest vegetation within rail home ranges is normally emergent creek-bank gumplant canopies directly connected to primary creek travel corridors. Cross-marsh movements over long distances during marsh submergence to alternative "upland" (landward edge) transition zones is a last resort when no other cover is available within or near home ranges, which is a characteristic trait of degraded, narrow salt marshes bordered by levees – not restored extensive tidal marsh plains.

There is no basis to assign primary high tide refuge functions for perigean spring high tides to landward HTZs of a restored, wide tidal marsh platform. Terrestrial-edge HTZs are alternative catastrophic flood refuge habitats, back-up refuges of last resort when internal home-range refugia are submerged. Emphasis on landward-edge HTZs over interior marsh high tide refuge habitat is a misapplication of a conceptual marsh model based on young, narrow fringing salt marshes bordered by artificial bay mud levees that have an unnatural distribution of high tide refuge habitat concentrated along the levee toe. This anthropogenic fringing salt marsh and levee model of high tide refuge habitat distribution is the converse of natural high tide refuge habitat structure of wide, geomorphically mature salt marsh platforms with complex creeks. Paradigmatic examples of natural high tide refuge habitat structure and distribution, suitable for restoration models at Eden Landing, are evident at remnant prehistoric tidal salt marshes of upper Newark Slough (South Bay), and China Camp State Park (North Bay), and elsewhere in the Estuary.

In a restoration design, primary high tide refugia should be well-distributed within home ranges of sensitive marsh wildlife, in relation to tidal creek bank patterns - where the tallest vegetation naturally occurs. Well-distributed, extensive high intertidal salt marsh "islands" (emergent high marsh mounds or berms) should be interpreted and designed as the first line of normal high tide refuge habitat (perigee spring high tides, storm high tides, with HTZs as infrequent "worst case" flood refuge (storm, perigee high spring tide, and warm Pacific sea level anomalies or extreme ENSO events).

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I-PB2-15 (cont.)

Natural distribution patterns of effective, emergent high tide refuge cover is visible in natural, prehistoric tidal salt marsh during marsh submergence events that occur during perigee spring high tides at China Camp State Park, Marin County. A narrow, dense, tall, mostly continuous band of tall gumplant and pickleweed vegetation canopy stands above the water surface in a narrow zone bordering tidal creeks. Long distances of open-water submerged marsh plain separate creek-bank refugia from sparse grassland cover the landward edge of the marsh. The "natural levee" pattern is purely vegetative: the marsh substrate surface is submerged 1-2 feet deep, including higher channel banks. Comparatively localized, sparse high tide cover naturally occurs at the terrestrial grassland ecotone along the landward shoreline.

Like China Camp Marsh, the last prehistoric tidal salt marsh with a natural terrestrial edge and high marsh creeks occurs at upper Newark Slough at the Don Edwards SF Bay National Wildlife Refuge. It similarly exhibits a pattern of well-developed high tide emergent vegetation canopy cover during marsh submergence events along banks of tidal creeks, where tall pickleweed and gumplant delineate the main slough and smaller branch tidal creeks. The landward marsh edge (corresponding with "back side" HTZ of Eden Landing) supports shorter grassland vegetation (including some stands of native perennial grassland) and shorter salt marsh vegetation. This pattern of distribution of high tide refuge habitat, concentrated in the interior marsh along creeks more than the landward edge, is repeated in the Estuary's other natural, prehistoric tidal marsh fragments. In contrast, narrow, young fringing salt marshes bordered by artificial bay mud levees have an unnatural distribution of high tide refuge habitat concentrated along the levee toe – a poor model for large-scale restoration of wide marsh platforms with complex creeks.

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I-PB2-15
(cont.)

Interior tidal marsh patterning of well-developed high tide emergent vegetation canopy cover is evident during marsh submergence events, concentrated along banks of tidal creeks in upper Newark Slough. Island-like patches of tall pickleweed and gumplant delineate smaller branch tidal creeks far from artificial levee or terrestrial shorelines.

The environmentally superior/preferable alternative should provide the maximum creek-parallel distribution of effective high tide refuge habitat (tall high intertidal marsh vegetation) in restored tidal marsh. Alternatives should not excessively weigh benefits of peripheral HTZs as high tide refuge habitat over internal high tide refuge habitat of the salt marsh plain. An early example of a tidal marsh restoration project that integrated both internal high marsh and landward-edge high tide transition zones as high marsh refuge for California Ridgway's rail and SMHM is the Bahia Wetlands Restoration Project in Novato, Marin County (California Department of Fish and Wildlife and Marin Audubon Society). In this case, broad habitat transition zones (non-irrigated horizontal levees, 10:1-20:1 slopes at the landward edge) and high marsh mounds and berms (aligned along constructed pilot channels) were combined, and developed stabilized high marsh to low salt marsh gradients that spread laterally over adjacent mudflats in the first year after construction. Radial marsh progradation from the mounds occurred much sooner and faster than pioneer colonization of mudflats.

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I-PB2-15 (cont.)

Upper intertidal berms and mounds were constructed along the margins of main pilot tidal channels to provide high tide refuge habitat patterns aligned with tidal channels in the example of the Mahoney Spur cell of Bahia Wetlands Restoration project (Novato, Marin County; California Department of Fish and Wildlife lands) in August 2008. By October 2009 (Google Earth image above), the berms and mounds were naturally colonized by salt marsh vegetation sooner than surrounding mudflats and graded levees. This was one of the first constructed high salt marsh mounds of this type and pattern. It is based on natural tidal creek-pattered distribution of high tide refuge habitat in tall creek bank vegetation.

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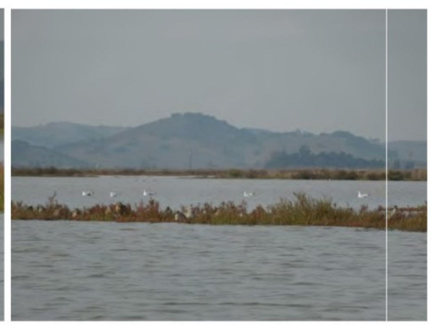
I-PB2-15 (cont.)

High salt marsh mounds and berms at Bahia in 2016, eight years after construction and tidal restoration have matured expanded laterally, and outpaced adjacent mudflats in salt marsh succession. Mudflats remain in early stages of pioneer salt marsh vegetation establishment.

Two examples of high salt marsh mounds at Bahia during a perigee spring high tide in November, 2014. Mounds are fringed with native cordgrass, spreading laterally onto adjacent mudflats. They are capped with pickleweed and gumplant only four years after tidal restoration, with no active planting. The mound substrate is submerged; high tide cover is provided by salt marsh vegetation canopy growing 1-2 ft above ground surface. Substrate elevations do not directly provide high tide cover.



Emergent vegetation cover of high marsh mounds stood above the water surface of shallowly submerged mound crests, and provided high tide roosts for large and small shorebirds (curlews, willets, sandpipers) during a perigee high spring tide, November 2012. Levees and landward-edge transition zones are not used as high tide roosts as frequently as the island-like high marsh mounds during marsh and mudflat submergence.

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I-PB2-15 (cont.)

The constructed wide Habitat Transition Zone (non-irrigated "horizontal levee") at Bahia in 2012 (year 4) supported dense native high salt marsh and transition zone vegetation, but almost pure low-growing non-native vegetation above the high tide line. The supratidal zone here provides sparse, poor winter cover during high tides. The uppermost intertidal zone provides ample tall semi-evergreen vegetation cover, but remote from developing tidal channel networks where primary rail habitat is expected. The HTZ in this position provides a "backstop" of high tide refuge for marsh wildlife when refuges internal to the marsh are submerged during the most exceptional, extreme high tides.

If high tide refuge designs internal to the restored tidal marsh are adequate, the flood protection designs of the alternatives (B, C, D) are largely and properly decoupled from the different alignments of HTZs at artificial "mid-complex" and "bay levee" locations. The alternative, unnatural HTZ locations at the bay levee and mid-complex (Alternative D) are unjustified by habitat benefits, and become essentially flood control primary-purpose designs, if the alternatives properly rely primarily on internal marsh "island" high tide refuge designs.

I-PB2-16

Tree root wads as shoreline enhancements: incomplete or infeasible design
The DEIR and Appendix D propose to use "root wads" of trees as bay shoreline treatment (alternative B), but without incorporating placement of coarse sediment (sand, gravel). The stated purpose (Alternative B) for tree root wads on the Bay levee was "to help create high tide refuge and help protect the levee from wave erosion. Tree "rootwads" are a natural slope stabilization technique often used in stream restoration design". This is an error of interpretation out of context. Root wads of trees are ordinarily used as scour objects in stream restoration to create erosional pool habitats where turbulent streamflow is concentrated, as well as components of bank stabilization when combined with other stabilization features.

Without coarse sediment to trap and buffer the logs and root wads, wave action at the bay shore would be reflected and concentrated, intensifying storm wave erosion. In order to

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I-PB2-16 (cont.)

function as a protective shoreline features, log or rootwad groins would need to be combined with a source of coarse sediment to trap. This was the basis of log groins at Aramburu Island habitat restoration project, which placed groins to check longshore drift of gravel. Most of the log groins there continue to perform this function six years after construction. Log groins on the exposed bay shoreline, subject to intensive wave action at high tide during storms, do not themselves provide high tide refuge for shorebirds or salt marsh wildlife during storm or high wind events. Unless large woody debris is embedded in the banks of tidal creeks within the salt marsh, where it may trap other debris or provides a foundation to elevate the vegetation canopy of climbing pickleweed, alkali-heath, or saltgrass, it will not act as any meaningful tidal flooding refuge.

Thank you for your attention to these comments, and for your laudable long-term efforts at managing the unprecedented regional tidal wetlands restoration project, of which Eden Landing is one part. Please contact me if you have any questions or interest in further information on the subjects covered in my comments.

Respectfully submitted,

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Cc:
Citizen's Committee to Complete the Refuge
Interested Parties

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Response to Baye, Peter (I-PB2)

I-PB2-1

See response to comment I-PB1-1.

I-PB2-2

See response to comment I-PB1-2.

I-PB2-3

See response to comment I-PB1-3.

I-PB2-4

See response to comment I-PB1-4.

I-PB2-5

See response to comment I-PB1-5.

I-PB2-6

See response to comment I-PB1-6.

I-PB2-7

See response to comment I-PB1-7.

I-PB2-8

See response to comment I-PB1-8.

I-PB2-9

See response to comment I-PB1-9.

I-PB2-10

See response to comment I-PB1-10.

I-PB2-11

See response to comment I-PB1-11.

I-PB2-12

See response to comment I-PB1-12.

I-PB2-13

See response to comment I-PB1-13.

I-PB2-14

See response to comment I-PB1-14.

I-PB2-15

See response to comment I-PB1-15. See also I-PB1-4 for a discussion of the landscape positions for the habitat transition zones in the Preferred Alternative.

I-PB2-16

See response to comment I-PB1-16.

Ervin, Jim (I-JE)

Via email: phase2comments@southbayrestoration.org

To: Southbayrestoration.org

From:
James Ervin
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Subject: **Comments regarding Phase 2 Planning for Eden Landing Restoration.**

I-JE-1 I reviewed the Eden Landing Phase 2 Draft Environmental Impact Statement & Report and attended the public meeting on May 8th. I greatly appreciate this opportunity to comment on the proposed plan.

I have witnessed ecological impacts resulting from the South Bay Salt Pond Restoration Project in the Alviso Marsh Complex adjacent to Lower Coyote Creek since 2005. As a result of that project, thousands of acres of former salt ponds were first opened to circulation with Bay water around 2004 to 2006, with several later restored to full tidal flow (Ponds A19, 20, and 21 in 2006. Pond A6 in 2010. Pond A17 in 2011.) or managed pond circulation (Pond A16 in 2011, Pond A8 complex in phases on Alviso Slough.) The authors of your Eden Landing reports are familiar with the history of Alviso Marsh Complex restoration. I hope that all the many lessons learned will also continue to guide the Eden Landing restoration. In my personal observation, Alviso Complex restoration appears to have met or exceeded almost all expectations set many years ago. This also is the general conclusion of the 2018 report: "Phase 1 studies summary of major findings of the South Bay Salt Pond Restoration Project" posted on the Salt Pond Restoration and USGS websites (https://pubs.er.usgs.gov/publication/ofr20181039). The report indicates that progress toward most goals are trending positive or exceeding expectations:

Some lessons learned from restoration efforts in the Alviso Marsh Complex:

1. **Sediment** accretion rates meet or exceed expectations. Sediment movement has not decreased mudflat habitat. (pp. 10-13)
2. **Shorebird and waterfowl** abundance and diversity continues to be supported, even expanded, as salt pond acreage decreased with two caveats: managed pond actions to support snowy plover breeding habitat exceeds expectations, but support for California least terns is still uncertain. (pp. 14-19)
3. **Mercury mobilization and methylation** has not increased as a result of opening circulation into former salt ponds, with one cavaet: a short-term increase in mercury was detected in tern eggs following opening of tide gates in Pond A8. However, the elevated mercury load was about one-third the load previously predicted from models and did not persist after initial construction. (pp. 20-28)
4. **Aquatic species (native fish)** do utilize the restored habitats in and adjacent to restored ponds, albeit the trend is still uncertain for steelhead and salmonids. However, it should be noted that data strongly indicate that fully restored "tidal ponds" support more native species of fish and invertebrates. "Managed ponds" and tidally-muted ponds support more non-native species. (pp. 29-33)

I-JE-1 (cont.)

5. **Water Quality** changes in the Alviso Complex resulting from pond restoration is still a mixed bag that bears some discussion. Dissolved oxygen concentrations in a marsh will fluctuate, and in fact have continued to do so in the Alviso Complex after restoration with no apparent ill effects. However, years of experience indicate that ponds with restricted circulation to the Bay suffer from accumulation of algal mats and crashes in dissolved oxygen concentrations, particularly in the warmest months. The 2018 report concludes that nuisance algal blooms causing low Dissolved Oxygen in managed ponds continues to show a negative trend. (pp.34-38)
6. **Invasive and nuisance species.** Marsh vegetation has colonized restored and managed ponds in line with expectations. California gull populations continue to be higher than desired and pose a predation threat to breeding shorebirds.

   Here I would like to note that the 2018 Phase I report falls a little short in this evaluation. In my personal observation, gulls appear to prefer dry pond areas for resting and breeding colony establishment. This is probably identified in other reports I do not have in hand. This should suggest that maximizing tidal restoration is a better strategy for minimizing gull colonization.

   The other shortfall in the Phase I report is that gulls are not the only invasive/nuisance species. There are many invasive aquatic species that should be identified and tracked as pond restoration progresses from Phase I through Phase II: Corbula clams, Yellowfin gobies, Rainwater killifish, and Inland/Mississippi silversides are a few of the endemic non-natives that may be considered “noxious invasive” to the degree they compete with, or displace, native species. (The native versus non-native issue is clouded a bit because we consider some non-native species like Striped bass and American shad to be desirable game fish.) As mentioned in item 4 above, fully restored tidal ponds support more native fishes and invertebrates. Managed ponds with highly muted circulation not only foster nuisance algae blooms, with attendant low dissolved oxygen crashes, but also nurture huge populations of tiny non-native fishes at the expense of native sticklebacks, herring, and longfin smelt, that we should otherwise prefer.

I-JE-2

Overall Comment on Phase 2 Eden Landing Restoration Plan: The plan offers a great set of four restoration alternatives. I strongly recommend “Alternative Eden B” restoration design. Alternative B maximizes the number of ponds that will be restored to fullest tidal circulation and affords sources of freshwater that will be critical to assure the greatest density and diversity of aquatic species.

I-JE-3

Why I don’t like Alternatives C and D. Alternatives C and D manifest a desire to control water height by adding levees and hydraulic control structures in the inland and southern ponds (Ponds E5, E6, E6C, etc.). This is understandable as a means to enhance waterfowl habitat for certain species, but lessons learned from the Phase I Alviso Complex Restoration indicate this is ultimately a fool’s errand. Managed ponds will have to be managed, and hydraulic control structures will have to be maintained, possibly into perpetuity under Alternative C. Meanwhile, nuisance algal blooms and late-summer crashes in dissolved oxygen will be ongoing problems calling for … more management. Fish screens will have to be installed and periodically cleaned to prevent large predator fish from entering many of these managed

I-JE-3 (cont.)

ponds or there will be huge fish kills in late summer. Much of the Eden Landing Complex will not mimic the natural estuarine function in the absence of tidal circulation and seasonal freshwater flushing. More importantly, the proposed north-south flood control levee may permanently divide and fragment the restored marsh complex. Opportunities to further expand more natural and desirable tidal marsh may be forever obstructed.

I-JE-4

I would like to add a little speculation as well: **We don't know how "managed ponds" will evolve over a long period of time**. With limited circulation and flushing, one would presume that salts and nutrients in the pond continue to build up to some degree. When successful, managed ponds host many thousands of diving and dabbling ducks and hosts of shore birds. A precocious five-year old may ask: "Where does all the bird poop go?" A more sophisticated adult would regard this as a salt and nutrient load problem. If we connect the dots, we may conclude that the nutrient load coupled with limited flushing is exactly why we observe bigger nuisance algal blooms and dissolved oxygen crashes in managed and muted ponds.

My speculation is that this problem may increase as years and decades pass. A similar problem has arisen in City of San Jose municipal and regional parks: Lake Cunningham and Almaden Lake. Lake Cunningham has no flushing whatsoever. Over two decades it has become a toxic cyanobacterial stew. Some tiny fish live in the lake, presumably sticklebacks and some non-natives. Some ducks, cormorants, and pelicans visit the lake, but not many. And, Lake Cunningham has been closed to all human recreation since early 2017 due to documented presence of cyanobacteria toxins. Lake Cunningham was managed for human recreation for decades until salts and nutrients simply overloaded the system. Now, it mainly serves cyanobacteria. The case of Almaden Lake is not so dire. Almaden is only periodically closed to human recreation because seasonal wet weather creek flows allow occasional flushing. Almaden is also deeper, and this helps limit the mass of nuisance algae that can form there. I would like to suggest that you add lessons from Lakes Cunningham and Almaden to your consideration of alternatives for Eden Landing restoration.

With absence or reduction in tidal flushing and mixing, managed ponds will be relatively stagnant. Negative impacts are not so noticeable in bird populations, which simply use managed ponds for roosting or limited foraging. However, there is a profound difference at the microbial level of primary producers (phytoplankton and other forms of algae) and primary and small secondary consumers like bacteria, ciliates, rotifers, cladocerans, copepods, etc. I am not aware of any rigorous study comparing microbial communities in managed versus restored ponds. Water quality data and anecdotal evidence suggest there may be a big difference. Phytoplankton comprising the base of the food web have not been described, but current evidence from circulating or managed ponds A16 and A18 in the Alviso complex is that managed and low-circulating ponds create conspicuously green water. There has been no documented ill-effect resulting from the green water. But we do not know if this may be a harbinger of cyanobacteria blooms or other ecological upsets. We only know that the greenness seems to be characteristic of restricted circulation.

I-JE-5

Why I like Alternative B. The estuarine ecology is based on a dynamic system, not a static system. Tides and seasonal freshwater flows are part of the energy that drives and maintains this system. Absent tidal flushing, stagnant ponds become algal swamps, then alkali flats, then salt pannes or desert. An ideal Alternative B would also maximize flow connections with the adjacent Alameda Flood Control

I-JE-5 (cont.)

Channel to contribute more freshwater flow. Unfortunately, from what I understand, connections to the Alameda Channel fall under Federal jurisdiction making that option unforeseeable for the near future. (How unfortunate that a human bureaucratic convention should block such an attractive option for restoration!) But, absent that connection, Alternative B is superior simply for restoring the maximum marsh area to tidal circulation and better habitat for native fish and benthic organisms.

Although excluded from current planning, the Alternative B option to someday connect a portion of Eden Landing Complex to discharge from the Union Sanitary District wastewater treatment should be given serious consideration. If the wastewater treatment includes nitrification (removal of ammonia) and some amount of denitrification (removal of at least some nitrate), the additional freshwater flow would be extremely beneficial to the future restored marsh complex. The freshwater flow emanating from the San Jose/Santa Clara Regional Wastewater Facility (SJ/SC RWF) has been subject to extensive study in recent years. By all analyses, the treated wastewater is a significant factor that contributes to portions of the Alviso Marsh Complex supporting the highest density and diversity of fishes found in all of San Francisco Bay. Various studies and findings are summarized near the end of each year's facility Annual SMR Report: http://www.sanjoseca.gov/Archive.aspx?AMID=161&Type=&ADID=

I-JE-6

A few specific comments on the Draft EIR and Restoration Plan:

Draft EIR, bottom of page ES-14 to top of ES-15 : Potentially Significant Impacts: Eden Landing Phase 2 Impact 3.5.3: *"Potential habitat conversion impacts to western snowy plovers. ... there would be a reduction of potential western snowy plover habitat under Alternative Eden B. ... the impacts under Alternative Eden B would be potentially significant."*

Comment. It is difficult to assess potentially significant impacts resulting from potential snowy plover habitat that does not currently exist. The impact on western snowy plover is speculatively based on potential nesting or roosting habitat that might prove useful to plovers, or it might not. Managing ponds for plover use is a very uncertain goal and likely could lead to future needs to control predators, experiment with substrates, place decoys and recordings, or a host of other additional management actions as ever more costly efforts to bend nature to our will. The counter-argument is that maintaining the inland and southern salt ponds as managed ponds will deprive native fish and benthic organisms of much needed tidal mudflat and marsh which serves or conveys primary production. These tiny fish and benthic bugs feed both bird and fish communities, including plovers. Most would agree that birds migrate to San Francisco Bay marshes because of the abundant food. We should tune our efforts to maximize restoration that returns ancient marshes to natural food production.

In any case, more complete analysis of potential biological colonization by a host of organisms, in addition to snowy plovers, under either restoration scenario would be useful here. It makes me uneasy that a single species may drive the complexion of the entire restoration unless the argument is very compelling.

I-JE-7

Biological Resources, P. 3.5-13, near top of page: *"Results of bird surveys at ponds managed for salt production by Cargill also suggest ... small and medium shorebirds, gulls, and eared grebes showed an increase in abundance with increases in salinity while piscivorous birds, egrets and herons, and diving*

I-JE-7 (cont.)

ducks showed marked decreases in abundance in in areas of higher salinity. These different responses are likely related to the interactions between water depth, salinity, and dissolved oxygen, and with their prey base. These differences support the assumption that a range of ponds with differing physical characteristics is necessary to support a diverse and robust avian community."

Comment. The above statement needs more elaboration. Portions of the statement regarding affinity of bird guilds to salinity levels do not entirely agree with conclusions by Susan De La Cruz, et al in the 2018 USGS Open File report: "Trends and Habitat Associations of Waterbirds Using the South Bay Salt Pond Restoration Project." (https://pubs.usgs.gov/of/2018/1040/ofr20181040.pdf) That report indicates a stronger correlation between water depth, as opposed to salinity, and presence of certain bird guilds. Grebes and gulls are the only guilds possibly attracted to the highest salinities. Water depth seems to be the major factor for all the other guilds. I am not aware of a study connecting dissolved oxygen concentration to bird utilization of a pond. (I have observed piscivorous birds exploiting fish stressed from low dissolved oxygen: stressed fish swim near the surface and create a temporary pelican, tern, and cormorant feeding frenzy.) I don't think that birds can detect low dissolved oxygen by itself.

Regardless of whether bird guilds are more affected by water depth or salinity, the above paragraph seems to conclude with circular logic: '... because bird guilds prefer different conditions, a range of physical pond types is necessary to support them.' I do not agree. From personal observation, I have seen shorebird guilds mass on Pond A19 mudflats at low tide, for example. Just a few hours later, shorebirds fly off as tide rises, then piscivorous birds, diving ducks and dabblers arrive. The birds evolved in marshes subject to a dynamic tidal cycle. They know that shallow ponds get deep, then shallow again, as tides change. You can create a static system with ponds at fixed water depth, and birds will utilize it: driving the observation that different guilds like certain conditions. But, the restoration will not be natural, and it will not support the microbial food web needed to adequately feed the entire fish and bird community at the top. Let tides control water depth. Birds can jump from one pond to another according to the tidal cycle like they have always done.

I-JE-8

Biological Resources, P. 3.5-23. Table 3.5-2: Bald eagle is evaluated as "Low potential to occur."

Comment. This should be changed to mirror the assessment for Golden eagle: "Potential to occur." There are now at least seven bald eagle nests in San Francisco Bay Area. One of the nests, in Milpitas adjacent to the Alviso Marsh Complex, fledged a chick in 2017 and now hosts two more chicks this year. Residents in Milpitas are daily photographing and Facebook posting photos of the parent eagles carrying ducks, coots, and striped bass from Alviso restored ponds to their growing chicks. I might go so far as to conclude that bald eagles are likely to occur at the restored Eden Landing Complex in the future.

I-JE-9

Comment. Longfin smelt is evaluated as "Known to occur." That statement is true. Given the current declining status of Longfin smelt in the San Francisco Bay and Delta areas, and further given the 2017 finding by Dr. Jim Hobbs that Longfin smelt are spawning in the Alviso Marsh Complex, **I strongly recommend that the overall report give more attention to this threatened native fish.** Furthermore, some specific factors associated with Longfin spawning and recruitment should be given consideration. For example, winter low water temperature and low salinity are the factors that trigger Longfin spawning. Will there be enough freshwater in winter to stimulate Longfins? Recruitment depends to a

I-JE-9 (cont.)

large degree on Mysid shrimp populations and Copepods. Will the restored versus managed ponds foster growth of mysids and copepods? These organisms are the basic food resources for practically all the estuarine fishes, so this is not an exclusively Longfin concern. Mysids and Copepods are barely or only vaguely mentioned as biological resources. If your restoration does not support these tiny critters, it will fail.

I-JE-10

Biological Resources, P. 3.5-94, first paragraph last sentence: *[In the context of Inland Ponds and Southern Ponds being retained and enhanced as managed ponds] "The enhanced managed ponds may increase habitat value for estuarine fish, but also result in increased abundance of non-native species and predation."*

Comment. This conclusion is not supported. A lesson learned from the Alviso Marsh Complex restoration is that managed ponds will support more non-native species at the expense of natives. Predation will not be a factor if fish screens are installed on managed pond hydraulic control structures. If fish screens are not installed, the managed ponds will likely become traps for large predators like striped bass, king salmon, sturgeon, and California halibut. USFWS early experience in Pond A16 around 2013 and 2014 was that king salmon found a way into the pond via an inadequate fish screen and died due to the low dissolved oxygen. City of San Jose experience with circulating pond A18 was that hundreds of striped bass, plus a few halibut, bat rays, and sturgeon entered the pond when the fish screen broke down in 2014. The large fish could not tolerate a late September dissolved oxygen crash in the pond nor could they find their way out via narrow channels. They too died in the pond. Repairs to the broken fish screen were costly, but urgent. There have been no reports of mass fish kills in nearby restored ponds.

I-JE-11

Biological Resources, P. 3.5-56, middle of page: *"... sedimentation patterns of the South bay are expected to result in a loss of intertidal mudflat, both due to conversion to emerging fringe marsh and conversion to subtidal habitat due to scour as a result of increased tidal flux and eventually because of sea-level rise. ... mudflat loss is expected to be greater if ponds are breached and tidal habitats restored (2007 Final EIS/R)."*

Comment. This statement should mention the 2018 Phase I findings that indicate that mudflat loss did not occur as a result of restoration in the Alviso Marsh Complex. Granted, deposition rates may not be as great in the Eden Landing Complex, but studis since 2007 strongly indicates that there was far more sedimentation in tidally restored ponds A6 and A21 than initially expected with practically no associated loss of mudflat.

I-JE-12

Biological Resources, P. 3.5-57, middle of page: For Alternative Eden B - *"Managed ponds would be removed from the Bay, Inland and Southern Ponds, and small shorebirds would have to rely on managed*

I-JE-12 (cont.)

ponds located elsewhere in the South Bay to provide stable environmental conditions that allow longer foraging and roosting periods."

Comment. At the very least, this sentence should be modified to say "small shorebirds MAY have to rely upon managed ponds ..." Findings in the 2018 Phase I report seem to indicate that small shorebird survival does not hinge upon the presence of managed ponds.

O-JE-13

Biological Resources, P. 3.5-66 to 77: *"Terns appear to be more mobile and more resilient to these changes, and are moving to new sites as pond are restored to tidal flows, however, they are not moving to newly created pond habitat with islands (Ibid)."*

Comment. Just an observation: The terns are almost certainly attracted to the food (tiny fish) that restored tidal ponds produce. The islands are placed in managed ponds with muted tidal flow, consequently less food. Terns don't like that!

I-JE-14

Biological Resources, P. 3.5-94, near top of page: "The enhanced managed ponds may increase habitat value for estuarine fish, but also result in increased abundance of non-native fish species and predation.

Comment. The enhanced managed ponds are unlikely to increase habitat value for estuarine fish, particularly if fish screens are installed. If fish screens are not utilized there may be high potential for fish kills.

I-JE-15

Biological Resources, P. 3.5-94, near top of page: *"Actions proposed for Alternative Eden C would be slightly less beneficial as those proposed under Alternative Eden B because the, in the former, the Inland or Southern Ponds would provide some limited habitat and access for fish that would not be provided in the latter."*

Comment. Change the word "slightly" to "significantly." There is more than enough information in the 2018 Phase I evaluation of Alviso Marsh Complex, and summarized elsewhere in this report, to boldly conclude that tidally restored ponds support native fishes. Managed ponds provide far less native fish habitat.

I-JE-16

Biological Resources, P. 3.5-120, third paragraph: Potential impacts to bay shrimp populations. ... *"At a program level, the SBSP Restoration Project is expected to have a net benefit on bay shrimp by increasing (to Bay levels) the salinities in some freshwater sloughs and channels in the South Bay ..."*

Comment. The California Bay Shrimp should be identified by its scientific name: C. fanciscorum. There is also a third native crangon shrimp: C. nigromaculata.

I-JE-16 (cont.)

https://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-125.pdf In addition, the above statement regarding salinity is not exactly true. Crangon shrimp show strong recruitment in the Bay when there is a strong winter or springtime freshwater flushing event, as happened in February 2017. In the absence of freshwater flushing, non-native palaemon shrimp tend to dominate. (Jim Hobbs personal communication and observation)

Thank you for this opportunity to comment!

Jim Ervin

I-JE-16
(cont.)

A few photos to illustrate points:

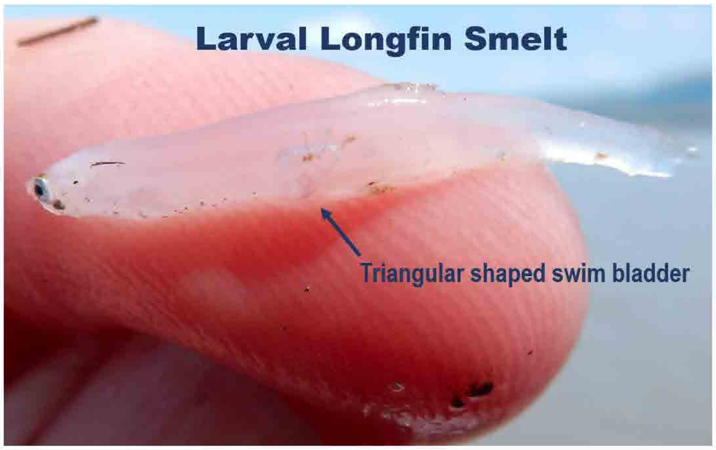
For better or worse, muted and managed ponds tend to produce green water! (no ill effects have been observed – so far!)

I-JE-16 (cont.)

Mysids are critical food for fingerling fish:

I-JE-16
(cont.)

Longfin smelt spawning in and near restored Alviso Marsh Complex ponds was discovered by Dr Jim Hobbs in late winter 2017:



Native Northern Anchovies also recruit in and near restored ponds.

I-JE-16
(cont.)

Native crangon shrimp. (C. franciscorum)

One of the Milpitas bald eagles with striped bass caught in Alviso Marsh restored pond in 2017.

Response to Ervin, Jim (I-JE)

I-JE-1

Monitoring and adaptive management actions are integral components of the SBSP Restoration Project; this approach would continue with implementation of Phase 2 actions in ELER. As per the Adaptive Management Plan, native and non-native estuarine fish will be monitored in tidal habitat, ponds, and sloughs. As discussed in MCR 2, Details of Designs, the SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. Focused monitoring of invasive/nuisance aquatic species will also be considered.

I-JE-2

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

I-JE-3

The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the project's intended ecological goals. Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. The Southern Ponds would be opened to muted tidal flows through a culvert system during the first phase of restoration; however, those ponds could be operated more as true managed ponds and not left open to constant muted tidal flows if ongoing monitoring shows that more managed ponds are needed for bird habitat. This is consistent with an adaptive management approach to the phased restoration of the Southern Ponds.

I-JE-4

With the Preferred Alternative, additional water control structure would be constructed in the Inland and Southern Ponds and some of the existing structures would be repaired. These improved water control structures would allow increased operational flexibility (relative to the existing conditions) to manage water depth and circulation in managed ponds that can be used to reduce residence time, increase dissolved oxygen concentrations, and reduce the potential for algae blooms.

I-JE-5

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative. To facilitate fish passage between the ACFCC and the restored ponds, the Preferred Alternative includes a connection between the Bay Ponds and the ACFCC that will no longer be through large culverts, as initially described, but instead through a full breach. This breach however, would be armored to prevent additional scour and uncontrolled widening that could undercut a new public access bridge on the Alameda Creek Regional Trail. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

I-JE-6

Western snowy plovers have not been recorded nesting in the Bay Ponds or Pond E5, but they have nested in Pond E6 (1 nest each in 2015 and 2018), along the north eastern border, on higher ground, and they have nested in Pond E6C in 2015 (8 nests), 2016 (8 nests), 2017 (2 nests), and 2018 (1 nest).. Because of the existing use of Pond E6C, this pond is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods.

The Preferred Alternative is intended to maximize tidal marsh restoration while still balancing multiple restoration goals. Restoration of tidal flow to the Bay Ponds would provide a large area of increased habitat value for salmonids and other native fish, improve conditions in southern Eden Landing, and provide good nursery and forage habitat for juvenile fish.

I-JE-7

Managed ponds have a more stable water surface elevation, and those ponds can be maintained with a certain water level and a certain salinity (to some extent) that can help produce and support specific types of prey (fish, invertebrates) that then attract certain types of foraging birds. It is not circular logic to try and provide a variety of habitats for a variety of bird species.

I-JE-8

The bald eagle is a rare visitor to the ELER Phase 2 area, while the golden eagle has been found to be an occasional forager during the non-breeding season. Although this may change in the future, the list is representative of occurrence frequencies to date.

I-JE-9

Section 3.5.3 (Impact 3.5-14) of the EIR discusses potential effects from the project on estuarine fish, including longfin smelt. Longfin smelt would benefit from the restored tidal marsh and channels which are expected to provide extensive and diverse foraging and nursery habitat for estuarine fish. Within the restored ponds, salinity and water temperature would be set by ambient conditions: the estuarine environment would reflect the combined mixture of fluvial flows and water from the Bay that passes through breaches and culverts, with the interior of the ponds generally expected to be well mixed due to tidal exchange. As such, salinity is expected to be lower when there is high fluvial outflow.

I-JE-10

The comparison being made is between the existing managed ponds and the proposed enhanced managed ponds. This is not a comparison between managed ponds and tidal habitat. Fish screen are not being proposed for control structures in the Inland and Southern Ponds.

I-JE-11

An additional clarifying sentence was included in Section 3.5.3 of the Final EIR that summarizes this Phase 1 finding.

I-JE-12

This sentence is intended to indicate that managed pond habitat would no longer be located in the Bay, Inland, and Southern Ponds with Alternative Eden B; not that small shorebirds are dependent on managed pond habitat. A clarifying phrase is included at the end of the sentence in the Final EIR.

I-JE-13

USGS data indicates that Forster's terns will forage in ponds but prefer tidal sloughs. The quote used is in reference to nesting terns not foraging terns.

I-JE-14

As discussed in response to comment I-JE-4, improved water control structures would allow operational flexibility when managing water depth and circulation in managed ponds and can be used to reduce residence time and increase dissolved oxygen concentrations, minimizing adverse conditions for fish and improving them relative to the existing conditions.

I-JE-15

Text was revised to remove the word slightly from the sentence.

I-JE-16

The scientific name is provided at the first time use the conventional name "California bay shrimp" is used in Section 3.5. The sentence quoted above is not referring to effects from freshwater pulse flows, but instead is referring to overall quantity of estuarine habitat.

Bogios, Constantine (I-CB1)

From: utility@sfei.org
To: SBSP Question
Subject: An SBSP question or comment
Date: Thursday, May 17, 2018 11:23:01 AM

First Name : Constantine
Last Name : Bogios
Organization :
Street Address : 2582 Oak Rd. #217
Street Address2 :
City : Walnut Creek
State : CA
Zip Code : 94597
Email : costabass@hotmail.com

This is regarding:
Habitat;

I-CB1-1
Question or comment:
I support plan B, full restoration of all 11 southern Eden Lannding phase 2 salt ponds to full tidal marsh in one stage

Response to Bogios, Constantine (I-CB1)

I-CB1-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Bogios, Constantine (I-CB2)

From: Constantine Gus Bogios
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Protect Native Species
Date: Thursday, May 17, 2018 11:24:11 AM

To Whom It May Convern,

I-CB2-1 I wish to voice my support to Alternative B full restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh in one stage.

Thank you - Costa

Sent from iCosta!!!

--

Response to Bogios, Constantine (I-CB2)

I-CB2-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Boniello, Ralph (I-RB)

June 5, 2018

South Bay Salt Ponds Restoration Project
Eden Landing Phase 2 Draft EIR/EIS

I-RB-1

I support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage. I support the recommendation *of* fisheries experts and the Alameda Creek Alliance who recommend full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

I support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

I support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk. I support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek. I support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

I specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.

I support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

Sincerely,

Ralph Boniello
Richmond, CA

Response to Boniello, Ralph (I-RB)

I-RB-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Clegg, James (I-JC)

From: James S. Clegg
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Artemia franciscana
Date: Tuesday, June 05, 2018 4:09:00 PM

I-JC-1 Is this valuable species still living in the South Bay salterns, or has it been destroyed?

James S. Clegg
Molecular and Cellular Biology
University of California, Davis and
Bodega Marine Laboratory
Bodega Bay, CA 94923

707 875 2010
707 875 2009 (fax)

Response to Clegg, James (I-JC)

I-JC-1

This species is still present and abundant in many of the moderate to higher salinity ponds.

Cook, J. (I-JPC)

From: jack pierce
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] EIR comments
Date: Tuesday, June 05, 2018 1:51:47 PM

I-JPC-1

Who will own and manage the trails? Will they be subject to closure or restrictions, like no dogs?

Are you getting rid of hunting, especially if there is endangered species?

Will the trails be protected from sea level rise?

Why doesn't the trail go to the shoreline as was promised in phase 1?

Will the trail connect to Fremont like was promised in phase 1?

What are the mitigation measures to guarantee the public will be allowed access?

Sincerely,

J. Cook
Union City cyclist

--

Response to Cook, J. (I-JPC)

I-JPC-1

See MCR 8, Maintenance Responsibilities, regarding CDFW's ownership of ELER and how local partnership will likely be sought for the long-term maintenance of trails, bridges, and viewing platforms (including signage, benches, etc.) within ELER. Phase 2 trails would have restricted hours (sunrise to sunset in ELER), but the spine trail would be open year-round except for approximately 10 days in November through January for sport waterfowl hunting. If East Bay Regional Park District agrees to operate the Bay Trail spine, dogs would be prohibited as is the case for their current operation of the spine along northern Eden Landing. As discussed in Section 3.6.4 of the EIR, limited waterfowl hunting at ELER would continue, though there would be a loss of available managed ponds for hunting.

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the Preferred Alternative includes a trail alignment through southern Eden Landing that would be located upon levees raised to a minimum elevation of 12 feet NAVD88, which is the same height as the proposed mid-complex levee (see also MCR 3, Sea-Level Rise).

None of the programmatic alternatives in the 2007 Final EIS/R included the construction of new shoreline trails in southern Eden Landing.

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the trail route selected in the Preferred Alternative connects to the Alameda Creek Regional Trail, which is located in the City of Fremont southeast of Pond CP3C.

Public access to southern Eden Landing would be provided on the indicated trail route. This access would not be a "mitigation measure" but rather an integral part of the proposed action itself.

Copper, Elizabeth (I-EC)

From: Elizabeth Copper
To: phase2comments@southbayrestoration.org
Cc: gfrost@audubon.org; "Jim Peugh"
Subject: [phase2comments] South San Francisco Bay Salt Pond Restoration Phase 2 - Eden Landing DEIR Comments
Date: Tuesday, June 05, 2018 6:07:40 PM

5 June 2018

Subject: Comments on Eden Landing DEIR -

I-EC-1

The selection of programmatic alternative C, up to 90% tidal marsh, 10% ponds is an extraordinary level of change to what has been identified in its pre-restoration condition as uniquely high value habitat for waterbirds. The efforts to evaluate the potential consequences of these changes have apparently been well-supported but current results are not sufficiently robust to justify Phase 2. Many of the evaluation measures have to date achieved only uncertain results. While some of those measures are tending positive, that should not be sufficient to move on to a level of change that approaches the maximum that would have been allowed in the 50-year programmatic EIS/R under alternative B.

The emphasis on tidal marsh does not reflect acknowledgment that the loss of tidal flats in San Francisco Bay has also been devastating. The importance of available high tide roosting habitat is not quantified. The makeup of high tide roost sites is not described and the distribution of roost sites throughout the bay is not included. The project relies on the ability to render 10% of the ponds of such high value that they can continue to support hundreds of thousands of waterbirds when 90% of the habitat they had will be lost. The results of efforts to date do not justify those assumptions.

The prey base within the salt ponds relied upon by hypersaline species such as eared grebes and phalaropes and to a lesser degree avocets and stilts are not discussed and the predicted outcome for these prey is apparently not addressed.

One of the The most significant measures of change will be the extent and density of vegetation. In the south San Diego Bay Salt Works during tidal restoration of ponds formerly part of a the salt production system, the abundance of many species of waterbirds increased for one or two years post-construction. The fill in those ponds provided expansive unvegetated flats which drew large numbers of foraging birds but as the salt marsh expanded many of the same species showed marked declines.

When issues such as the importance of biofilm are raised it is evident that the depth of understanding of the marine ecosystem is immature. The research supported by this project should be applauded for its breadth and given a chance to provide the guidance that was intended in the project's embrace of adaptive management. This is a Western Hemisphere Shorebird site of global importance. There should not be a rush to change it unless there is a guarantee that the knowledge to preserve the current values can be maintained.

I am concerned that the Programmatic Plan EIS was deemed to sufficient to support these actions by reference without the benefit of review of the research meant to guide adaptive management. That research suggests that the choice of alternatives should be reviewed and revised.

Thank you for the opportunity to comment.

Elizabeth Copper
227 F Avenue
Coronado, CA 92118
ecopper@san.rr.com

--
You received this message because you are subscribed to the Google Groups "Phase 2

Response to Copper, Elizabeth (I-EC)

I-EC-1

This comment is not about the adequacy or accuracy of the Draft EIS/R but rather reflects questions about the 2007 Final EIS/R. Programmatic Alternative C was selected as the Preferred Alternative in the 2007 Final EIS/R, but the selection of the 90-10 alternative for the program as a whole is an upper bound, not a hard and fast goal. The lower bound is the 50-50 alternative, and the plan is to end up somewhere in the middle, depending on how the various ecosystems and species respond.

Many of the specific issues raised in this comment are discussed in the context of the Phase 2 actions at ELER in Section 3.5.3 of the EIR, including the availability of high tide roosting habitats for small birds, preferences of eared grebes and phalaropes for prey in high-salinity ponds, foraging preferences for avocets and stilts, and changes in habitat type from managed ponds to mudflat to vegetated marsh with breaching and natural sediment accretion. Although there is less emphasis on the life history of specific prey species, changes to foraging habitat are discussed for different guilds/groupings of birds.

Waterbird surveys are an integral part of the Adaptive Management Plan and ongoing survey information would to be used during phased restoration at ELER. As described in MCR 1, Selection of the Preferred Alternative, Pond E6C is proposed to be enhanced and maintained as seasonal habitat for western snowy plover and other pond nesting birds in the summer, while providing deeper open water for overwintering diving ducks and dabbling ducks, among other migratory shorebird species during the spring and fall migration periods. The adjacent Inland Ponds (E5 and E6) would also remain managed ponds during the first phase of restoration; however, if monitoring and implementation of the Adaptive Management Plan determines that tidal restoration of Ponds E6 and E5 is most beneficial, then Ponds E5 and E6 would be open to muted tidal flow. Conversely, the Southern Ponds would be opened to muted tidal flows through a culvert system during the first phase of restoration; however, those ponds could be operated more as true managed ponds and not left open to constant muted tidal flows if ongoing monitoring shows that more managed ponds are needed for bird habitat.

The SBSP Restoration Project Management Team is committed to implementing lessons learned through its own Adaptive Management Plan as well as through the insights and contributions of knowledgeable people in regulatory agencies, research bodies, nongovernmental or advocacy organizations, and the public. Current research is regularly evaluated and those insights and major scientific findings guide ongoing restoration actions.

Coyne, Brian (I-BC)

From: Brian Coyne
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] comments on Eden Landing Draft EIR
Date: Tuesday, June 05, 2018 9:42:10 AM

To whom it may concern,

I-BC-1 I'm writing about the draft EIR for Eden Landing.

I am strongly in favor of this project. My primary experience of the area is as a trail user. For that reason, I want to strongly urge you to choose Alternative C. Alternative C is, if I'm reading the documents correctly, the only option that includes a trail bridge over the Alameda Creek Flood Control Channel. This bridge is absolutely crucial for connecting the various trails of the region and completing the Bay Trail through this area. Without this bridge, trail users would have to make a long detour back to the bridge at Ardenwood / Union City Boulevard, a road that is notorious among bicyclists for unsafe car traffic.

Completing the Bay Trail through Eden Landing will create a continuous trail route between Oakland, Palo Alto, and San Jose. This will be an incredible resource for the whole Bay Area, facilitating sustainable transportation and engagement with these restored natural areas. I urge you to move forward with the project and choose Alternative C.

Sincerely,

Brian Coyne
San Francisco

--

Response to Coyne, Brian (I-BC)

I-BC-1

As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the Preferred Alternative includes a trail alignment through southern Eden Landing that includes the public access bridge over the ACFCC.

Dalal, Namita (I-ND)

From: "namita dalal" via Phase 2 Comments
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] salt ponds restoration
Date: Thursday, May 17, 2018 4:56:20 PM

I-ND-1

- We generally support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

- Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

- We support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

- We support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk.

- We support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek.

- We specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.

- We support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

- We support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

Thank you
Namita

--

Response to Dalal, Namita (I-ND)

I-ND-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Devine, Timothy (I-TD)

-----Original Message-----
From: utility@sfei.org [mailto:utility@sfei.org]
Sent: Friday, April 13, 2018 7:46 AM
To: SBSP Question
Subject: An SBSP question or comment

First Name : Timothy
Last Name : Devine
Organization :
Street Address : 24702 Broadmore Ave.
Street Address2 :
City : Hayward
State : CA
Zip Code : 94544
Email : goosedevine@yahoo.com

This is regarding:
Habitat; Public Access and Recreation; Other

I-TD-1

Question or comment:
We have an opportunity to recover 2 iconic species to the Alameda Creek watershed: Coho Salmon and Steelhead Trout. Restoration of habitat and stream flows should be focused on saving these fish and allowing them to thrive. I believe these priorities should come before any other use of water from this Creek's watershed. Restoration is the number one priority. Thank you!

Response to Devine, Timothy (I-TD)

I-TD-1

See MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Galvan, Stonetree (I-SG)

From: stonetree galvan
To: phase2comments@southbayrestoration.org; senator@feinstein.senate.gov
Subject: [phase2comments] NEPA COMMENTS Eden Landing Phase 2 Draft Environmental Impact Statement/Report
Date: Monday, May 21, 2018 4:40:39 PM

To Whom It May Concern:

I-SG-1

1. Did you change the project boundaries from the Phase 1 project from which this project is tiered? If so please provide an analysis of the potential impacts of the affected areas that were excluded from or added to the new project boundaries?
2. The EIR/EIS suggests that recreational trails can only be completed on lands owned by the project, yet I have understood that the Cargill ponds are managed by CDFW, so what is the agreement for use of these private lands? Is hunting allowed on these lands, and by what agreement?
3. Is there an agreement in place to use Alameda County Flood Control facilities for recreational use? Will the project build and manage trails on these lands? Who will manage these trails?
4. Who maintains and manages the recreational facilities in the first phase of the Eden landing Restoration? After it was was completed, I could not go there for a year or more, as I recall. Since construction completion, how many days have these trails been closed, and why?
5. Will trailhead and parking facilities be provided at trail entry points?
6. Who will maintain and manage the new trail facilities? Is there an agreement in place for this? If there is no agreement for use by Alameda County, City of Hayward, Cargill or others, where will the recreational facilities be constructed to meet the project goal?
7. If CDFW manages the trails, how will they be managed to ensure they are kept open? Will CDFW manage the trails on Alameda County or Cargill property?
8. What commitment will the project make to ensure completion of a connected trail segment that connects to the existing Bay Trail at Alameda Creek Flood Control Channel at Ardenwood Blvd.?
9. The report identifies project options, but does not provide a recommended alternative. For recreational facilities, how will that be decided?
10. What percentage of the project construction budget has been allocated to recreation, one of the main project goals?
11. What percentage of Phase 2 land area will be committed to public access for recreational use?
12. Chapter 3.8 and Chapter 4: Land Use and Cumulative Effects. There is no discussion of recreation, public access, or other policies in these plans that relate to shoreline access. Please provide analysis of the policies in each of the general plans related to public access. Please include a discussion of relevant plans as they relate to shoreline access. I thought that some of these plans show a shoreline trail along old Alameda Creek.
13. All three of the options appear to preclude shoreline access to the Bay, as shown on the Bay Plan, Bay Trail Plan, and Alameda County Bicycle and Pedestrian Plans, part of the General Plans. What is the mitigation measure or environmental commitment to address these inconsistencies and help make the project ensure that maximum feasible shoreline access will be provided, and that the Bay Trail will be completed, as promised in the Phase I project.
14. Chapter 3.10. Please provide a discussion of public space as it relates to Environmental Justice.CItizens in this area. Do you think disadvantaged communities have been denied an opportunity to access the shoreline in this region, unlike similar areas on the

I-SG-1 (cont.)

west side of SF Bay. What amount of facilities will be provided to ensure access for healthy outdoor activities along the Bay, and that they will not be closed or degrade due to poor construction?

15. Chapter 5: Other NEPA Considerations. Is there a Park Closure Analysis? Closure of trails may affect the limited recreational facilities in this region.
16. What is the NEPA environmentally preferred alternative?

Response to Galvan, Stonetree (I-SG)

I-SG-1

1) The ELER Phase 2 project area is a subset of the overall SBSP Restoration Project area that focuses on the Phase 2 actions at Eden Landing. The project area also includes an offloader and slurry pipe system within the Bay, which is analyzed in the EIR. The regional setting provides information on a broader area extending beyond the immediate project vicinity. Indirect effects on a larger regional area (such as potential changes in flyover populations) are discussed under the specific resource topic.

2) Each of the trail route options analyzed in the EIR crosses over or includes areas that are owned or managed by others (such as the J-ponds) and would therefore require easements or agreements from outside parties. No arrangement exists between CDFW and Cargill regarding operations of Pond CP3C or any other pond. The lands that remain under Cargill ownership are not open to the general public.

3) An easement or an agreement with the ACFWCD would be developed prior to bridging the J-ponds and providing trail access over the 20-tide gate structure. See MCR 8, Maintenance Responsibilities, regarding local partnership for the long-term maintenance of trails, bridges, and viewing platforms (including signage, benches, etc.).

4) See MCR 8, Maintenance Responsibilities, regarding management of the Phase 1 trails. The trails and kayak launch completed as part of ELER Phase 1 were opened within a few months of their completion. The Phase 1 trails are closed to general use on waterfowl hunt days (currently 10 days per year) to ensure public safety.

5) As discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the preferred trail alignment is more of a through-trail used for longer hikes or bicycle rides to or from existing trailheads, and consequently there would be a reduced need for a new parking area. However, as part of ongoing operational activities at northern Eden Landing, CDFW could expand the parking area built near Phase 1 of the project to accommodate any additional demand by opening and improving the overflow parking area, as appropriate. Currently the lot occasionally fills only for brief periods on certain weekend days, particularly during special events. Weekend and peak demand will continue to be monitored at that site by CDFW, and the overflow area could be opened if significant new demand is supported.

6-7) See MCR 8, Maintenance Responsibilities, regarding local partnership for the long-term maintenance of trails, bridges, and viewing platforms.

8) A preferred trail alignment is selected in the Final EIR, CDFW would then need to approve the project with the selected trail alignment, design drawings would be further developed, project permits would be obtained, necessary easements or agreements would be obtained, design drawings and contractor specification would be finalized, and contractor bids would be solicited. Each of these permitting, design, and pre-construction elements would be required prior to construction of the public access trail through southern Eden Landing.

9) See MCR 7, Public Access Trails (Routes, Elevations, and Parking), for a description of how and why the preferred trail route was selected.

10-11) It would be difficult to allocate project construction costs between different resource areas, as levee improvements and other features can address multiple project goals. However, the import of materials for levee improvements and the construction of habitat transition zones represent one of the most substantial construction elements in the proposed project. With respect to land area, the levees that would support the public access trail also provide habitat separation. Although Phase 2 actions would provide public access to new areas within the ponds, it would not provide access to all the ponds, or all of the perimeter levees.

12) Clarifying text is included in Section 3.8.2 of the Final EIR to discuss shoreline and open space principles of the Alameda County General Plan as it relates to shoreline access. For a general description of the regulatory setting as it relates to recreation and public access, see Section 3.6.2 of the EIR. Note that Section 4.3 of the EIR discuss the effects of the incremental contribution from the project from the development of public access and trails in the context of other reasonably foreseeable projects in the project vicinity.

13) The three possible shoreline (Bay Trail) alignments adjacent to or through the area's wetlands are different from previous planning documents because they are based the restoration goals of the Project, conditions of the existing levees, and the need to avoid sensitive wildlife species. As discussed in Section 3.6.2 of the EIR, the Bay Trail Plan includes a shoreline spur to the Bay at OAC. However, as discussed in MCR 7, Public Access Trails (Routes, Elevations, and Parking), the action alternatives did not include a new trail all the way to San Francisco Bay along OAC because much of the necessary tidal exchange into the project site would come from OAC along the north perimeter of southern Eden Landing, through multiple breaches into OAC and levee lowering. Tidal exchange along OAC is required because the outer, bay-facing levee along Pond E1 and E2 would be improved and because only controlled openings into southern Eden Landing are possible on its southern boundary with the ACFCC. This makes it infeasible to place a trail to the Bay along that alignment. The SBSP Restoration Project proponents have been coordinating with local and regional agencies regarding these Phase 2 actions in southern Eden Landing.

14) See Section 3.10.3 of the EIR for a discussion of how new recreational and public access facilities, which would provide enhanced access to outdoor recreational activities and improve the "livability" for the local communities, could affect the lifestyles and social interactions for the communities near ELER. See also MCR 7, Public Access Trails (Routes, Elevations, and Parking), regarding the type and amount of public access facilities provided in the Preferred Alternative.

15) Phase 2 actions in ELER would not require the closure of an existing park. However, some trail segments may be affected during construction; for example, sections of the Alameda Creek Regional Trail would be closed during construction of a public access bridge over the ACFCC. Effects resulting from the temporary construction-related closure of adjacent public parks or other recreation facilities are discussed in Section 3.6.4 of the EIR.

16) See MCR 1, Selection of the Preferred Alternative, and Chapter 6 of the Final EIR, which identifies the Preferred Alternative (as well as the Environmentally Superior Alternative) for Phase 2 at Eden Landing. The federal lead agency will identify the Environmentally Preferred Alternative as part of its NEPA process.

Johnson, Ralph (I-RJ)

From: Ralph Johnson
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Draft Environmental Impact Statement/Report for Phase 2 alternative plans at the Eden Landing ponds.
Date: Tuesday, June 05, 2018 10:01:21 AM

Good morning,

I-RJ-1

I have two comments that are related to the flood protection aspects of the project:

- I prefer Alternative Eden B. From a flood protection perspective, an engineered levee may be needed in the future to protect the inland communities from tidal flooding or excessive Flood hazard Insurance. The levee alignment in this alternative is preferable because it has the best underlying soil material (it has a minimum of bay mud under its alignment) which will result in a lower overall cost to construct an engineered levee.
- I would encourage the project to explore trading either pond E4C or CP3C (assuming Cargill is willing to sell) with the Flood Control District for the "J" ponds. The "J" ponds receive storm water from Lines J2 and J3. Line J3 drains into the "J" ponds shown in the alternative. Line J2 drains into a ponding area immediately to the east of pond CP3C. and is not depicted in the alternative. The two ponding areas are joined together by a channel at the base of the old landfill and the only outlet for both ponding areas is into Alameda Creek from the J2 ponding area at a tide gate structure just to the east of Cal Hill. It would make sense to consolidate the ponding areas and make better use of the one existing outfall.

Thank you,

Ralph Johnson

--

Response to Johnson, Ralph (I-RJ)

I-RJ-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. The Preferred Alternative includes levee improvements at multiple locations (e.g., outboard, mid-complex, and backside levees). The backside levee would be an engineered structure, but it would not be a FEMA-accredited levee designed specifically for flood protection.

There are currently no agreements for land acquisition of Pond CP3C or for a trade between the J-ponds and Pond E4C. Such agreements would not be precluded due to Phase 2 actions at ELER.

Knopf, Clay (I-CK)

From: utility@sfei.org
To: SBSP Question
Subject: An SBSP question or comment
Date: Saturday, May 26, 2018 1:50:14 PM

First Name : clay
Last Name : knopf
Organization : THCGA
Street Address : 2313 S. Fork Rd
Street Address2 :
City : Twain Harte
State : CA
Zip Code : 95383
Email : clayk@att.net

This is regarding:
Habitat;

Question or comment:

I-CK-1 Dear Sirs,

I am writing to encourage your agency to adopt alternative "B" for the South Bay Salt Pond Restoration Project, to restore all eleven Southern Eden Landing phase 2 salt ponds to full tidal marsh in one stage. This is an excellent opportunity to improve functional habitat for anadramous fish, while reducing flood damage risk in lower Alameda Creek.

Please include maximum access points to restored wetlands from the Creek and Bay, including levee breaches wherever feasible.
I also support construction of a pilot channel for Steelhead passage between Alameda Creek and Bay Ponds E-2 and E-4.

I further support all feasible levee lowering and or breaching to increase hydrologic and fish habitat connectivity between stream channels and restored marshes. I encourage improvement and raising of the two miles of existing, Bay-facing levees of Ponds E-1 and E-2. This would allow for important sheltering of sensitive marsh habitats.

I thank you for considering the needs of threatened fish and wildlife populations while improving our human infrastructure. In the end the value of our culture relies on our ability to coexist with, and sustain a robust environment.

Sincerely, Clay Knopf

Response to Knopf, Clay (I-CK)

I-CK-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative.

Marshak, Bob (I-BM)

From: Bob Marshak
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Comments on Salt Pond Restoration Projects
Date: Tuesday, May 22, 2018 7:47:13 PM

I-BM-1 I want to express my support for the plan. Above all, I support the actions that would be beneficial to native fish and, ultimately, help our steelhead thrive.

I look forward to seeing the projects going forward.

Bob M

--
Bob Marshak
clickandcast@gmail.com

--
You received this message because you are subscribed to the Google Groups "Phase 2 Comments" group.
To unsubscribe from this group and stop receiving emails from it, send an email to phase2comments+unsubscribe@southbayrestoration.org.

Response to Marshak, Bob (I-BM)

I-BM-1

See MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Morelli, Leslie (I-LM)

From: rlmorelli@comcast.net
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] South Bay Salt Pond Restoration Project comments
Date: Thursday, April 12, 2018 9:45:37 PM

I-LM-1 I generally support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

I support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

I support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk.

I support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek.

I specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.

I support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

I support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish

Thank you for your consideration.

Sincerely,

Leslie Morelli

460 Center Street #6247

Moraga, CA 94570

Response to Morelli, Leslie (I-LM)

I-LM-1

See MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Nicholas, Myasha (I-MN)

From: m n
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Comments on Salt Ponds Restoration
Date: Saturday, May 26, 2018 8:06:38 PM

To whom it may concern,

I-MN-1 I am a long-time Union City resident, former employee of EBRPD and have worked at Coyote Hills Regional Park as a Naturalist/Park Interpreter for over 4 years. I am a strong supporter of the Salt Ponds Restoration project:

I generally support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage. Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead. I support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

Thank you very much for your consideration,

Myasha Nicholas

--

Response to Nicholas, Myasha (I-MN)

I-MN-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Phillips, Barbara (I-BP)

From: utility@sfei.org
To: SBSP Question
Subject: An SBSP question or comment
Date: Monday, May 14, 2018 10:33:25 PM

First Name : Barbara
Last Name : Phillips
Organization :
Street Address :
Street Address2 :
City : berkeley
State : ca
Zip Code : 94702
Email : etoilerb@pacbell.net

This is regarding:
Habitat;

I-BP-1

Question or comment:
support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

Response to Phillips, Barbara (I-BP)

I-BP-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Richardson, Matt (I-MR)

-----Original Message-----
From: utility@sfei.org [mailto:utility@sfei.org]
Sent: Friday, April 13, 2018 5:04 PM
To: SBSP Question
Subject: An SBSP question or comment

First Name : Matt
Last Name : Richardson
Organization :
Street Address : 1855 Green St
Street Address2 :
City : San Francisco
State : CA
Zip Code : 94123
Email : richardson034@gmail.com

This is regarding:
Habitat;

I-MR-1

Question or comment:
To Whom it May Concern,

I am a native to the Bay Area and really the Easy Bay. I enjoy the outdoors for its visual beauty but also for activities such as sailing, hiking and fly fishing.

We have done so much to interfere with our native trout and steelhead I really believe we need to do as much as we can to allow them to recover - bc they can.

I strongly encourage you to support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

My understanding is that Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile fish; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

In addition, I would encourage the construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk.

Thank you very much for the opportunity to provide public input!!
Regards,
Matt

Response to Richardson, Matt (I-MR)

I-MR-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Scordelis, Philip (I-PS)

From: "Pal Scor" via Phase 2 Comments
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] Alameda Creek
Date: Friday, May 18, 2018 8:19:17 AM

I-PS-1

I am a retired fisheries biologist whose career spanned 32 years. My first experience with Alameda Creek occurred in 1975 when my UC Berkeley ichthyology class taught by Professor George Barlow visited the creek to collect fish samples. I have followed the efforts to restore the creek for over 25 years now, and fully support all the proposals of the Alameda Creek Alliance:

For the restoration of Eden Landing salt ponds to tidal marsh, the most beneficial alternative for steelhead trout in Alameda Creek would be Alternative B, restoring the entire project area to tidal marsh in one stage by major levee alterations and improvement. Here is what the Alameda Creek Alliance supports:

- We generally support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

- Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

- We support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

- We support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk.

- We support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek.

- We specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.

- We support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

- We support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

Philip Scordelis
3218 Maria Court
Concord, CA 94518

Response to Scordelis, Philip (I-PS)

I-PS-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

Tepe, Alan (I-AT)

From: utility@sfei.org
To: SBSP Question
Subject: An SBSP question or comment
Date: Tuesday, June 05, 2018 3:27:48 PM

First Name : Alan
Last Name : Tepe
Organization : Mr
Street Address : 327 RIVERSIDE AVE
Street Address2 :
City : FREMONT
State : California
Zip Code : 94536-2920
Email : alan.tepe@gmail.com

This is regarding:
Habitat;

I-AT-1

Question or comment:
I support Salt Ponds Restoration Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh.

Response to Tepe, Alan (I-AT)

I-AT-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Thompson, Lawrence (I-LT)

From:	utility@sfei.org
To:	SBSP Question
Subject:	An SBSP question or comment
Date:	Saturday, April 21, 2018 1:14:45 PM

First Name : Lawrence
Last Name : Thompson
Organization :
Street Address : 1069 Felicia Ct.
Street Address2 :
City : Livermore
State : CA
Zip Code : 94550
Email : thompson14ster@gmail.com

This is regarding:
Habitat;

I-LT-1

Question or comment:
For the restoration of Eden Landing salt ponds to tidal marsh, the most beneficial alternative for Steelhead Trout in Alameda Creek would be: Alternative B, which restores the entire project area to tidal marsh in one stage by major levee alterations. Specifically, I support:

1. Alternative B, restoring of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh in one step. This approach will provide the most amount of habitat for juvenile salmonids
2. Breaching of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.
3. Constructing of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, I support a breach of the levee to improve fish access to and from the restored marsh, which I understand would not increase flooding risk.
4. Raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek.
5. Raising and improving approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This change would prevent wave over-topping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.
6. Lowering of all levees that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.
7. Making connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

Response to Thompson, Lawrence (I-LT)

I-LT-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

SV (I-SV)

-----Original Message-----
From: utility@sfei.org [mailto:utility@sfei.org]
Sent: Monday, April 16, 2018 3:43 PM
To: SBSP Question
Subject: An SBSP question or comment

First Name : s
Last Name : v
Organization :
Street Address : e castro valley blvd
Street Address2 :
City : castro valley
State : ca
Zip Code : 94552
Email : frognibble@yahoo.com

This is regarding:
Habitat;

I-SV-1

Question or comment:
Pertaining to the draft environmental review for the South Bay Salt Pond Restoration Project. The draft Environmental Impact Statement evaluates restoration alternatives for 2,270 acres of former salt ponds at Eden Landing, adjacent to the mouth of Alameda Creek. There are many project elements beneficial to native fish that are being considered - Please make these improvements. This is an opportunity to ensure that the restoration project connects Alameda Creek to beneficial nursery habitat for young fish in the restored salt marshes, so our steelhead can grow big before leaving for the Bay and ocean.
Sincerely,
SV

Response to SV (I-SV)

I-SV-1

See MCR 5, Fish Habitat Restoration, regarding the fisheries restoration features of the Preferred Alternative.

Woodcock, Charlene (I-CW)

From: Charlene Woodcock
To: phase2comments@southbayrestoration.org
Subject: [phase2comments] I support South Bay Salt Ponds Restoration Alternative B, restoring the entire project area to tidal marsh
Date: Friday, May 18, 2018 8:49:53 AM

I-CW-1 I wholeheartedly support the goals of the Alameda Creek Alliance. We want to restore the health of our fisheries and ecological balance to our natural environment.

- We generally support Alternative B, restoration of all 11 southern Eden Landing phase 2 salt ponds to full tidal marsh, in one stage.

- Fisheries experts recommended full tidal restoration since it will provide the most amount of habitat for juvenile salmonids; and suggest multiple points of access to restored wetlands from lower Alameda Creek, the Bay and Old Alameda Creek channel, to increase connectivity between fish habitats and reduce predation risk for steelhead.

- We support breaches of existing levees to provide maximum connectivity for fish from the Alameda Creek Flood Control Channel, the Bay and Old Alameda Creek channel to the restored wetlands.

- We support construction of a pilot channel to allow passage of steelhead from Alameda Creek into the Bay Ponds E2 and E4. Rather than a water control structure at this location, we support a breach of the levee to improve fish access to and from the restored marsh, which we understand would not increase flooding risk.

- We support raising any levees in the project area where required to manage flood risk, to safely allow maximum connection of tidal marshes to lower Alameda Creek.

- We specifically support the proposed raising and improvement of approximately 2 miles of the existing Bay-facing levees of Ponds E1 and E2. This would prevent wave overtopping and subsequent scour and erosion of the restoring marsh in the Bay Ponds behind it; provide a habitat transition zone; and could make it possible to breach more of the interior levees to improve fish movement.

- We support all feasible levee lowering that does not cause flooding risk, to increase hydraulic and fish connectivity between channels and marshes.

- We support connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells to allow for freshwater and brackish water inputs to restored marshes, to create water habitat transition zones beneficial to fish.

Thank you.

Charlene M. Woodcock
2355 Virginia Street
Berkeley CA 94709

--

Response to Woodcock, Charlene (I-CW)

I-CW-1

See MCR 1, Selection of the Preferred Alternative, regarding common components in Alternative Eden B and the Preferred Alternative. See also MCR 5, Fish Habitat Restoration, which provides a broad explanation of the types of fish habitat restoration and enhancements included in the Preferred Alternative and the pond's increased habitat connectivity to OAC and the ACFCC. Pilot channels, lowered levees at Ponds E1 and E2, and improvements to the bay-facing levee, are also included in the Preferred Alternative. The Inland Ponds (E5, E6, and E6C) are not planned for tidal restoration in the Preferred Alternative during the first phase of restoration because of the Project's need to balance multiple types of habitat restoration and enhancement actions. The long-term operation of those ponds as enhanced managed ponds may be necessary to achieve the full balance of the Project's intended ecological goals. Although connections to Union Sanitary District treated water and ACWD Aquifer Reclamation Program wells are not currently proposed, later connections by others would not be prevented by project actions.

2.3 Late Submissions

Comments from the organization that submitted a comment letter after the close of the comment period, and the responses to those comments, are presented in this section. The comment period was not extended for this organization, but their comments are provided here for completeness.

2.3.1 Organizations and Businesses

Sierra Club, San Francisco Bay (O-SC)

SIERRA CLUB
SAN FRANCISCO BAY
Serving Alameda, Contra Costa, Marin and San Francisco counties

Reply to: jewellspalding@mac.com

June 15, 2018

Via Email Only: phase2comments@southbayrestoration.org

Ms. Brenda Buxton
Deputy Project Manager,
Bay Conservancy Program State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, California 94612-1401

Ms. Anne Morkill, Project Leader
U.S. Fish and Wildlife Service
Don Edwards San Francisco Bay NWR
1 Marshlands Road
Fremont, California 94555

Re: Draft Environmental Impact Statement/Report (DEIS/DEIR):
Phase 2, Eden Landing Ecological Reserve Complex,
South Bay Salt Pond Restoration Project

Dear Ms. Buxton:

On behalf of the Southern Alameda County Group of the Sierra Club's San Francisco Bay Chapter, thank you for the opportunity to submit comments regarding the Eden Landing Phase 2 Draft Environmental Impact Statement/Report (DEIR). Further, thank you for extending our time to provide you with our comments. Below we reference the comments by Citizen's Committee to Complete the Refuge (CCCR), Audubon California, San Francisco Baykeeper and Ohlone Audubon Society collectively referred as CCCR.

Project Goal 1: Habitat

Both the CCCR and Alameda Creek Alliance (ACA) support the levee breach of the Alameda Creek Flood Control Channel into Bay Ponds E2 and E4 as proposed in Alternative B, with the latter organization emphasizing the maximization of connectivity for anadromous fish populations. If another Alternative is selected, this breach needs to be incorporated into that Alternative to achieve the minimal impacts of the overall project goals.

The CCCR also references multiple Phase 2 Impacts from Chapter 3 Section 5. We likewise point out that the EIR needs to address how habitat requirements for the number of types of observed bird species in Eden Landing Ecological Reserve (ESER) will be fulfilled with the restoration without causing population declines (i.e. minimizing competition for space and

2530 San Pablo Ave., Suite I, Berkeley, CA 94702 Tel. (510) 848-0800 Email: info@sfbaysc.org resources). In other words, an Alternative needs to be selected which allows for the greatest area of habitat, including nesting and foraging locations, for recorded species.

Project Goal 3: Public Access and Recreational Opportunities

A feature in the DEIR is the inclusion of and/or connectivity to the Bay Trail. While Alternative D includes "extending the Bay Trail spine through Southern Eden Landing," the DEIR states that each Alternative "includes extending the Bay Trail from existing trail in northern Eden Landing near the Eden Shores development to the southeast corner of Pond E6C." We support the incorporation of the Bay Trail completion for this area, but point out that any selected trail option be one of those that are the least environmentally impactful to habitat and wildlife. This includes that if a bridge was constructed across Alameda Creek to Coyote Hills Regional Park, it be the least environmentally damaging option to include only bicycles/pedestrians, and exclude any possibility to accommodate motor vehicles.

Closing Remarks

As monitoring is a major component of Phase 2 Alternatives, a stated long-term commitment to this monitoring, as well as seeking funds for further restoration, needs to be clearly stated to address any potential detrimental outcomes to habitat from the project.

We look forward to reviewing the responses to the submitted comments, and, ultimately, the successful restoration of this vital habitat.

Sincerely,

Jewell Spalding

Jewell Spalding, Chair
Southern Alameda County Group
San Francisco Bay Chapter, Sierra Club

cc: Chair & Director via email only

Response to Sierra Club, San Francisco Bay (O-SC)

Issues raised by these comments have already been addressed in previous responses. Responses to the Citizen's Committee to Complete the Refuge, CA Audubon, SF Baykeeper and Ohlone Audubon Society's comments can be found in Section 2.2.3 of this appendix. MCR 1, Selection of the Preferred Alternative, discusses the restoration components of the Preferred Alternative. MCR 7, Public Access Trails (Routes, Elevations, and Parking), discusses the preferred trail alignment through southern Eden Landing. Potential recreation-oriented impacts to sensitive species and their habitats are discussed in Section 3.5.3 of the EIR. The public access bridge over the ACFCC is included in the Preferred Alternative. Potential impacts of this feature were analyzed in the EIR under Alternative Eden C. Maintenance Responsibilities are discussed in MCR 8.

APPENDIX K

ADAPTIVE MANAGEMENT PLAN FOR SOUTH BAY SALT POND RESTORATION PROJECT

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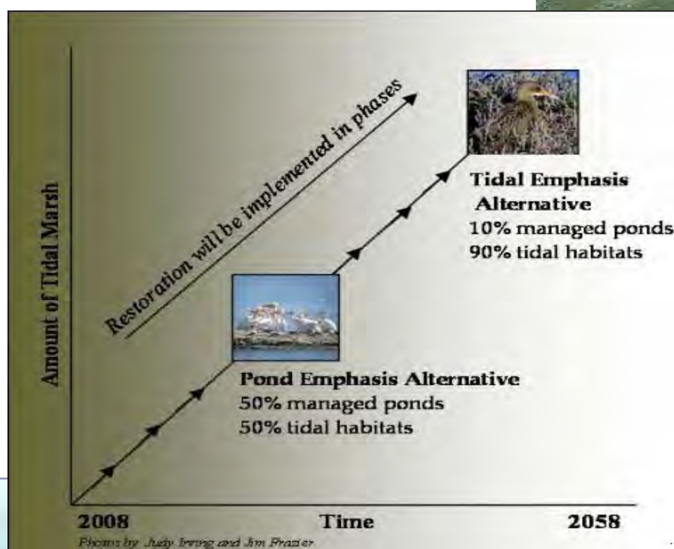
SOUTH BAY SALT POND RESTORATION PROJECT

ADAPTIVE MANAGEMENT PLAN



November 14, 2007
Science Team Report for the South Bay Salt Pond Restoration Project

Lead Author: Lynne Trulio
With Assistance from: Deborah Clark, Steve Ritchie, Amy Hutzel, and the Science Team

SOUTH BAY SALT POND RESTORATION PROJECT
ADMINISTRATIVE DRAFT ADAPTIVE MANAGEMENT PLAN

Table of Contents

SOUTH BAY SALT POND RESTORATION PROJECT
SCIENCE TEAM MEMBERS

Lynne Trulio, Lead Scientist	San Jose State University
John Callaway	University of San Francisco
Joshua Collins	San Francisco Estuary Institute
Edward Gross	Environmental Consultant
Bruce Herbold	US Environmental Protection Agency
Michael Josselyn	WRA, Inc.
Frederic Nichols	US Geological Survey (ret.)
Gillian O'Doherty	NOAA Restoration Center
David Schoellhamer	US Geological Survey
Cheryl Strong	San Francisco Bay Bird Observatory (now with USFWS)
Danielle LeFer	San Francisco Bay Bird Observatory
Lois Takahashi	University of California, Los Angeles
John Takekawa	US Geological Survey
Dilip Trivedi	Moffat and Nichol
Nils Warnock	PRBO Conservation Science

Executive Summary

This Adaptive Management Plan (AMP) is integral to the South Bay Salt Pond Restoration Project and is designed to help to guide the planning and implementation of each Project phase. Adaptive management provides a directed approach to achieving the Project Objectives through learning from restoration and management actions—actions for which many scientific and social uncertainties exist. The AMP lays out the background for adaptive management in Part 1, including the importance of adaptive management in the Project and how adaptive management will direct this long-term effort toward achieving the Project Objectives. Part 2 describes the foundations for adaptive management developed during the planning process, especially the key uncertainties, monitoring, applied studies, and modeling. The scientific approach to generating information and its use in decision-making for the long-term Project as well as the Phase 1 actions is described in Part 3. Part 4 discusses the institutional structures and processes for undertaking adaptive management. This AMP provides direction for the Project, especially Phase 1, based on the best current information. However, the Plan itself is designed to be adaptive and, therefore, many elements including the key uncertainties, applied studies, and the institutional structure may change and evolve over time.

In March 2003, state and federal agencies acquired 15,100 acres (>6100 hectares) of solar evaporation salt ponds in South San Francisco Bay from Cargill, Inc. These former salt ponds became the South Bay Salt Pond Restoration Project (the Project), which is managed collaboratively by the California State Coastal Conservancy (SCC), the U.S. Fish and Wildlife Service (FWS), and the California Department of Fish and Game (DFG). The Project is composed of three complexes; FWS owns and manages the Alviso and Ravenswood pond complexes and DFG owns and manages the Eden Landing pond complex. In 2003, the FWS and DFG began implementing the Initial Stewardship Plan (ISP), a management strategy to decouple the ponds from salt-making and prepare the ponds for restoration under the Project. From 2003-2007, the Project undertook a comprehensive planning process, in which the Project participants: 1. developed the Project's Objectives; 2. developed the scientific foundation; 3. engaged the public; 3. coordinated with the Army Corps of Engineers (ACOE) on the South San Francisco Bay Shoreline Study, a closely-related multi-objective study that includes the Project area; and 5. produced an EIS/R that evaluates the Project, as a whole, for 50 years as well as the Phase 1 actions, which are the first actions the Project Managers will implement as part of the 50-year program. The adaptive management approach described in this AMP is integrated into the *South Bay Salt Pond Restoration Project EIS/R.*

The overarching mission of the Project is the restoration and enhancement of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The six Project Objectives (Table 1, see page 3), based on this mission, are central to Project planning and implementation. While much is known about the South Bay ecosystem, the Project participants identified eight key uncertainties that could make meeting the Project Objectives difficult. These uncertainties included sediment dynamics, bird response to changing habitats, non-avian species responses, mercury issues, invasive and non-native species, water quality, public access and wildlife, and social dynamics. The overarching uncertainty of global climate change is incorporated, defacto, into each of the specific key uncertainties.

The Project participants developed a number of visions for what the restored ecosystem could look like in 50 years. In particular, the EIS/R for the Project evaluated three alternatives: "No Project" in which ISP management continues for 50 years, a 50% tidal:50% managed pond

alternative in which approximately 50% of the Project Area is returned to tidal action and 50% is managed as ponded habitat, and 90% tidal:10% managed pond. While NEPA may require the Project Managers to identify a "preferred alternative", the Project participants agree that, due to the many uncertainties, the mix of habitats that will optimally meet the Project Objectives—including the amount of tidal restoration and its location--cannot be predicted at this time. Given this, the Project will implement restoration and management in phases and will use adaptive management as the process for determining how far the system can move toward full tidal action and associated tidal habitats, while still meeting the Project Objectives.

For this Project to succeed, no phase can proceed without including adaptive management as an element of the design and implementation. The Adaptive Management Staircase in Figure 2 (see page 8) is a conceptual view of this process. Adaptive management will provide the information needed to determine how far to proceed along the staircase and at what pace. Implicit in the staircase and the Project's core mission is that the Project will continue to add tidal habitat to the system, so long as the other Project Objectives are met. Also implicit is the possibility, although unlikely, that the Project might stop adding tidal habitat before 50% of the Project Area is returned to tidal action, if substantial unanticipated problems are identified. However, taking that action would require a new NEPA/CEQA evaluation and reconsideration by all regulatory agencies.

The AMP describes how providing public access, one of the goals of the Project, is also subject to adaptive management. The Adaptive Management Approach for Recreation and Public Access (Figure 3, page 9) shows that the suite of public access features described in Phase 1 is the minimum level of public access the Project will provide. Whether additional recreation and access features are provided in the future will be determined through a process that weighs both effects of access on target species and public demand for particular features.

During the planning stage, the Project moved forward with monitoring, applied studies, and model development. Monitoring during Project planning began in 2003 and characterized baseline conditions in all 54 ponds as well as the associated sloughs, and, to some extent, the South Bay before and after ISP implementation. This program also included compliance monitoring, specifically to track water quality conditions before and after culverts connecting ponds to the Bay were opened for ISP operation. Applied studies were initiated during planning, including a research effort to establish baseline levels of mercury in indicator (sentinel) species, a study of the physical and vegetation changes in response to restored tidal actions at the Island Ponds, and studies of bird use of managed and unmanaged ponds. In addition, the Project developed two large-scale models to predict physical and biological changes in response to management, and tapped a team of modelers to begin developing a detailed predictive, landscape-scale model.

Adaptive management of the Project is based on restoration targets, monitoring, applied studies, and modeling that will be used to generate the science-based information managers will need for decision-making. Adaptive management begins with clear, measurable restoration targets that link directly to the Project Objectives. Appendix 3 lists 28 restoration targets for the Project, which should be monitored to determine if more tidal habitat will be restored, i.e., whether the Project will continue along the adaptive management staircase. Monitoring, using appropriate parameters, allows Project Managers to assess progress toward Project Objectives. The Project participants identified the most essential parameters and some potential methods for collecting the needed data. The monitoring parameters in Appendix 3 are all expected to be measured beginning with Phase 1. Applied studies are listed for each restoration target and, during Phase 1, they will provide data to reduce uncertainties related to achieving the Project Objectives. Each restoration target has a management trigger for action if the system is not performing well. For each management trigger there is a list of potential actions the Project Managers might take if a management trigger is reached.

Both simple and complex numerical models will be employed throughout the adaptive management process to integrate knowledge gained from monitoring and applied studies, allow improved interpretation and extrapolation of observed trends, test and refine hypotheses, and aid in identification of key uncertainties. While individual applied studies may contain some modeling aspects, the Project has need of an integrated model that simulates interactions among physical and biological processes. A successful model will integrate new information as it becomes available and will allow Project Managers to evaluate movement along the adaptive management staircase.

Phase 1 of the Project will be implemented beginning in 2008 and actions, including restoring tidal action to some ponds, managing other ponds, and integrating public access, are planned for each of the three pond complexes. In Phase 1, specific applied studies are coordinated with each restoration and management action and are designed to produce information to help manage the current Phase as well as plan up-coming phases of restoration. Studies in Phase 1 focus on bird response to changing habitats, mercury methylation, public access and wildlife interactions, and pond management effects on the Bay.

The Project will need an effective institutional structure to achieve these four basic adaptive management functions:

1. Generate and synthesize data from monitoring to track restoration progress and from applied studies and modeling to reduce key uncertainties;
2. Convert the synthesized data into effective short- and long-term management decisions;
3. Involve the public in decision-making and make management decisions transparent; and
4. Store and organize Project information for use by the decision-makers and the public.

The organizational structure that will be used to carry out these functions includes the Project Management Team (PMT), which is responsible for decision-making and taking action on those decisions, the Science Program, which will generate and interpret data, the Information Management Staff, which will organize, store and disseminate Project information, and the Stakeholder Forum plus Local Working Groups, which will provide perspectives from the public. The PMT will make decisions on what monitoring, applied studies, and modeling to fund; actions needed to modify current phases; and the design of future phases. In addition to decision-making, the PMT also has important fund-raising and public outreach functions. Regulatory and funding entities will be involved in the Project as members of the PMT, when appropriate.

The Science Program will be run by two science managers, who will be members of the PMT and will set the direction for and oversee the work of the Science Program. It is anticipated that an array of contractors will do the work required for the Science Program, including collecting and analyzing monitoring data, conducting applied studies, providing reports that analyze and synthesize monitoring and applied studies results, and peer-reviewing Program products and the Program itself. The science managers will use the information generated by the contractors to revise and prioritize monitoring and applied studies and to make recommendations to the full PMT on management actions for current phases and the design of future phases.

Public involvement as an especially important component of successful adaptive management. The public will have multiple avenues to learn about Project activities and provide input to the Project Managers, including through the website as well as Stakeholder Forum and Local Work Group meetings. Collaborative learning among scientists, managers, and the public, will allow for public comment and input on the decision-making process and ensure transparency through Project reporting.

Project participants will operate using processes that integrate their activities on a yearly and more frequent basis. The Project will use processes that coordinate Project participants for effective decision-making and restoration implementation. As with other aspects of the Project, the institutional structures and processes are designed to be flexible, allowing them to evolve to achieve effective adaptive management.

All Project reports mentioned in this document are available through the California State Coastal Conservancy, California Department of Fish and Game, Don Edwards San Francisco Bay National Wildlife Refuge or the Project's website (http://www.southbayrestoration.org).

PART 1. INTRODUCTION: Rationale for Adaptive Management

A. Purpose

This Adaptive Management Plan (AMP) is an integral part the South Bay Salt Pond Restoration Project implementation and provides a strategy for achieving the Project Objectives. Adaptive management provides a guided approach to learning from restoration and management actions—actions for which many scientific and social uncertainties exist. In Part 1, the AMP gives the rationale for adaptive management of the Project. Part 2 describes the monitoring, applied studies, and modeling conducted during planning, which laid the foundation for adaptive management of the Project. This work was used to develop a data collection approach based on restoration targets, monitoring, applied studies, and management targets, described in Part 3, that will provide data for management responses. Part 4 describes the institutional structures and processes by which Project Managers, scientists, and stakeholders will work together for effective adaptive management decision-making. This AMP provides direction for the Project, especially in Phase 1, based on the best current information. However, the Plan itself is designed to be adaptive and elements such as the key uncertainties, applied studies, and the institutional structure may change and evolve over time.

B. The Role of Adaptive Management

Project Background. In March 2003, state and federal agencies acquired 15,100 acres (>6100 hectares) of solar evaporation salt ponds in South San Francisco Bay from Cargill, Inc. This acquisition provides the opportunity to restore wetlands on a scale unprecedented on the west coast of North America. The South Bay Salt Pond Restoration Project (the Project) is managed collaboratively by the U.S. Fish and Wildlife Service (FWS), the California Department of Fish and Game (DFG), and the California State Coastal Conservancy (SCC). The overarching goal of the Project is the restoration and management of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The Project Management Team (PMT) and the Stakeholders developed six Project Objectives, based on this goal (Table 1).

The Project Area consists of 54 ponds ranging from 30 to 680 acres in size in three distinct pond complexes bordering South San Francisco Bay: the Alviso complex (7,997 acres in 25 ponds), the Eden Landing complex (5,450 acres in 22 ponds), and the Ravenswood complex (1,618 acres in 7 ponds) (Figure 1). The entire Project Area is surrounded by the highly urbanized landscape of the South Bay, also known as Silicon Valley. In 2005, according to the U.S. Census Bureau, over 3.8 million people lived in San Mateo, Santa Clara, and Alameda Counties (see http://quickfacts.census.gov/qfd/states/06000.html), the counties that border the three pond complexes. This urban landscape brings a significant human dimension to the Project. Project Objectives that focus on flood management, public access, mosquito control, and infrastructure protection attest to the importance of social factors in the Project.

The pond complexes consist primarily of former wetlands that were diked off from the Bay as early as the 1860s (Siegel and Bachand 2002). Creation of the levees, extensive urbanization, and other actions in the Project region had large effects on the ecosystem of the South San Francisco Bay (south of the San Bruno Shoal) including:

- the loss of at least 85% of historic tidal wetlands;
- changes in sediment dynamics;
- changes in freshwater flows;

- introduction of pollutants, especially mercury;
- changes in species composition and distribution, and
- significant population changes for a number of key species.

The restoration of substantial tidal habitat in the South Bay to reduce or reverse these impacts has long been a goal of the public and agencies (Habitat Goals 2000). However, complete restoration of tidal habitat to historic acreages would eliminate the salt ponds, which are now used for foraging, roosting and nesting by a wide variety of resident and migratory bird species. To maintain these species' presence in the South Bay, restoration and management of the Project Area must balance tidal habitat restoration with preservation of current habitat uses.

As a condition of the purchase, Cargill, Inc. was responsible for reducing pond salinity to the "transfer level", a condition set by the Regional Water Quality Control Board (RWQCB). Cargill, Inc. transferred the Eden Landing and Alviso ponds (except Ponds A22 and A23, which had not yet met the salinity transfer standard) to the DFG and FWS, respectively, between 2004 and 2005. Upon transfer, the agencies began to manage the ponds under a strategy called the Initial Stewardship Plan (ISP). The ISP is designed to control water salinities and maintain the ponds as independent systems that no longer make salt. In other words, the ISP decouples the ponds from salt making. ISP management produces low to moderate salinity ponds prepared for restoration or other management action as determined by the Project. Pond management under the ISP is described in the *South Bay Salt Ponds Initial Stewardship Plan* (Life Science 2003a, b). As a result of ISP management, pond conditions, especially salinity, have changed since the purchase. These changes have been monitored by the USGS, whose monitoring program is summarized in Part 2.

Much is known about the South Bay ecosystem (Goals Project 1999, 2000). On the landscape level, the EcoAtlas Baylands Maps provide excellent historical information on the extent, configuration and bathymetry of South Bay habitats in the 1800s (SFEI, 1998) and today (Collins and Grossinger, 2005). Current pollutant levels are under study (Davis, 2005) and the USGS has collected 30 years of data on the water quality, phytoplankton community, and pollutant levels in the South Bay (www.sfbay.wr.usgs.gov/access/wqdata/index.html). On the habitat scale, researchers have collected significant data on the evolution of restoring tidal habitat (Orr, et al., 2003), sediment dynamics (Schoellhamer et al., 2005), hydrodynamics, and tidal habitat community composition (Josselyn, 1983; PWA and Faber, 2004). Many species have received research attention, including the endangered California clapper rail (*Rallus longirostris obsoletus*) and salt marsh harvest mouse (*Reithrodontomys raviventris*), as well as invasive and non-native species (Josselyn, et al. 2005). The FWS has good data sets on winter waterfowl abundances and Point Reyes Bird Observatory (PRBO) has documented shorebird use of salt ponds and other South Bay habitats (Warnock, et al., 2002).

Despite the information available, a number of uncertainties and knowledge gaps exist that could inhibit the Project's potential to reach its Objectives. Monitoring and applied studies conducted during the Project's planning stage provided data on some of the uncertainties. However, all the uncertainties cannot be resolved before restoration starts. In fact, many data gaps can only be addressed by implementing restoration actions and learning from the results. Given this, the Project participants agreed that restoration and management should be implemented in phases and use adaptive management as the process for determining how far the system can move toward full tidal action and associated tidal habitats, while still meeting the Project Objectives.

Rationale for Adaptive Management. The process of learning by doing and then using the results to improve management actions is called *adaptive management* (Walters and Holling, 1990) and this process is a critical component of South Bay Salt Pond Restoration Project implementation. For this Project to meet its Objectives (Table 1), no phase can proceed without including adaptive management as a design and implementation element. Adaptive management is essential to keeping the Project on track toward its Objectives and is the primary tool identified in the *South Bay Salt Pond Restoration Project EIS/R* (2007) for avoiding significant impacts from the Project. The information produced through adaptive management will permit effective changes to current phases and assist in the design of future phases. If information is not collected and applied to management decisions, aspects of the Project will fail or *appear* to fail. Monitoring and applied study information will inform Project Managers as to whether the Project is meeting its Objectives and if not, whether problems are due to the Project or to forces beyond the Project's control. Without adaptive management, Project Managers will not understand the restored system nor will they be able to explain their management actions to the public. Ignorance of the ecosystem may jeopardize public support and funding for future phases and may result in significant negative impacts to the South Bay system and beyond.

Restoration practitioners have found that, because knowledge of natural and social systems is incomplete, systems will respond in unexpected ways. Surprises are also inherent in restoration because nature is variable and unpredictable, especially at large spatial scales and over long time frames. Adaptive management allows managers to prepare for and respond to novel events, from unexpected changes in dissolved oxygen levels to vandalism. When and where such events occur may not be predictable, but part of the adaptive approach is to anticipate the range of events and system responses that might occur and develop a process for dealing with them if they do happen. Monitoring and applied studies can help to prevent unintended consequences of the Project or, when they occur, can help to minimize any negative impacts and address them before they become substantial. Adaptive management allows the Project to move forward in light of regulatory requirements (NEPA, CEQA, FESA) by providing a process for preventing significant negative environmental impacts, to the greatest extent feasible.

This Project has multiple objectives and there may be trade-offs or costs as well as benefits. For example, the planning for this Project balanced the ecological benefits of tidal habitat restoration with the reduction of benefits that the salt ponds provide to some species. The Project also balances other goals such as amounts and locations of tidal restoration with required flood protection and public access with wildlife protection. Monitoring, applied studies, and modeling will help Project Managers understand the trade-offs and their social implications in order to make informed decisions.

TABLE 1. South Bay Salt Pond Restoration Project Objectives

Objective 1. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to:

A. Promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.
B. Maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees.

C. Support increased abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles and amphibians.

Objective 2. Maintain or improve existing levels of flood protection in the South Bay area.

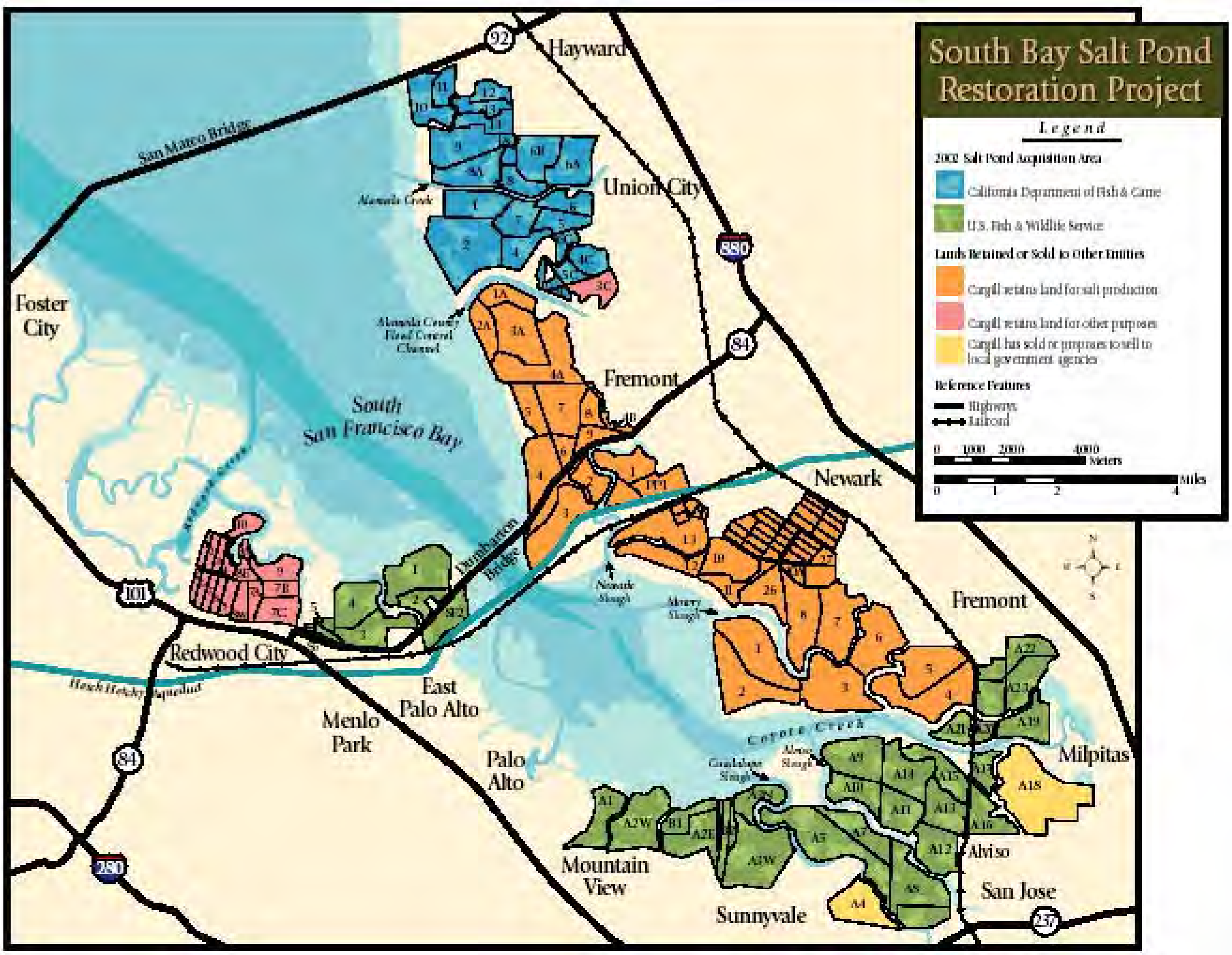
Objective 3. Provide public access opportunities compatible with wildlife and habitat goals.

Objective 4. Protect or improve existing levels of water and sediment quality in the South Bay and take into account ecological risks caused by restoration.

Objective 5. Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species and manage the spread of non-native invasive species.

Objective 6. Protect the services provided by existing infrastructure (e.g. power lines).

FIGURE 1. The South Bay Salt Pond Restoration Project Area.
Blue ponds are the Eden Landing complex owned by the DFG; green ponds from Mountain View to Fremont are the Alviso Complex and those in Menlo Park are the Ravenswood complex, all owned by FWS. Cargill, Inc. retains ownership of the pink ponds. The orange ponds are mostly owned by the FWS, but Cargill continues to make salt there under an easement agreement. Yellow ponds are in the ownership of local government agencies.



C. Adaptive Management Defined

Adaptive management for natural resources was first described by Holling (1978). While there are many current definitions of adaptive management, one of the most applicable to this Project comes from Jacobson (2003) who states, "Adaptive management is a cyclic, learning-oriented approach to the management of complex environmental systems that are characterized by high levels of uncertainty about system processes and the potential ecological, social and economic impacts of different management options. As a generic approach, adaptive management is characterized by management that monitors the results of policies and/or management actions, and integrates this new learning, adapting policy and management actions as necessary."

In an adaptive management approach, resource management and restoration policies are viewed as scientific experiments. This concept is important because the environmental outcomes of management policies are often uncertain. Adaptive management encourages an ecosystem–level approach to resource management and encourages close collaboration among scientists, managers, and other stakeholders on key policy decisions (Jacobson 2003). To be effective, decision-making processes must be flexible and designed to be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

Adaptive management is a "formal process for continually improving management policies and practices by learning from their outcomes" (Taylor et al. 1997) and it incorporates natural variability in evaluating the results of management actions. Effective adaptive management is not trial and error, which typically reflects an incomplete understanding of critical components of the system. It does not focus solely on tracking and reacting to the fast, immediate variables; this leads to perpetual reactive, crisis management. For fundamental change, adaptive management monitoring includes slow, driving variables. Light and Blann (2001) explain this approach by stating that, "adaptive management is a planned approach to reliably learn why policies (or critical components of policies) succeed or fail". Restoration fails when managers do not learn from actions and policies and, ultimately, miss restoration goals.

This Project will occur in phases over an expected 50-year implementation horizon. This Project's adaptive management approach will allow Project Managers to learn from their actions and will achieve these four functions:

1. Generate science-based information for managers;
2. Convert information into effective management decisions;
3. Involve the public to help provide management direction; and
4. Store and organize information for use by the decision-makers and the public.

To summarize the role of adaptive management in ecosystem restoration projects, the National Research Council (2003) has said, "The learning process that will guide the 'adaptive implementation' of the Restoration Plan will depend on a research strategy that effectively combines monitoring, modeling, and experimental research with a high level of attention to information management, data synthesis and periodic re-synthesis of information throughout the implementation and operation of the Restoration Plan." The National Research Council (2003) also notes that, "As with any long-term environmental project, but especially one committed to an adaptive approach, learning depends on the continuity of adequate funding." While this AMP does not specifically discuss sources of funding or funding mechanisms, the Project participants recognize this is a critical issue for the Project. Securing adequate, constant, long-term funding will be a primary activity of the Project Management Team throughout the life of the Project and its adaptive management.

D. Visions of South Bay Ecosystem Restoration

The Project's geographic scale, encompassing most of the "baylands" and associated species within the South Bay as well as the interconnectedness of all the components, makes this an ecosystem restoration project. An ecosystem is composed of interacting elements of the physical and biological world that produce large-scale processes. Carbon uptake and loss, energy exchange, nutrient cycling and the water balance are typical processes used to distinguish one ecosystem from another (Woodward 1994). Ecosystems have characteristic disturbance regimes, microclimates, successional processes, and species diversity and interactions that occur over the majority of the system (Woodward 1994). To promote a healthy ecosystem and to restore maximum ecological diversity, adaptive management information for the Project must include the entire South Bay ecosystem, the Bay itself, and factors beyond the Bay that are significant influences on South Bay conditions.

Ecosystem restoration is complex and scientific understanding of ecological systems is insufficient to the task of restoring fully-functional systems. There are major information gaps and poor predictive capabilities on long-term and large spatial scales. Given our incomplete knowledge, a basic goal of restoration is to manipulate the system as little as possible and allow natural processes to restore ecological structures and functions, to the greatest extent feasible (National Research Council, 1992). Allowing nature to do the work is often the most successful approach to restoration and in many cases requires less management and reduces project costs. However, the South Bay is a highly altered system in an urban setting; some Project Objectives may be reachable only through constant management. Adaptive management will be used to determine the minimum amount of human intervention needed. In addition, restoring sustainable habitats for rare and indicator species may require intervention that focuses on particular species, habitats, or habitat components. While species-specific management may be necessary, it should not replace the Project's ecosystem focus.

The Project participants conceived a range of visions for the restored ecosystem in 2050. Based on Project input, the Consultant Team evaluated a "No Project" scenario and two Project alternatives—50% tidal habitat:50% managed pond and 90% tidal habitat:10% managed pond—in the *South Bay Salt Pond Restoration Project EIS/R* (2007) for the NEPA/CEQA process (Figure 2). While NEPA may require the Project Managers to identify a "preferred alternative", the Project participants realize that, due to many uncertainties, the mix of habitats that will optimally meet the Project Objectives—including the amount of tidal restoration and its location--cannot be predicted at this time. Specifically, the Project's Science Team identified eight key uncertainties relative to the Project Objectives, which include sediment dynamics, water quality, bird response to changing habitats, mercury methylation, invasive and nuisance species issues, effects on non-avian species, public access and wildlife interactions and social dynamics (see Part 2, Section B). Given these uncertainties, the Project will use adaptive management as the process for determining how far the system can move toward restoring full tidal action and tidal habitats, while still meeting the Project Objectives. The visions for the 50-year landscape are arranged in Figure 2 along a gradient from the landscape with the most managed pond and least tidal habitat (Phase 1) to the system with the most tidal habitat.

The *South Bay Salt Pond Restoration Project EIS/R* (2007) describes the "No Project" alternative as one in which restoration is not implemented but, rather, the Project area is managed indefinitely under the ISP. Under this scenario, ponds would continue to be managed as they are under the ISP and the agencies would maintain critical levees for flood protection.

Other levees would fail, allowing some tidal habitat restoration. Public access features would not be implemented. They also analyzed a 50% tidal habitat:50% managed pond mix and a 90% tidal habitat:10% managed pond scenario. These two scenarios form the likely "bookends" for what the Project area would look like in 50 years. The EIS/R assumes that at least 50% of the Project area would be restored to tidal habitat, but recognizes that the final configuration at 50 years would be a tidal habitat/managed pond mix somewhere between 50:50 and 90:10, as depicted in Figure 2. The EIS/R used information from this AMP to describe how adaptive management will be used to determine the optimal mix of habitats and avoid significant environmental impacts and the AMP is included as an appendix to that document. In essence, the proposed 50-year program is an adaptive management approach to restoration.

In addition to habitat restoration, the EIS/R describes how the Project will meet the other two parts of its mission: preserving or improving on current levels of flood protection and providing high quality, wildlife-compatible public access. The flood protection strategy for the Project is integral to the restoration plan. It is a combination of three elements: 1) levees along the landward edges of ponds to prevent tidal flooding, 2) restoration of tidal habitats along sloughs to increase floodplain storage, and 3) restoration of tidal habitats along sloughs thereby increasing tidal exchange and slough scour for greater channel conveyance. For more detailed planning and implementation of restoration incorporating flood protection, the Project Managers are collaborating with the Army Corps of Engineers (Corps) on the South San Francisco Bay Shoreline Study. The Project Managers will work with the Corps to ensure flood protection is achieved, but adaptively managed as the Project progresses.

A program for high quality, diverse public access, including trails, overlooks, and interpretive features, will also be adaptively managed. Public access features are designed to meet wildlife compatibility requirements, based on current information. However, there is significant uncertainty about the effects of public access on sensitive species. Information from monitoring and applied studies will be used to adaptively manage public access based on: 1) public access effects on wildlife, and 2) public demand for access/recreation features. For example, wildlife managers currently assume that public access features, such as trails, will negatively affect California clapper rails and Western snowy plovers, which are listed species. Studies of trail effects on these species may confirm this suspicion, requiring protective measures; or data may refute this assumption, suggesting that agencies revisit the issue of public access adjacency to these species. Project Managers will also evaluate assumptions about what features the public wants and then adjust current and future Project actions to meet those desires, whenever possible. The Project's approach to adaptive management of public access is depicted in Figure 3, which shows that the public access features planned for the first phase of the Project are the minimum in public access the Project will provide. Whether additional recreation and access features are provided will be determined through a process that weighs both effects of access on target species and public demand for particular features.

Adaptive management will provide the information needed to determine how far to proceed along the tidal habitat staircase and at what pace; Project information may show that the Project should move more quickly or slowly along the staircase. Implicit in the adaptive management staircase and the Project's core mission is that the Project will continue to add tidal habitat to the system, so long as the other Project Objectives are achieved. It is also possible, although unlikely, that the Project Managers might stop adding tidal habitat before 50% of the Project area is returned to tidal action, if substantial problems are identified at that point. However, because the EIS/R evaluated the impacts of 50% tidal habitat as the minimum level of restoration, i.e. the lower "bookend", if Project Managers wish to restore less than that amount, they would need, at the very least, to revisit regulatory requirements with permitting agencies. For example, the FWS Endangered Species Office may undertake a jeopardy analysis for listed species.

In each Project phase, adaptive management will be most effective if Project Managers implement actions for which outcomes are most certain and include those actions that provide good opportunities to study uncertainties. In moving the Project along the adaptive management staircase (Figure 2), Project Managers should take care to avoid designing and implementing irreversible actions for which there is a moderate to high risk of not achieving Project Objectives, and they should avoid taking actions that preclude reaching more complete levels of tidal action. As Project Managers learn more about the system through adaptive management, more types of actions will become predictable and can be implemented.

FIGURE 2. Adaptive Management Staircase for Tidal Habitat Restoration
(MP=percent of managed ponded habitat; ISP=Initial Stewardship Plan)

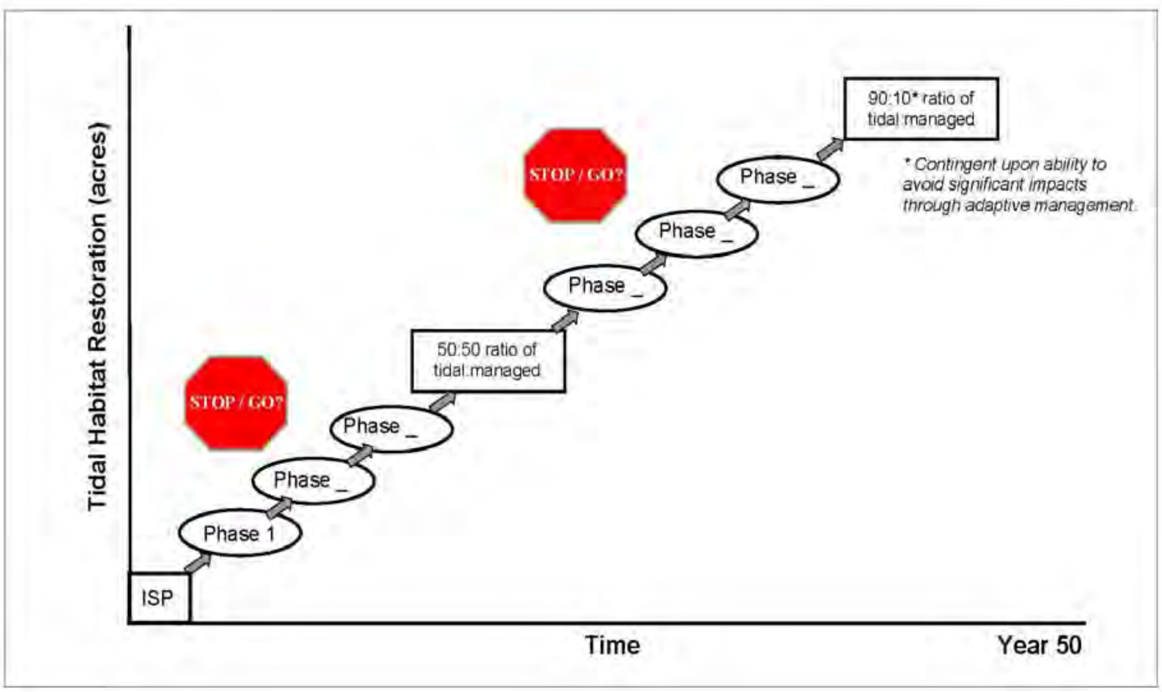
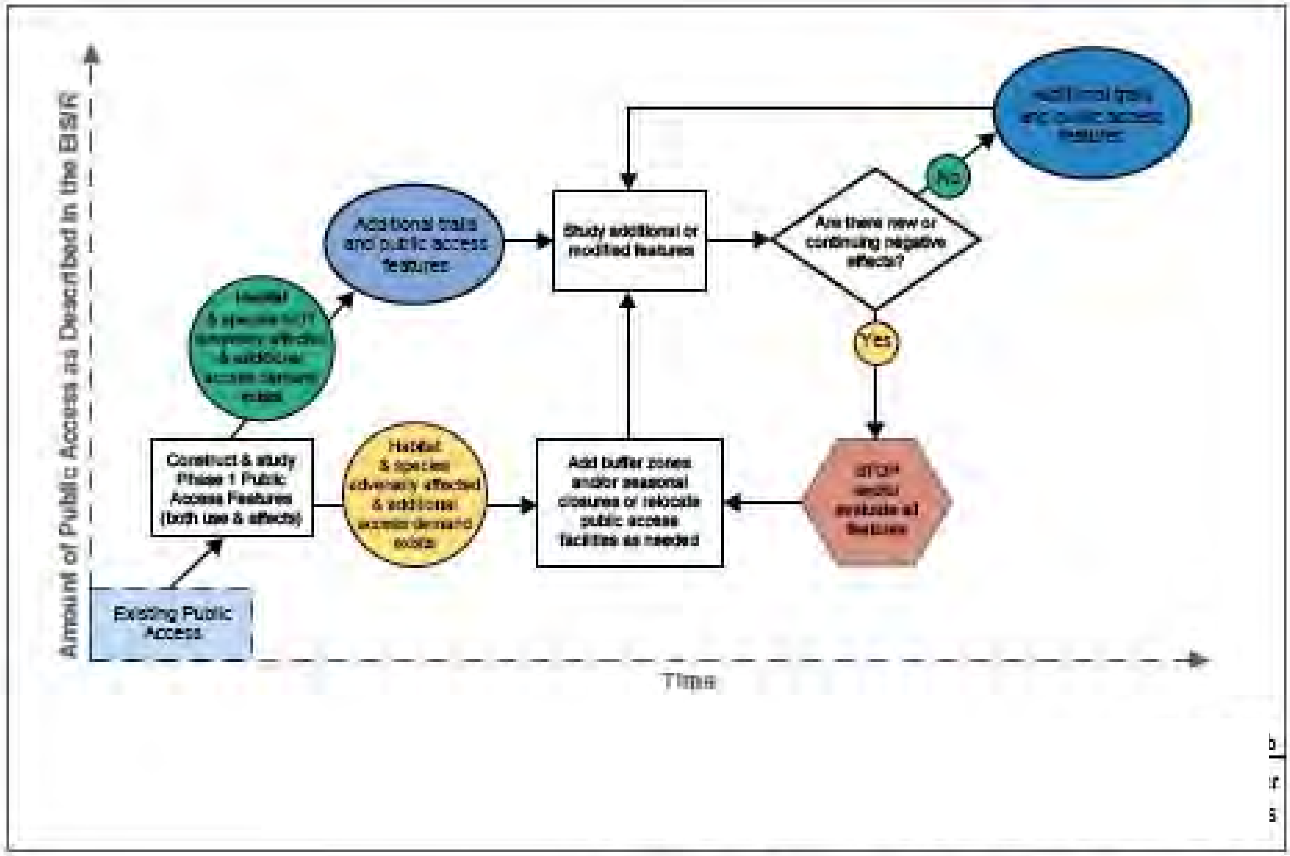


FIGURE 3. Adaptive Management Approach for Recreation and Public Access



PART 2. PLANNING: The Foundation for Adaptive Management

A. Key Uncertainties and Applied Studies

During the planning phase from 2003-2007, the Project participants worked together to lay the groundwork for adaptive management during Project implementation. The Science Team led the effort that developed the science foundation for the Project by writing a series of Science Syntheses (focused literature reviews), holding technical workshops on important Project issues, and identifying the Project's key uncertainties, which led to a list of applied studies for testing. The Project Management Team worked with USGS and the San Francisco Bay Bird Observatory (SFBBO) to develop a plan for baseline data collection that the USGS conducted for the Project. The Consultant Team developed significant amounts of information for the Project through its EIS/R research and, with review from some Science Team members, developed several large-scale predictive models. Given the uncertainties, the Project participants agreed that incorporating adaptive management into the Project was essential to success.

A primary task relevant to adaptive management was to determine where gaps in our knowledge about South Bay ecosystem functioning or restoration significantly hinder our ability to achieve the Project Objectives. The Science Team, with input from the other Project participants, identified the following list of key Project uncertainties:

- **Sediment dynamics**, especially the extent to which tidal habitat restoration might result in the loss of slough and Bay tidal mudflat habitat (links to Project Objective 1A and 1C).
- **Bird use of changing habitats**, especially the extent to which tidal habitat species can be recovered while maintaining the diversity and abundance of nesting and migratory waterbirds observed during pre-ISP conditions (links to Project Objective 1B).
- **Effects on non-avian species**, especially the extent to which restoration and management will affect fish and other critical species in the South Bay ecosystem (links to Project Objective 1C).
- **Mercury**, especially the extent to which Project restoration and management actions might result in an increase in bioavailable mercury in the food chain above pre-ISP levels (links to Project Objective 4).
- **Water quality**, especially the effects of pond management regimes on slough and Bay water quality and important species (links to Project Objective 4).
- **Invasive and nuisance species**, especially the invasive *Spartina* hybrids, red foxes, California gulls, and mosquitoes (links to Project Objective 5).
- **Public access and wildlife**, especially the extent to which various forms of public access and recreation can be integrated into the Project without significantly affecting wildlife (links to Project Objective 3).
- **Social dynamics**, especially the extent to which the local population in the South Bay will actively support the Restoration Project over time (links to all Project Objectives, but especially Project Objectives 2 and 3).

The Project's Science Syntheses (available from the managing agencies or on the Project website) provide more information on the connection between these uncertainties and the Project Objectives.

The Science Team then developed a list of the highest priority applied studies, to be researched through hypothesis testing and modeling, in order to reduce the eight key uncertainties. Table 2 lists the 21 applied studies questions and when research is expected to occur. Each of these questions will require multiple studies in order to develop adequate information for management. In addition, numerical modeling is essential to address questions and develop predictive power. Specifically, sediment dynamics questions, water quality, mercury transport, bird carrying capacity, and effects of human population dynamics all require modeling. Results from many of the applied studies and models are needed to proceed from Phase 1 into later phases. Appendix 1 describes the rationale for each most of the applied studies and gives likely hypotheses for testing or modeling, conceptual study designs, and management uses for the information. All applied studies research for this Project will undergo peer review an must employ well-designed, unbiased data collection and analysis methods, as accepted in their fields.

Several caveats about research are worth noting. First, some studies may require construction of features for isolating treatments or otherwise implementing the manipulation and may, in some cases, conflict with restoration goals (Walters, 1997). For example, providing tidal action into specific ponds to test mercury methylation may result in increased mercury in the system. Whenever possible, irreversible changes for study manipulations will be avoided. But, if they cannot, Project Managers will need to evaluate the trade-offs between the benefits the study provides and the costs to achieving a Project Objective. Second, although they are chosen to try to reduce unknowns and develop meaningful management information, some studies may not produce data that are immediately useful to the Project or may produce completely unexpected results. Project Managers will minimize these situations by regularly evaluating key uncertainties and *requiring that proposed studies link directly to management*. The Science Team during planning did an excellent job ??? of selecting the most critical uncertainties and studies.

It is absolutely critical, throughout the life of the Project, that the Project Managers and scientists continue to carefully select a targeted, short list of key applied studies for funding that are specifically linked to management needs and achieving the Project Objectives. Unless research needs are tightly defined, the Project can easily veer off in a direction of collecting large amounts of data that ultimately do little to help managers. This direction would be highly detrimental to the Project. Therefore, one of the most important on-going tasks of the science managers will be to tightly define the most critical applied studies and modeling efforts that provide the information managers need in a timely manner. The science managers will achieve this through regular review of the key uncertainties and applied studies, with direct input from the Project Managers.

During planning, the Project and other agencies initiated a number of applied studies to begin this component of adaptive management; they are listed in Table 3. Major study efforts included the research program developed by San Francisco Estuary Institute (SFEI), USGS, and the Santa Clara Valley Water District (SCVWD) to help establish baseline levels of mercury in indicator (sentinel) species and to assess whether restoring a managed pond, A8, to reversible muted tidal action will increase mercury levels in these species. The reversibility of this project will limit species' exposure. In addition, FWS and USGS undertook a multi-million dollar study of mercury levels in San Francisco Bay and Delta birds, funded through the CALFED process. This research included study of mercury levels in South Bay avocets, stilts, and terns. Another major research effort, this one funded by the Project, focused on the physical and vegetation changes at the Island Ponds, Ponds A19, A20, and A21, during the first year after they were breached. Research was initiated at these ponds just prior to breaching in March 2006. Other applied studies undertaken by PRBO Conservation Science (PRBO), San Francisco Bay Bird

Observatory (SFBBO), and San Jose State University (SJSU) focused on bird use of habitats and public access-wildlife interactions.

While each of the 21 applied studies is considered essential to reducing key uncertainties, studies should be sequenced in a way that takes advantage of ecosystem conditions as the Project progresses. Sequencing the studies ensures that critical path research is started when the timing is appropriate. From a funding standpoint, sequencing lists the studies that need to be funded immediately and those for which funding will not be needed until later. Appendix 2 gives the three-tiered approach and rationale for sequencing the studies that the Science Team identified during planning. Briefly, the three tiers are:

Sequence 1 includes studies to be implemented at the beginning of Phase 1 or before, either because they address a direct threat to our ability to achieve Project Objectives, because Phase 1 provides ideal conditions to study the question, or the findings are essential to implementing future actions. Studies focus on bird use of managed habitats, mercury methylation, pond management effects on the Bay, California gull impacts, public access and wildlife interactions, and assessing public support for the Project.

Sequence 2 includes studies to be initiated some time in Phase 1, but more fully in conjunction with future Project actions. Phase 1 conditions are not ideal for addressing these questions, but some data can begin to be collected in Phase 1. Studies focus on sediment dynamics in restored ponds and the Bay, *Spartina* and other invasive species, and boating effects on wildlife.

Sequence 3 includes studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected. Studies focus on tidal restoration effects on species, pond/panne habitat, costs/benefits of restoration on local communities, and effects of long-term population and demographic change.

TABLE 2. Key Scientific Uncertainties and Applied Studies

	Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.	**Where Studies are Planned**
	Sediment Dynamics. Is there sufficient sediment available in the South Bay to support marsh development without causing unacceptable impacts to existing habitats?	
1	**Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?** Sediment deposition has varied greatly over the last 150 years. Large-scale restoration occurring over decades will also affect sediment dynamics throughout the South Bay and regional study will be required to understand these changes.	Island Ponds, Phase 1 at A6 & E8A/9/8X
2	**Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay?** Sediment accretion into the restored ponds is expected to reduce the amount of mudflat in the South Bay, but it is not known whether mudflat loss will be significant in terms of acreage or its effect on South Bay ecology. Such changes are expected to occur over decades.	Phase 1 at A6, A8 & E8A/9/8X
3	**Will restoration activities always result in a net decrease in flood hazard?** Increased tidal prism will scour slough channels within a relative short time frame (months to years) and reduce flood hazard. Changes in tidal elevations and prism in sloughs occurring over months to years may potentially increase flood hazard.	Phase 1 at A6 & E8A/9/8X
	Bird Use of Changing Habitats. Can the existing number and diversity of migratory and breeding shorebirds and waterfowl be supported in a changing (reduced salt pond) habitat area?	
4	**Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?** Overall ecosystem changes and effects must be measured and compiled over decades to understand the overall implication of South Bay restoration on migratory birds. Some factors that could affect bird numbers are changes in disease and predation rates, food availability, and nest competition.	During and after Phase 1
5	**Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds?** Simple changes to existing pond management or simple habitat alteration may significantly benefit nesting snowy plovers while still providing nesting and foraging habitat for other species, but the extent of potential benefits is not known.	ISP at E6A, E6B, E8, & E16

<u>Key Uncertainties</u>, in italics, are followed by specific, high-priority <u>Applied Study Questions</u> (in bold) with a <u>brief explanation</u> of the importance of each question.		**Where Studies are Planned**
<u>Bird Use of Changing Habitats</u>. (continued)		
6	**Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?** Ponds managed as small-scale salt pond systems may provide enhanced benefits for wide range of birds. But, the extent to which they can improve the prey base and increase foraging shorebird densities in the short and long-term is not known.	Phase 1 at E12/13
7	**To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner?** Changing salt pond island configurations may result in significant increases in nesting and foraging bird densities but to what extent is not known.	Phase 1 at A16 & SF2
8	**Will pond and panne habitats in restoring tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?** Naturally-maintained pond and panne habitat within marshes could potentially provide significant habitat for many species that currently use ponds. But, little is known about the extent of potential benefits to waterbird species on short or long timescales.	Phase 1 at E8A/9/8X
9	**How do California clapper rails and/or other key tidal habitat species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?** Increased tidal habitat is expected to boost populations of California clapper rails and other key species, but the data on the conditions that produce high quality habitat for survival and reproduction are needed.	As appropriate habitat develops
<u>Effects on Non-Avian Species</u>. Can restoration actions be configured to maximize benefits to non-avian species both onsite and in adjacent waterways?		
10	**To what extent will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?** The extent to which restoring tidal habitats will affect native species, including steelhead, harbor seals, native fish and oysters, is unknown. This question requires long-term study on local and regional scales relevant to the species examined.	During and after Phase 1

Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.		Where Studies are Planned
Mercury. Will mercury be mobilized into the food web of the South Bay and beyond at a greater rate than prior to restoration?		
11	**Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species?** Restoration actions could increase the bioavailability of mercury in sediment and water. Bioavailable mercury becomes a problem when it leads to deleterious accumulation in wildlife and people. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this toxic pollutant.	ISP at A8 and Phase 1 at E8A/9/8X & A8
12	**Will pond management increase MeHg levels in ponds and pond-associated sentinel species?** Pond management could increase the bioavailability of mercury in sediment and water over pre-ISP conditions. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this pollutant.	Phase 1 as part of A8 study
Water quality: Will restoration adversely affect water quality and productivity?		
13	**What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal habitat restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay?** Pond management and resulting water discharges to the Bay have the potential to decrease slough and Bay water quality and affect Bay species, but little is known of the short or long-term effects of pond management on the South Bay ecosystem. Restoring tidal action to ponds will increase the tidal prism and tidal currents in South Bay. South Bay phytoplankton dynamics at the base of the food web are dependent on hydrodynamics and mixing.	Phase 1
Invasive and Nuisance Species. Can invasive and nuisance species such as Spartina alterniflora (or the invasive Spartina hybrid), corvids and the California gull and, if warranted, raptors such as the northern harrier, be controlled. I f not, how can the impacts of these species be reduced in future phases of the project?		
14	**Where not adequately eradicated, does invasive *Spartina* and hybrids significantly reduce aquatic species and shorebird uses?** The Invasive Spartina Project is a comprehensive program to control *Spartina alterniflora* hybrids to a level at which native species are not threatened. If this Project is not successful, this applied studies question would need investigation.	Depends on Invasive Spartina Project results
15	**Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds?** Data indicate that a number of native predatory species are increasing in population and are negatively affecting native breeding birds, but the extent of the impacts are not known.	Phase 1 at A6, A16, & SF2

	Key Uncertainties, in italics, are followed by specific, high-priority Applied Study Questions (in bold) with a brief explanation of the importance of each question.	Where Studies are Planned
	Public Access and Wildlife. Will trails and other public access features / activities have significant negative effects on wildlife species?	
16	**Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?** While there is a strong constituency for increased boating access, there is almost no information in the San Francisco Bay on the immediate or long-term effects of recreational boating on birds or other target species in different habitat types.	During and after Phase 1
17	**Will landside public access significantly affect birds or other target species on short or long timescales?** Information on the short and long-term effects of general and specific trail uses, such as dog walking, on birds and other key species in different habitat types (ponds, sloughs, tidal habitat) is mostly lacking, as is information on effective mitigation measures.	Phase 1 at E12/13, A16, & SF2
18	**Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?** The public's desire for recreational uses changes over time. Understanding and providing the opportunities people value, to the extent feasible, is essential for the Project engender stewardship and public support in the short and long-term.	Phase 1
	Social Dynamics. How can the Project gain support from the public now and into the future?	
19	**Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?** While the Project does not seem to generate opposition and habitat restoration seems popular in the Bay Area, there are factors that may impede public and political support, such as competing funding initiatives and very local community concerns.	Phase 1
20	**What are the benefits and costs associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?** Cities/municipal governments may worry about economic costs and benefits attributable to the Project that will spill over into jurisdictions, especially concentrated costs, but also benefits attributable to the Project. The project will also generate regional benefits (and perhaps costs).	During and after Phase 1
21	**Will impacts associated with population growth and development adjacent to the project sites and beyond be successfully managed over the long timescale at the regional scale?** Population growth, densification, and development in the South Bay and the region as a whole will affect the ability of adaptive management to reach the project objectives. There is some information on population growth, but little information on how the particular patterns of growth and development will affect the project sites.	During and after Phase 1

TABLE 3. Monitoring, Applied Studies, and Modeling during Project Planning

	Project or Study*	Funded By*	Funding Amount
	Monitoring Project		
1	Pond and Project Area Monitoring—USGS, J. Takekawa, D. Schoellhamer, B. Jaffe (2003-05)	Project	~$600K/year (2003-05) ~$350K/year (2005-06)
2	LIDAR Survey of South Bay--TerraPoint	Project	$178K
3	Bathymetric Survey of the South Bay--Sea Surveyor, Inc.	Project	$380K
4	Urban Levee Flood Management Requirements--Moffat and Nichol	Project	$300K
5	ISP Water Quality Monitoring--USGS, J. Takekawa	FWS and DFG	
6	ISP Mercury Monitoring—USGS, K. Miles (2005-06)	FWS and DFG	~$50K
	Applied Study		
1	Island Ponds initial physical and vegetation change—UC Berkeley, M. Stacey; USF, J. Callaway; SFSU, T. Parker *Applied Studies Question*: Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?	Project	~$100,000
2	Water Quality Data QC and Compilation—USGS, J. Cloern *Applied Study Question*: What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal habitat restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay?	USGS	In-kind
3	Pond A8/South Bay Mercury Study--SFEI, USGS, SCVWD *Applied Study Questions*: * Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? * Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	SCVWD, FWS, SFF, SCC, RMP	$750,000
4	Bird Diversity and Abundance on Newark Ponds—SFBBO *Applied Study Question*: Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?	SFF and FWS	$80K for 2 years

	Project or Study*	Funded By*	Funding Amount
5	Bird Use of Mature and Restored Marshes—PRBO *Applied Study Questions*: * Will pond and panne habitats in restored tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term? * How do California clapper rails and/or other key tidal habitat species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?	SFF	$60K for 2 years
6	Snowy Plover use of Managed Ponds; Harbor Seal Response to Watercraft; CA Gull Impacts to Nesting Birds—SJSU, L. Trulio *Applied Study Questions*: * Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds? * Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? * Will California gulls, ravens, and crows adversely affect (through predation and encroachment) nesting birds in managed ponds?	SJSU	In-kind
7	Hg in SF Bay-Delta Birds: Trophic pathways, bioaccumulations, and ecotoxicological risk to avian reproduction—USGS, J. Ackerman; FWS personnel *Applied Study Questions*: * Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? * Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	CALFED	$2 million total (not all in South Bay)
8	Native Oyster Establishment Study—Save the Bay, M. Latta *Applied Study Question*: Will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?	Save the Bay, NOAA, SJSU	
	Modeling Project		
1	Small and Large-Scale 3-D Integrative model	SCC	Approximately $3 million
2	South Bay Geomorphic Assessment—PWA	Project	
3	Habitat Conversion Model—PRBO	Project	$215K
4	NOAA/URS Fish Model	NOAA Fisheries	In-kind

* Acronyms: FWS=US Fish and Wildlife Service; DFG=California Department of Fish and Game; SCVWD=Santa Clara Valley Water District; SFF=San Francisco Foundation; SCC=Coastal Conservancy; SJSU=San Jose State University

B. Baseline Monitoring

Data Collection. Monitoring during Project planning began in 2003 to characterize conditions in the ponds, sloughs, and, to some extent, the Bay before and after ISP implementation (Table 3). This extensive monitoring effort provided both baseline data and a foundation for long-term, adaptive management monitoring. Reports are available through the California State Coastal Conservancy, California Department of Fish and Game, Don Edwards National Wildlife Refuge, or the Project's website (http://www.southbayrestoration.org).

USGS was contracted to do intensive and wide-spread baseline monitoring. USGS staff collected data on all 54 ponds and the data set from 2003-2005 included these parameters:

- bathymetry (depth and topography) of the ponds, sloughs, and South Bay;
- monthly bird abundance and diversity in the ponds;
- water salinity, pH, temperature, turbidity, DO, nitrogen (NH_4-N and NO_3-N), total and soluable phosphorus, and sulfur concentrations;
- chlorophyll 'a' (primary productivity);
- sediment salt content, particle size, and bulk density;
- invertebrate composition in sediment cores and from the water column (collected once);
- monthly fish abundance and diversity, and habitat characteristics at capture locations;
- Hg and MeHg levels in sediment in the Alviso and Eden Landing ponds, MeHg levels in invertebrates; bacteria community analysis at high and low MeHg production sites in Eden Landing ponds.

In 2005-2006, the USGS continued data collection at the 54 ponds with these exceptions:

1. No collection of benthic organisms;
2. No fish collection in ponds;
3. Bi-monthly bird surveys on all ponds, instead of monthly; and
4. Bi-monthly bird surveys on tidal flats in the Bay and sloughs were added.

In addition to pond bathymetry, bathymetry of the tidal flats and topography of levees was measured by LiDAR; subtidal bathymetry with some sediment surface classification was collected by Sea Surveyor, Inc. In fall 2005, SFBBO began a two-year study of bird use of the Refuge ponds in the South Bay that are still operated by Cargill for salt production. These data add to the baseline information on bird use of South Bay habitats.

Little data on pond conditions prior to the acquisition in 2003 were collected, although USGS collected data from 2001-2003 on selected Alviso salt ponds regarding water quality, nutrient concentrations, the structure of pelagic and benthic invertebrate communities, and waterbird abundance and distribution. Other information on South Bay conditions prior to the acquisition have been collected over the years by many different groups and agencies. There are many USGS reports (including those from 30-year monitoring programs), SFEI reports such as those for the Regional Monitoring Program and the EcoAtlas, agency monitoring programs (DFG South Bay fish monitoring), and graduate student theses. Some of these data were useful in planning and may be valuable in the future.

One source of multi-source data is the comprehensive catalog of water quality data sets compiled by the USGS (accurate through October 2006). South Bay Salt Pond Restoration Program Water Quality Data Inventory is an overview of the water quality information--chemical, physical, and biological—collected by many groups in and around South San Francisco Bay and the salt ponds. This Inventory is designed to help Project participants and other researchers find water quality data sets and ancillary environmental information from other groups working in the region (see http://www.southbayrestoration.org).

Pond Conditions. Data from the Project's monitoring efforts showed that pond conditions changed during the 2003 to 2005 monitoring period compared to conditions during Cargill's salt pond operation. During 2003 to 2004, Cargill reduced pond salinities to meet the transfer standard. In 2004, water control structures (gated culverts) were installed in Ponds A1 through A3W (Charleston Slough to Guadalupe Slough) in the Alviso complex and, in July 2004, the culverts were opened allowing Bay waters to flow into these ponds for the first time in many decades. Gated culverts were installed and opened to the Bay in 2004 in Ponds B2 and B10 at Eden Landing and in 2005 at Ponds A5 through A17 (Guadalupe Slough to Coyote Creek) in the Alviso complex. Then, in March 2006, the three Island Ponds, between Coyote Creek and Mud Slough, were opened to unrestricted tidal action. Thus, the monitoring that began in 2003 occurred when Cargill was reducing salinities and included approximately a year of data before ISP operation began in 2004.

The USGS summarized its data on water quality, water and sediment mercury levels, biotics, and bathymetry, for use during planning. Initial data showed some interesting findings. In the first migratory season after the ISP was implemented, shorebird numbers increased at both the Eden Landing and Alviso Complexes by at least 100% from pre-ISP conditions (Takekawa pers. comm.). FWS data for waterfowl showed similar increases in the Alviso complex (Morris pers. comm.). However, in the Eden Landing complex, water level draw-downs reduced habitat and bird use by piscivores, diving ducks, and grebes substantially from pre-ISP levels. Continued monitoring will determine whether these changes actually resulted from changing pond conditions as a result of the ISP or from inter-annual variation, and whether species responses will continue over time.

The USGS also conducted compliance monitoring, specifically to track water quality conditions before and after culverts were opened for ISP operation. One year of monitoring has shown that salinity, which Project Managers worried would not meet requirements set by the Regional Water Quality Control Board (RWQCB), has not been a problem. However, low dissolved oxygen (DO) levels, which were anticipated to a degree, have plagued a number of ponds during the summers of 2004 and 2005. These early findings show that management actions in the Project area are already causing changes in the system, some of which are not easily predictable and require study to fully understand.

C. Modeling During Planning

Models that integrate data and are able to predict system response to management actions will be invaluable to Project Managers as they deal with changing conditions and design future phases. During planning, several modeling approaches were developed to help predict changes to the system (Table 3). Philip Williams and Associates used the South Bay Geomorphic Assessment to predict large-scale habitat changes under various restoration scenarios. This general model used existing information on pond, slough and Bay bathymetry, sediment/hydrodynamics, sediment accretion rates, and a number of other factors to predict tidal habitat evolution and habitat acreages under different tidal habitat to pond ratios. Estimates of sea level rise, based on the predictions from the Intergovernmental Panel on Climate Change that were available during model development, were included in the South Bay Geomorphic Assessment to assess whether sediment accretion in restoring marshes would keep pace with sea-level rise due to global climate change. The results of this assessment were used in the EIS/R to evaluate the impacts of the “No Project”, 50% tidal:50% managed pond, and 90% tidal:10% managed pond alternatives. The Consultant Team also conducted hydrodynamic modeling, coastal flooding analyses and fluvial flooding analyses to further evaluate the three scenarios for the EIS/R.

A second model set, the Habitat Conversion Model, was developed by PRBO to predict bird population response to the restoration alternatives. Using the habitat change results predicted by the South Bay Geomorphic Assessment, PRBO used its model to estimate how bird populations currently using the South Bay might change in response to different tidal to pond ratios. These results were also used in the EIS/R to evaluate the impacts of different alternatives. The model will continue to be refined and used in the future as part of the monitoring analysis for migratory waterbirds.

Formal and informal reviews of these models by other scientists revealed limitations in their predictive power. The time line for Project planning did not allow further refinement of these models before implementation. Thus, model refinement and development will be part of long-term adaptive management. In particular, the Project is in need of modeling tools for predicting large-scale and long-term geomorphic and ecological changes to the system. While some tools do exist in the public domain, a concerted research effort is needed to identify and adapt an appropriate model to the South Bay system. For the long-term success of this Project, a 3-D model that integrates key physical parameters over small and large-scales and multiple timescales is needed to predict sediment dynamics, contaminant transport, salinity gradients and other factors in response to management actions and to external factors such as climate change. A research team associated with the Project developed a proposal for this type of model and the Project sought funding for it (Appendix 1). Research at the Island Ponds initiated during planning produced data and small-scale modeling that will be used as inputs into the larger model.

The uses of landscape-scale predictive models are varied:

1. To forecast the response of the system and parts of the system to different restoration and/or management actions, and thereby function as a design tool;

2. To predict certain types of conditions, such as low dissolved oxygen areas; for example, models can be used to identify areas of the Project that are likely to have problems meeting water quality requirements;

3. To indicate where applied studies are needed by showing key gaps in knowledge of the system;

4. To inform monitoring programs and allow spatial and temporal interpolation among monitoring data;

5. To explain trends and act as a diagnostic tool to determine system response to hypothetical cases or alternative scenarios. For example, if *Spartina alterniflora* hybrids cannot be controlled and studies indicate this invader will have a significant effect on the South Bay ecosystem, then modeling alternative scenarios will be required to predict ecosystem response to this new state and predict how the system might respond to new management actions; and

6. To provide the public with real-time information and analysis of system conditions.

All of these uses will help Project Managers adaptively manage the South Bay while allowing the public and researchers access to Project information.

D. Conceptual Models Illustrating Adaptive Management

During the planning process, the Project participants learned that some aspects of the South Bay ecosystem are fairly well understood and the outcomes of management actions for these parts of the system are relatively certain. For example, there are good data for the rate of marsh development in South Bay marshes. Tracking relatively predictable restoration responses requires one data collection approach, while reducing uncertainty in restoration outcomes requires another. Predictable outcomes are assessed through monitoring, which is repeated data collection to assess system progress. Monitoring tracks system responses through time to allow Project Managers to assess whether expected changes are, in fact, occurring. Uncertainties are reduced through applied studies (Table 2), in which hypotheses are tested to develop cause-and-effect knowledge about the environment.

The relationship between monitoring and applied studies in the South Bay Salt Pond Restoration Project is depicted in Figures 4-6 using conceptual models that illustrate ecosystem processes and outcomes. These figures are based on conceptual models, for tidal habitat, managed pond, and landscape levels, described in the *South Bay Salt Pond Restoration Project Conceptual Models* (Trulio, et al. 2004). These conceptual models link different restoration and management actions to anticipated responses in the South Bay ponds and the overall ecosystem.

In Figures 4-6, current conditions under ISP management are changed through the Project's management and restoration actions ("Project Actions"), and these actions result in expected, and desired, effects on the system ("Results"). Monitoring topics are aspects of the environment that the Project will measure to assess progress toward the desired "results" and detect possible problems. The applied studies are questions whose answers will help reduce uncertainty in reaching the "results". Look along the top of the figures to see the changes the Project expects to occur and will monitor at tidal habitat, pond, and landscape levels. Actual changes will be compared to the expected results to assess restoration progress. Along the bottom of each diagram are corresponding lists of applied study questions that will be answered to reduce uncertainty and offer insight into why the system is responding in a particular way. A complete listing of all the monitoring parameters, applied studies, and modeling that the Project plans to undertake is found in Part 3 and Appendix 3, the Adaptive Management Summary Table.

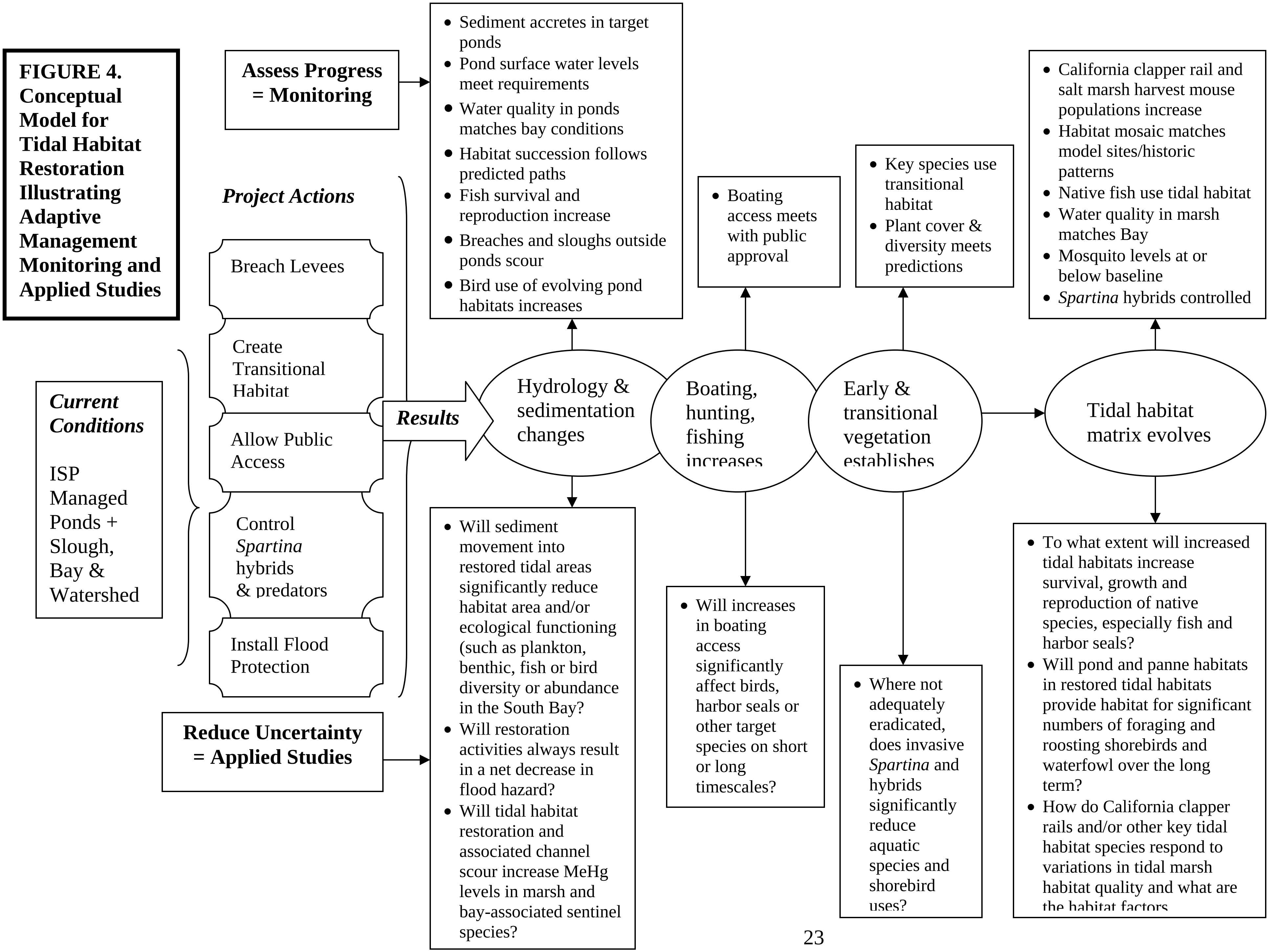


FIGURE 4. Conceptual Model for Tidal Habitat Restoration Illustrating Adaptive Management Monitoring and Applied Studies

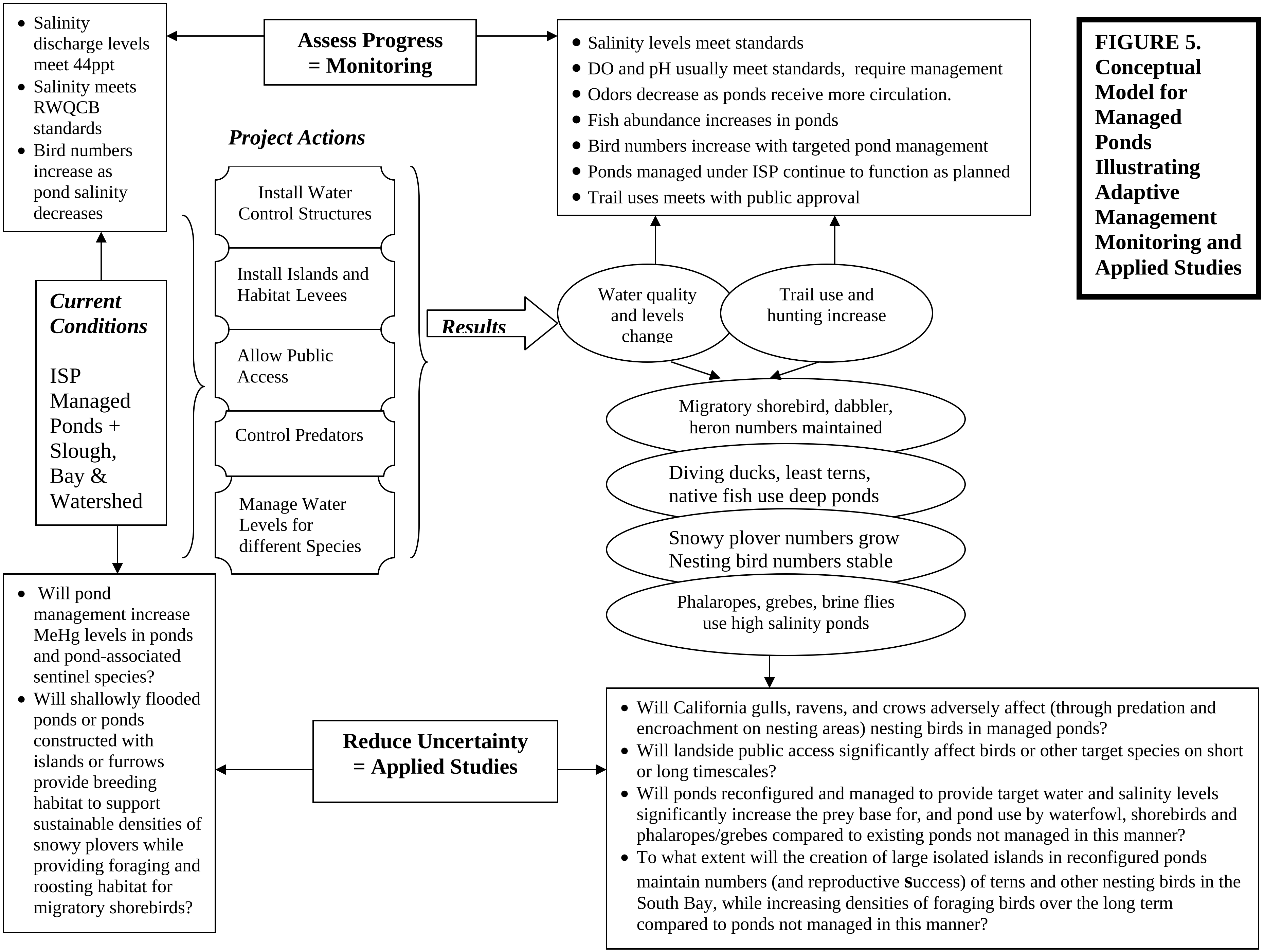


FIGURE 5. Conceptual Model for Managed Ponds Illustrating Adaptive Management Monitoring and Applied Studies

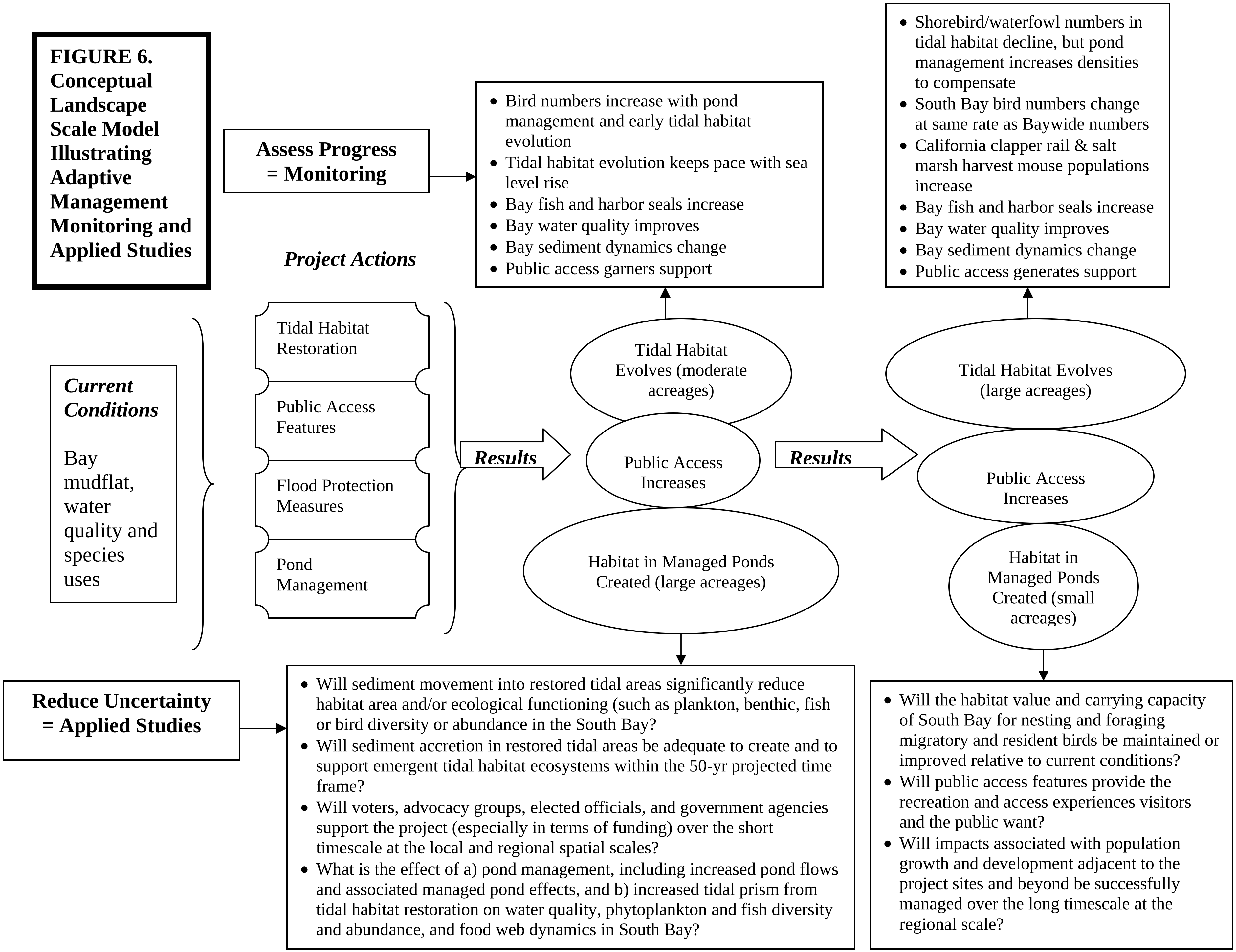


FIGURE 6. Conceptual Landscape Scale Model Illustrating Adaptive Management Monitoring and Applied Studies

Part 3. IMPLEMENTATION SCIENCE: Information for Decision-Making

A. Elements of Adaptive Management Science

Work done during the planning phase established the foundation for the adaptive management data collection and analysis approach described here. This section describes the scientific approach--based on restoration targets, monitoring, applied studies, and modeling--for providing the information that managers will need for decision-making. Appendix 3, the Adaptive Management Summary Table, integrates data collection and management, and ties them to the Project Objectives.

This adaptive management approach begins with a limited set of quantitative restoration targets for the Project Objectives that allow restoration progress to be tracked. We chose only targets that must be assessed to determine whether or not Project Managers can implement more tidal action while continuing to achieve the Project Objectives, in other words whether the Project can move further along the adaptive management staircase depicted in Figure 2. Thus, benefits or impacts from the Project that would not affect the decision to add more tidal habitat are not included. This restriction is important. While there are many factors that could be monitored, a feasible monitoring program can include only the most critical elements.

In Phase 1, Project Managers expect to implement all the monitoring and applied studies listed in the Adaptive Management Summary Table in Appendix 3. However, parameters will be monitored with different levels of effort based on management needs. While all applied studies in the Table will be undertaken, complete results to some questions, especially sediment dynamics, may not be possible until other action, such as restoration of more acres to tidal action, is initiated. The Adaptive Management Summary Table links the data collection needed for adaptive management with decision-making. Here is a summary of the role of each column in the Table:

Category. Categories are the basic elements of the ecosystem that must be monitored to determine whether the Project Objectives are being met or are likely to be met in the future and, therefore, whether the Project can move forward with more tidal restoration. The applicable Project Objectives are listed for each category.

Restoration Target. Each restoration target is a direct measure of a Category and each gives measurable goals for what the Project should achieve to successfully meet each of the Project Objectives. Typical data sources for developing these targets are the literature, quantitative baseline data (such as that collected by USGS, PRBO or SFBBO), or requirements set by a regulatory agency, such as standards for dissolved oxygen levels or population levels for California clapper rail recovery. Targets include both long-term goals (50-year horizon) and intermediate conditions as the ecosystem changes. Restoration targets are expected to evolve as more information about the system is collected.

Monitoring Parameter. The Project participants chose monitoring parameters they believe are the most effective and efficient way to assess change with respect to the restoration targets. This column gives the variables to be measured and a basic monitoring approach. Specific methods are given only when needed to make the approach clear. The parameter, method, spatial scale, and timing of monitoring must be adequate to detect change. For example, the first restoration target under sediment dynamics is “no significant decrease in South Bay intertidal and subtidal habitat". Assessing this target requires calculating the areas of restored pond, outboard mudflat, and subtidal shallows. A combination of monitoring methods might be used, such as: 1) bathymetry and LiDAR survey every 5 years; 2) survey of sediment accumulation annually in ponds opened to tidal action; and 3) a limited number of localized bathymetry surveys in certain priority areas. This column lists appropriate monitoring parameters, but cannot fully describe the monitoring regime. A monitoring plan—giving methods, protocols, timing and responsible parties—will be developed by the Project for implementation in Phase 1.

Spatial Scale for Monitoring Results. This column gives the spatial scale at which monitoring should occur to detect results usable by Project Managers.

Expected Time frame for Decision-making. This is the time frame in which change could realistically be detected leading to management actions to adjust the restoration actions.

Management Trigger. While the restoration targets identify the desired outcomes relative to the Project Objectives, the management triggers identify the point at which technical analysts believe the system may not be performing as expected, i.e., potentially moving away from achieving a restoration target. At this point, Project Managers should evaluate the status of the Project and consider management actions. Triggers have been set intentionally at a low threshold to ensure early evaluation and potential action, rather than waiting until substantial problems have developed. The threshold is also designed to avoid significant environmental impacts as identified in the *South Bay Salt Pond Restoration Project EIS/R* (2007).

Applied Studies. The relevant Applied Studies from Table 2 are listed for each restoration target. Descriptions of each applied study appear in Appendix 1.

Potential Management Actions. In the event that a management trigger is tripped, the Project Management Team will need to take action based on the available information. This column lists typical classes of management actions available to Project Managers and some examples of those actions. The exact management action will depend on the nature of the problem and the appropriate remedies available. Typically, the first management action will be to conduct a thorough review of the available information that can inform management on the trigger. Often, Project Managers will ask experts, both associated with and external to the Project, to analyze the relevant information and provide a range of appropriate management actions, including their risks and costs.

B. Linking Science-generated Information

Restoration Targets. The Project's restoration targets, monitoring, applied studies, and modeling are integrated to generate the scientific information managers need for decision-making. In a nutshell, adaptive management relies on clear, measurable restoration targets that directly track the Project Objectives; monitoring is used to assess progress toward those targets; applied studies help Project Managers understand why the system is performing the way it is, relative to the targets, and help reduce uncertainty; modeling is used to try to predict the effects of management actions and to integrate and analyze information for analysis.

The Society of Wetland Scientists (2003) recommends that restoration planning materials clearly state science-based restoration targets (also known as success criteria or performance standards) that are indicators of habitat structure and function. These targets should be "measurable attributes of restored or created wetlands that, when measured over an appropriate period, can be used to judge whether project objectives have been met" (Society of Wetland Scientists, 2003). Typically, they are quantitative benchmarks that are used for measuring progress toward restoration objectives and for determining when the system is diverging from the desired restoration trajectory. Restoration targets should be set for final Project conditions, as well as the interim conditions expected as the Project develops. Restoration targets are a temporary set of expectations that will change as our knowledge of the system increases (National Research Council, 2003).

The targets in the Adaptive Management Summary Table (Appendix 3) were developed cooperatively by the Project Managers, Science Team, Consultant Team, Stakeholders, and appropriate regulatory agencies. Quantitative targets, such as minimum numbers, or ranges of variability, do not yet exist for all restoration targets. Restoration targets will be developed using existing data, such as that collected by the USGS for the Project, or other data sources outside the Project. Some restoration targets will be set by regulatory agencies. For example, water quality standards are determined by the RWQCB, and the FWS will set restoration targets for the California clapper rail and salt marsh harvest mouse through the Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California, which is expected to be released in 2008. Maintaining consistency with the Recovery Plan is especially important for the Project because the South Bay is a significant restoration area for these endangered species.

During planning, the Project participants began developing measurable restoration targets and they will continue to refine them early in Phase 1. The task of setting restoration targets is often difficult. For example, the Project Managers will set population levels as restoration targets for many species, including migratory shorebirds. Setting population targets for these birds is difficult because pre-ISP data are often spotty; in some cases new data will need to be collected over time. In addition, population numbers are often highly variable from year to year, which will make it a challenge to know if the Project is either positively or negatively affecting bird numbers. Despite these difficulties, it is important to try to set and meet target species levels. Although there is significant uncertainty in many population numbers, if monitoring is complete, it will be possible to determine whether species numbers in the South Bay are meeting a baseline level and/or changing at the same rate as the larger Bay-wide or flyway population.

Some restoration targets may be difficult to meet. For example, it is not likely that the Project will be able to meet water quality standards in all ponds all the time. However, these situations will result in studies providing more information on why ponds do or do not meet the standards and what can be done. Restoration targets should hold the Project to levels of performance that are under the Project's control and not to levels that are controlled by external factors. For example, one Project Objective is to maintain the current levels of migratory bird species using the Project Area. If this number declines due to Project activities, Project managers are expected to take action to reverse the decline. However, if the decline is due to other factors, such as loss of arctic nesting habitat, then this is not due to the Project actions and managers will not be expected to (and will probably not be able to) reverse this decline. The Project Managers and scientists have tried to anticipate external factors that will need to be tracked and have included them in monitoring or applied studies for the Project. Project participants will continue to identify important external factors throughout the life of the Project as part of adaptive management. Even with this work, the causes of decline or change may not always be apparent and Project Managers may have to make decisions given the information they have. Advice from experts should always be sought in these cases and Project Managers should carefully document the reasoning and data that went into their final decision.

The Adaptive Management Summary Table lists specific restoration targets for all Project Objectives except for Objective 5, implementing measures to control invasive and nuisance species, and Objective 6, protecting infrastructure. Achieving invasive and nuisance species control is measured with respect to impacts on target species or communities. Thus, targets relative to Objective 5 are given under the Tidal Habitat Establishment, California Clapper Rail, Breeding Birds, and Western Snowy Plover categories in the Table. Protecting infrastructure is a design issue that will not alone determine whether the Project proceeds along the adaptive management staircase. Infrastructure evaluation will be part of the operations and maintenance plans that DFG and FWS will develop for their pond complexes.

Even with the best research, restoration targets may not be entirely accurate, and ranges of certainty and natural variation may not be known. Careful monitoring and applied studies will reveal whether the target should be revised and, if so, how. While the Project Objectives themselves are expected to remain unchanged throughout the life of the Project, restoration targets are very likely to change as knowledge of the system increases (National Research Council 2003). Each year, in their evaluation of the Project's performance, Project scientists and managers will review the restoration targets in light of adaptive management monitoring and study results to determine if they are still appropriate and accurate measures of progress toward the Project Objectives.

Monitoring Parameters. Callaway, et al. (2001) state that, "Assessment is the quantitative evaluation of selected ecosystem attributes, and monitoring is the systematic repetition of the assessment process, that is, measurement of the same attributes in the same way, on a regular schedule. The placement and timing of samples are tailored to the spatial and temporal variability… A one-time sample does not constitute monitoring, nor does the haphazard timing of repeated assessments or repeated measurement…using different sampling methods. The essence of monitoring is consistency. At the same time, monitoring programs must be able to evolve." The purposes of monitoring are to:

- assess progress toward Project Objectives;
- evaluate effects of a specified management action;
- characterize baseline/reference conditions;
- track regulatory compliance; and
- detect early signs of potential problems and anticipated changes.

To achieve these purposes, the Project will measure a large number of monitoring parameters. The Project's 50-year horizon necessitates measuring short- and long-term characteristics. For example, we expect that large-scale changes in the area of mudflat (the first restoration target in the table) will not be detected for 10-20 years. In contrast, breeding birds are likely to respond to restoration changes in the next breeding season. In addition to varying time scales, the Project will track structures and functions at these spatial and ecological scales:

- <u>Beyond the Ecosystem Scale (Entire Bay Area and Beyond)</u>: Parameters at this level measure large-scale processes, often external to the ecosystem, that will affect the Project. Three such metrics relevant to the Project are:
    - Pacific flyway species composition and abundances;
    - Sea-level rise, especially effects on tidal habitat evolution and flood protection;

- California and Bay Area human population change.

If information on these parameters is needed, Project Managers will seek out the data from other entities. If data are not being collected by others, the Project may initiate its own data collection efforts.

- Ecosystem Scale (South Bay and Multiple Pond Complexes): Ecosystems are large-scale phenomena driven by water, carbon, energy, and nutrient dynamics. Parameters proposed to measure physical aspects include sediment measures (sediment deposition or erosion and suspended sediment concentrations), water quality conditions, and mercury-level changes in populations in the food web. Ecological parameters will include the extent and distribution of habitats in the South Bay ecosystem, landscape-level marsh development, habitat connectivity, bird species diversity in the Project Area, fish community changes, and plankton community changes.
- Community Scale (Pond level): Ecological communities are characterized by the diversity and interaction of species in a particular area. Major communities in the Project Area are tidal marsh habitats, managed pond, tidal mudflat, and subtidal/deep water communities. Parameters will include nutrient levels, vegetation composition and cover, succession, bird/fish/benthic community composition, food chain development, water quality measures, predator-prey dynamics, mercury levels, and interaction of non-native/invasive with target native species.
- Population Scale (Species level): The Project will monitor population changes in a number of listed and indicator species, as well as specific non-native species, such as *Spartina alterniflora* (and hybrids), and nuisance species, especially mosquitoes and California gulls (*Larus californicus*). Typical population parameters are distribution, abundance, breeding success, predation impacts, habitat quality, and quantity.

The Adaptive Management Summary Table lays out the monitoring for the Project, beginning in Phase 1. For these parameters, the Project will develop monitoring plans, which will be peer-reviewed. Plans should include these elements:

- protocols for measuring parameters including the location of measurements, timing and frequency of monitoring, monitoring methods and a schedule for rapid review of data to compare to management targets;
- construction-related monitoring parameters and protocols;
- roles and responsibilities for monitoring, including who will do what, when, and where;
- specific instructions for data analysis, interpretation, presentation, and storage;
- protocols for ensuring QA/QC;
- report requirements and deadlines; and
- funding approach for monitoring.

The Project Managers will develop monitoring plans for implementation beginning in Phase 1. Whenever possible, monitoring methods should be designed to collect data for multiple parameters. For example, aerial photo and satellite data collection methods can be very economical and can provide information on a range of parameters (Table 4). More labor-intensive field data collection once a month may be needed, but a wide range of sampling can be done in one visit. Collecting sediment cores and topographic elevations, perhaps done once a year, will provide valuable data for a number of parameters. Volunteers may be able to collect a range of data using simple assessment methods. Collecting some data may not even be necessary if that information is already being collected by other organizations. For example, the Regional Monitoring Program (RMP), a program of the San Francisco Estuary Institute, may already be collecting some of the pollutant data the Project will need. Finally, some time-consuming and expensive methods, such as call counts for California clapper rails, may be the only way to assess some parameters.

Well-implemented operations and maintenance (O & M) programs are important to supporting accurate monitoring results. Simply stated, O & M activities are those tasks required to keep the Project running as designed. These activities include a wide range of tasks such as operating and maintaining tide gates as required, checking and repairing infrastructure protections (such as riprap or other armoring), and fixing damage due to vandalism. When O & M activities are current and the Project is functioning as designed, monitoring will track how the system is performing based on the effects of management actions. Without up-to-date O & M, monitoring results may detect problems in the system stemming from the effects of poor maintenance rather than from the management actions themselves.

The Project's science program during implementation will be responsible for collecting and interpreting monitoring data for the Project Managers to use in adjusting current actions and designing future Project actions. In particular, Project Managers and scientists will look for evidence that the system is diverging from restoration targets and for evidence of unexpected outcomes--both of which may require management action. These situations may also require additional or new applied studies to understand system responses. Project science managers will make recommendations to the Project Managers on appropriate monitoring parameters, methods, and emerging applied study needs. Data and analyses will be made available to the public via the Project's website and other outreach mechanisms.

TABLE 4. Efficient Monitoring Methods and Parameters they Measure

Monitoring Method	**Examples of Parameters Measured**
Aerial Photos or satellite Images	• Aerial extent of tidal habitat • Connectivity of habitats • Form, location, density of channels • Primary productivity • Location, extent of invasive plants, where appropriate
Photo monitoring	• Use of levees by predators, especially red fox, cats, etc. • Nest activities
Monthly site visits	• Waterbird abundance & diversity • Counts of trail users • Water samples for nutrients, productivity, pollutants
Water quality data sondes	• DO, salinity, temperature, sediment concentrations, currents • Water level elevations
Sediment Cores	• Benthic species diversity • Accretion/erosion rates • Presence of contaminants

Applied Studies. Monitoring indicates what is happening, but typically not why it is happening. Applied studies will help close the gaps in our knowledge about how to reach restoration targets and will help managers understand why the system is responding as it is. The applied studies listed in Table 2 were identified by the Science Team during planning as most critical to achieving the Project Objectives. However, not all the applied studies listed in the table can be thoroughly investigated in Phase 1. For example, Phase 1 actions will not allow study of large-scale sediment movement. Thus, the applied studies for the Project should be sequenced and undertaken when conditions permit (Appendix 2).

The Project will generally use competitive proposal processes (Appendix 4) to identify researchers for applied studies, although a directed solicitation process may be used from time to time. The Project's science managers will review the list of priority applied studies each year, or more often if needed, and will make recommendations to the Project Managers as to which studies should be undertaken and when. Individual contractors, as part of the Project's science program, will be responsible for synthesizing and interpreting the information from these studies, which will be used to revise the monitoring program, adjust current actions, and design future Project actions. Research through applied studies is expected to be published in peer-reviewed publications and the applied studies program will be peer-reviewed periodically as part of the Project's external review. Part 4 gives more detail on the process for identification and review of applied studies.

While the applied studies listed in Table 2 are those most critical to informing movement along the adaptive management staircases (Figure 2 and 3), there are many other areas of research, not related directly to adding more tidal habitat, that could benefit the Project. The Project Managers and scientists will encourage researchers interested in other relevant studies to undertake this work. Such areas of study include restoration of native oyster populations, habitat requirements of western pond turtles, and habitat requirements of native rare plants, and basic or theoretical research into South Bay ecosystem processes. Certainly, researchers will present Project Managers with a wide array of research ideas. The Project will not be able to provide funding for all such studies, but Project Managers should assist to the extent they can with permits, letters of support, and other in-kind services, for valuable studies when appropriate. If demand is great for this type of research, the Project's science managers may develop a review system to help managers select research most likely to assist the Project.

Modeling. The development and application of numerical models is an important component of the Adaptive Management Plan. While some applied studies may contain modeling components, the primary modeling endeavor will be the development and application of an integrated model that captures "understanding of system processes based on information currently available, to identify important areas of uncertainty where additional information is needed, and to predict system outcomes under different scenarios" (National Science Panel, 2005). The development, revision, and application of the model will require continual effort during implementation.

This model will be used to integrate and analyze applied studies, monitoring, and other Project information for use by the Project Managers. In particular, the model should allow managers to predict how the system is likely to respond to management actions and also to external factors such as sea-level rise and other consequences of climate change. This forecasting function will be especially valuable for designing future Project phases. The model will also inform applied studies by allowing preliminary testing and refinement of hypotheses and improve monitoring programs by identifying areas of variability that should be resolved by monitoring. A state-of-the-art numerical model will also be useful for many additional restoration projects and other environmental studies in South San Francisco Bay.

The scope of the mechanistic model will be large given the many physical and ecological processes relevant to the Project, and the model's development will likely be incremental with early efforts focusing on hydrodynamics, water quality, sediment transport and geomorphic change. While model development is expected to be a multi-million project, this effort will be less expensive and more productive than funding parallel development of models by multiple consulting and research teams. This should be a public domain, open source model so that it is available to all researchers and consultants for continued development, testing and application to the Project and other restoration efforts in the South Bay. All data used in model applications will be made available on a website. Data will include initial conditions and boundary condition data, other model inputs, and calibration and validation data.

The model formulation and calibration should be documented and published in peer-reviewed literature to ensure that any important shortcoming of the model formation or degree of calibration is quickly identified. As additional refinement and calibration of the model is performed, this information will be provided on the website in a timely manner. As with monitoring and applied studies, the Project's modeling efforts will be peer-reviewed as part of external Project review.

C. Linking Information and Management Actions

Adaptive management cycle. Figure 7 illustrates the cyclic, adaptive management process of information generation and decision-making. As earlier described, the restoration targets are the expected Project outcomes and management triggers are the thresholds that indicate the Project may be diverging from a restoration target. These triggers are set to trip well in advance of significant impacts to the system and, if reached, signal the Project Managers will take steps to understand what is happening and, if necessary, take action to put the system back on track toward the restoration target (Figure 8). As Figure 7 shows, the PMT and science managers will review and regularly update the restoration targets and management triggers with new information as part of adaptive project management. The adaptive management process also allows for review the Project's six primary Objectives if the Project is not able to achieve one or more of them. However, any changes to these Objectives will require consultation with the Stakeholders, as they were central in developing these goals. The adaptive management cycle is a continual process of updating restoration targets and triggers, appraising applied studies and monitoring needs, designing current and future phases, and generating information to determine if the Project is meeting its Objectives.

Responses to management triggers. What will the Project Managers' responses be when data show a management trigger is reached? The Adaptive Management Summary Table (Appendix 3) lists a suite of potential management actions Project Managers could take. In each case, one of the first actions will be for the Project Managers and scientists to study the information more thoroughly to understand what may be happening with the system. This analysis may be achieved through a meeting of Project participants, or workshops, and/or written evaluation from a panel of experts, when time allows. The exact management actions taken will depend on the nature of the problem, the results of the in-depth analysis, and the management options available. Management actions available for some triggers will be diverse, but others will be proscribed, especially those in response to triggers linked to regulatory standards.

Project Managers will be prepared for situations requiring rapid response as well as those allowing slow response. In some cases, a tripped management trigger must result in rapid action by the Project participants. In the rapid-response scenario, monitoring data are reviewed in a timely manner by the Project scientists, especially the Monitoring Director (see Part 4), and reported to the Project Managers. If Project Managers and scientists determine that a threshold has been reached, they will confer with other experts and Project participants to determine the best course of action. Action may be quickly taken to prevent or minimize damage to the system. Rapid action is essential in the case, for example, of low dissolved oxygen levels, which can cause fish die-offs and other ecological problems within days. Such situations allow little time for public interaction at the time of the event and Project Managers may have to take action without public input. In all such cases, the public will be informed of actions taken and invited to comment on the events to help managers improve their actions in these rapid-response situations.

For other management triggers, responses will be slower, allowing more time for study and stakeholder involvement before corrective action is taken. An ideal example of this is the population trigger for migratory shorebirds. The entire "restoration target-monitoring-trigger-management response" scenario for shorebirds will be a long-term process. First, the restoration target for shorebird population numbers will take several years to produce and will continue to be refined for many years. This target development process is lengthy because there is very little information on shorebird numbers in the South Bay prior to the Project monitoring. In addition, shorebird numbers are extremely variable from year to year and, therefore, the target will be designed to include the natural variation shown by Bay-wide populations. South Bay and Bay-wide populations will be monitored and compared to the target to determine whether South Bay population change is different from Bay-wide shorebird population trends. Gathering enough data to statistically assess these trends will, most likely, take a number of years. While the management trigger will be set recognizing the wide natural variation inherent in shorebird numbers, it is meant to trip very early to prevent problems from becoming too great. Thus, if the trigger is reached, the Project Managers will begin by convening experts to determine if shorebirds are declining and, if so, is the Project responsible in a substantive way. There will be time for significant scientific and public input to assess the information and determine appropriate corrective actions, if they are necessary.

Public access decisions will also be adaptively managed using the same rapid and slow response processes. For example, a rapid response scenario could occur if, hypothetically, a listed species were to establish nesting sites adjacent to a public access, spur trail. Since nesting birds are very sensitive to human disturbance (Carney and Sydeman, 1999; Trulio, 2005) and listed species are protected by law, Project managers and scientists would rapidly evaluate whether the trail was likely to be a significant disturbance to the animals. If so, they might take action to seasonally close or reroute the trail. The public, especially stakeholders, would be informed of the management actions, but as with most rapid response scenarios, there would be little time for public input before action was needed. Managers would receive public input at follow-up meetings to help improve responses in the future. There will also be many slow-response scenarios. For example, information from public access applied studies may show that some species are more sensitive to trails, i.e. experience more disturbance, than others. Project managers, scientists, and other experts would assess whether a trigger had been tripped. If so, the process of holding workshops with experts, meeting with stakeholders, and assessing potential management actions would be initiated.

Action not initiated by management triggers. The Adaptive Management Summary Table and the previous discussion have focused on what the Project Managers should do to get the system back on track if the targets are *not being reached*. This risk-averse approach is designed to prevent the Project from harming the South Bay system. Not only is this approach essential from an ecosystem health standpoint, but it is required by NEPA/CEQA as well as regulatory agencies that require that the Project avoid or mitigate significant impacts of the implemented restoration and management actions (Figure 8). Finally, this approach provides the best assurance possible that the Project Managers will meet the Project Objectives--goals that are important to the funders, agencies, legislators, and all the members of the public who were involved in helping make this Project possible.

While it is important to be cautious, Project information may indicate that, instead of things going awry, they may be going very well, even exceeding the targets expected. For example, data may show that California clapper rails are responding very quickly and positively to new tidal habitat with population numbers and densities exceeding targets. Or, foraging shorebird numbers in tidal habitat may be greater than expected, showing these habitats are supporting more birds than predicted. Or, assumptions that public access has impacts on one or more listed species may not be supported. These Project results, in which restoration targets are exceeded, will also be evaluated by Project Managers and scientists for management action. Exceeding expected outcomes will have implications for how fast and how much tidal habitat is restored, the locations and amounts of public access, and movement along the adaptive management staircase, in general. Since the monitoring parameters in the Adaptive Management Summary Table are set up to track progress toward the targets, they will function well to show when the Project is advancing quickly and exceeding expectations, as well as the when the Project is diverging from expected outcomes.

FIGURE 7. Adaptive Management Process

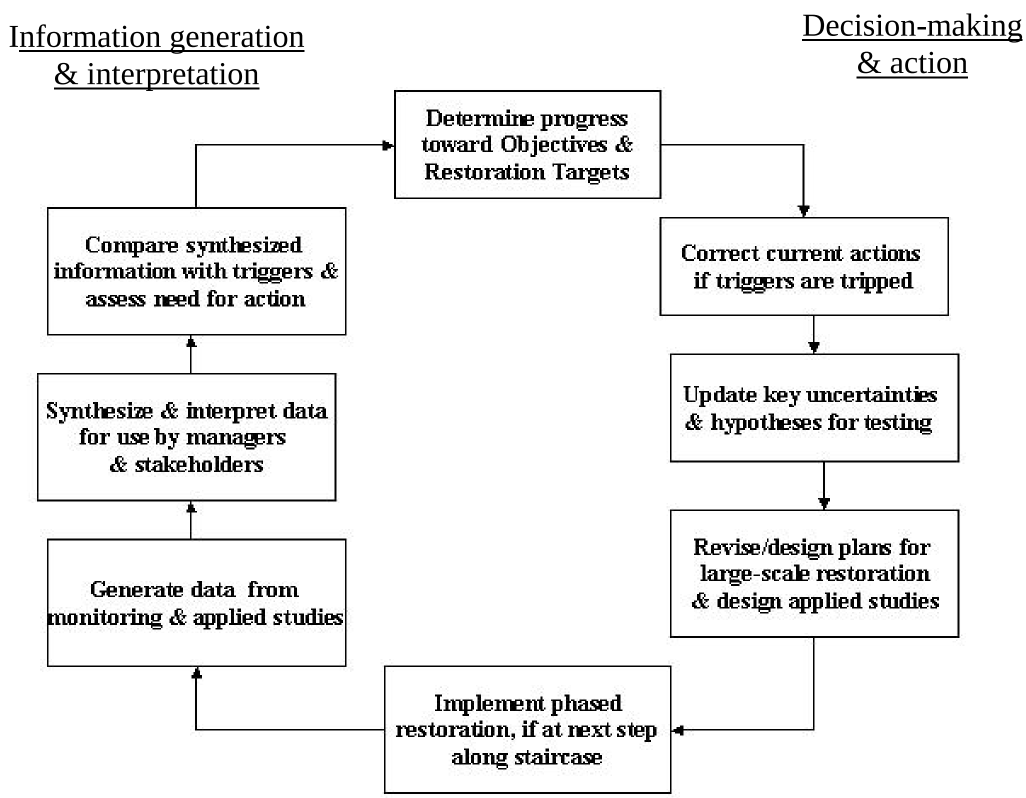
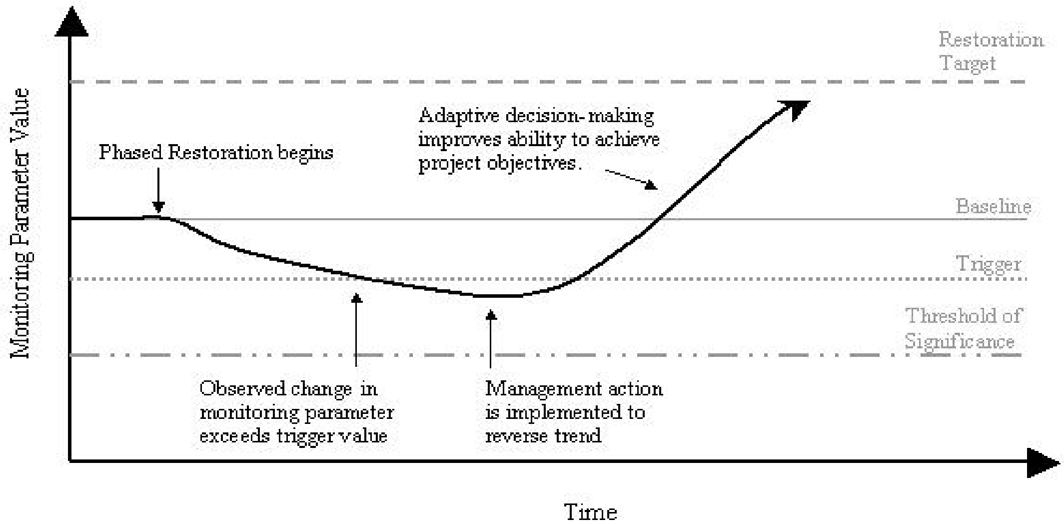


FIGURE 8. Linking Restoration Targets to Management Triggers



D. Phase 1 Applied Studies, Modeling, and Restoration Techniques

In 2008, planning for the Restoration Project will be complete and the Project Managers will begin implementing a set of Phase 1 actions. The Phase 1 actions were chosen because they are visible to the public, are expected to provide early successes in meeting Project Objectives, and allow testing for a series of applied studies to reduce key uncertainties. Table 5 lists the Phase 1 actions evaluated in the *South Bay Salt Pond Restoration Project EIS/R* (2007) and Figure 9 shows the locations. Table 5 also shows the applied studies associated with each action.

Phase 1 applied studies are coordinated with each restoration and management action. These studies are predominately focused on questions related to bird use of changing habitats, mercury issues, and public access-wildlife interactions. Project Managers need information on these uncertainties before they can determine how much tidal action to restore in future phases. Two large-scale experiments are planned to test key questions (see descriptions in Appendix 5). Ponds A16 and SF2 will be engineered with a large number of islands of different shapes, sizes and densities to assess the applied studies question: Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner? At ponds E12/13, the Project will assess the extent to which ponds reconfigured and managed to provide specific water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds, and phalaropes/grebes; these ponds will be reconfigured as a small-scale salt pond system. Public access-wildlife interaction studies will be included in both these experiments. Studies of mercury methylation in response to management actions will continue into Phase 1, especially at Pond A8, which will be constructed as a reversible, muted tidal system used to assess mercury methylation changes in response to restoring tidal action. This action will also allow study of the extent to which salmon are able to enter and leave A8 through the water control structure.

Another issue for the Project during Phase 1 will be the effect on the Bay of ponds that are reconfigured or still managed as described in the ISP. Under the ISP, groups of ponds were linked together for circulation in a coordinated design of water intake and outflow to prevent salt making. Operation under this system quickly revealed unexpected changes in water quality and bird use. Changes due to Phase 1 actions will further affect pond ecology, requiring that they are monitored and studied to understand how ponds are functioning within the restoration project and with respect to the Bay.

As described earlier, Phase 1 efforts will include development and application of a numerical model that integrates physical and biological processes of the system to identify uncertainties and to predict system responses to potential management actions or external factors, such as climate change. This core model will be focused on predicting physical processes and changes in the far South Bay, below the Dumbarton Bridge, over 50 years. Model development will likely be incremental with early efforts focusing on hydrodynamics, water quality, sediment transport and geomorphic change. Small-scale model development and calibration began during planning at the Island Ponds. The Habitat Conversion Model for predicting bird response to changing habitats should be refined in Phase 1 to provide more predictive power. Ultimately, the Project would benefit from developing models to predict how human population and demographic changes will affect the Bay and restoration potential.

In addition to applied studies, the Phase 1 actions will include design features and pond operations whose feasibility and effectiveness deserve study. These “restoration techniques” (Table 5) do not require hypothesis testing, but their effectiveness requires documentation. Monitoring the effectiveness and sustainability of these techniques will inform the future planning, and possibly indicate changes to Phase 1. These restoration techniques have been identified for inclusion in Phase 1:

- <u>Vegetation Management on Islands and in Managed Ponds</u>. While some vegetation on nesting islands may be acceptable, design features and/or management is necessary to prevent dense, tall vegetation from substantially encroaching on the islands and to maintain habitat for species averse to nesting in vegetation. Vegetation management may also be required in areas of ponds managed for shallow water habitat. Phase 1 provides an early opportunity to learn about which methods are most effective at preventing vegetation growth and, if needed, controlling vegetation.
- <u>Water Management for Discharge Requirements</u>. The shallow water environment of managed ponds provides valuable habitat that supports various species of invertebrates and fish, many of which serve as food for nesting birds. However, compliance with water quality discharge requirements for discharge to Bay sloughs, particularly dissolved oxygen (DO), has been problematic during ISP operations. Reconfigured Phase 1 ponds will include approaches to determine cost-effective strategies to meet regulatory standards while simultaneously providing high quality bird habitat.

- Predator Control at Managed Ponds. Islands within managed ponds provide nesting habitat for a variety of birds. The proposed Phase 1 includes tidal restoration and pond reconfiguration to add nesting islands to managed ponds. These actions will displace predatory California gulls currently nesting in Pond A6, increase wetland nesting habitat for predatory northern harriers in restored marshes, create island nesting habitat that may attract breeding California gulls, and concentrate nesting islands for terns and other birds into fewer locations. As a result, predation pressure by avian (and possibly mammalian) predators on birds nesting on the islands could increase, potentially limiting the number and success of nesting birds utilizing the islands. Phase 1 management actions will include approaches to examine the most efficient and cost-effective methods for preventing and/or controlling predation.
- Sustainability of Constructed Marsh Pond/Panne Habitat. Pannes and ponds were typical, but not ubiquitous, features of historic salt marshes that provided important habitat for certain bird species. These features have rarely formed naturally in restored marshes, and constructed marsh ponds and pannes have been difficult to maintain due to vegetation colonization and erosion of the topographic elements that control tidal inundation. Phase 1 actions include restoration techniques to evaluate if constructed pond and panne habitat can be maintained through natural processes over the long-term.
- Ditch Blocks and Interior Channel Development. Re-establishment of the relict tidal drainage network is typically preferable since channel complexity provides a variety of microhabitats that support many marsh-dependent species. However, during channel formation within former salt ponds, borrow ditches tend to capture and dominate the evolution of the tidal drainage system. Phase 1 actions include restoration techniques to evaluate the extent to which ditch blocks enhance the re-establishment of relict dendritic channel networks within restored marshes. Information from the Island Pond restoration will also be used in this evaluation.
- Gypsum Pre-Treatment and Vegetation Establishment. The plant community is central to the biological functions of a wetland ecosystem, although the presence of gypsum may inhibit vegetation establishment by blocking root growth, preventing full drainage at low tide, or other factors. Phase 1 action at Pond E8A includes mechanically disturbing the existing gypsum layers prior to tidal restoration to examine the effectiveness of pre-treatment. Vegetation establishment (overall and by species) in treated areas will be compared with monitoring data from areas where the gypsum layers are intact.
- Wave-Break Berms and Pond Sedimentation. Wind blowing across open expanses of water, such as low restoration sites at high water, can generate waves that are sufficient to inhibit sediment deposition and re-suspend previously deposited material. These effects can slow or possibly prevent marsh plain formation. Monitoring elements associated with Phase 1 tidal habitat restoration has been included to assess the effectiveness of wave breaks at increasing pond sedimentation rates, and inform fetch spacing.

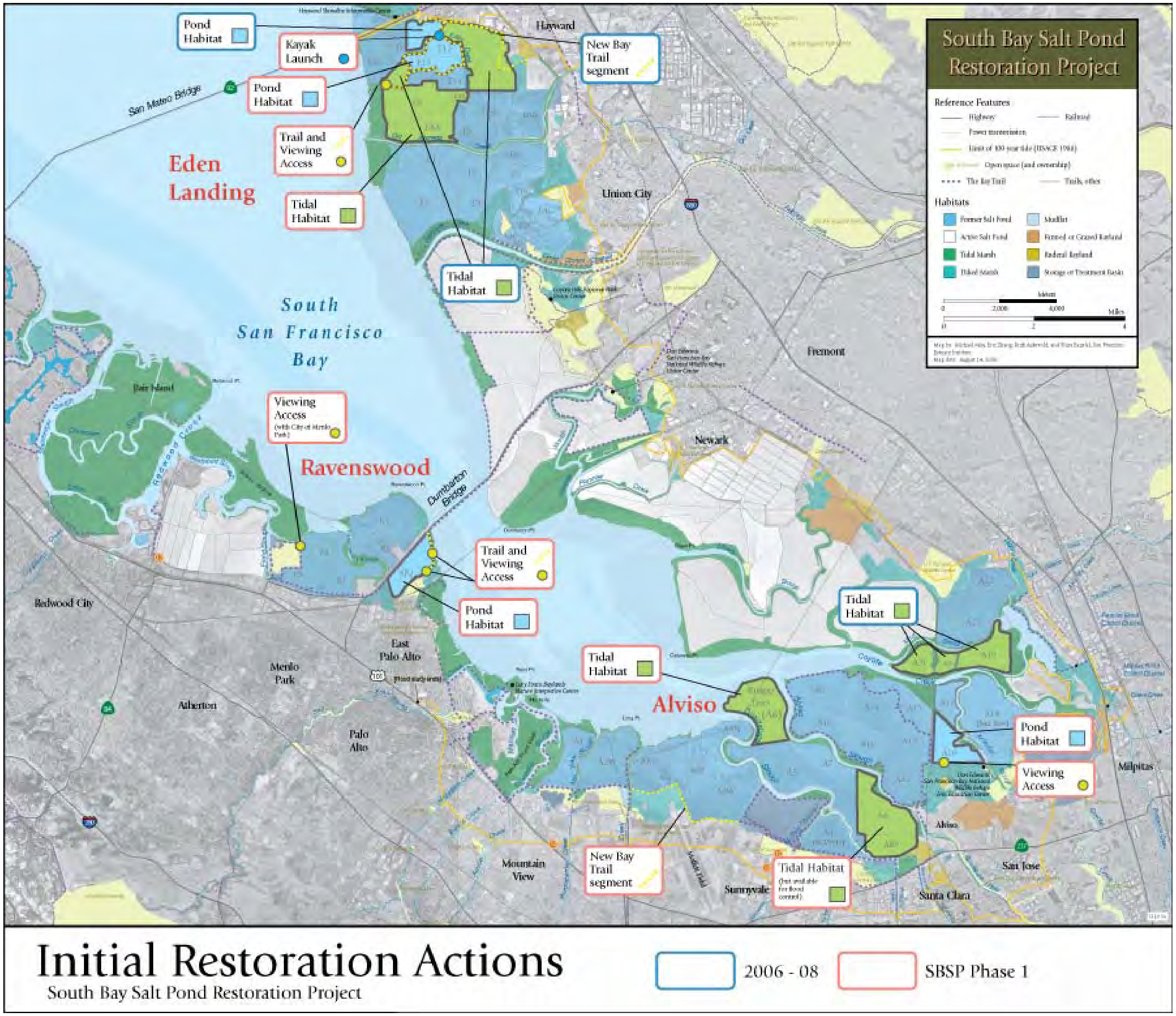
TABLE 5. Phase 1 Applied Studies and Restoration Techniques Questions

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Tidal habitat restoration	A6 (Perimeter breaches to mouth of Alviso Slough and Guadalupe Slough.) E8A/9/8X (Restoration plan developed in coordination with Alameda County Flood Control and Water Conservation District. Perimeter levee breaches connect ponds to Old Alameda Creek, North Creek, and Mt Eden Creek)	<u>Applied Studies</u> • Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame? (Modeling required) • Will sediment movement into restored tidal areas significantly reduce shallow water habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? • E8: Will restoration activities always result in a net decrease in flood hazard? • E8: Will pond and panne habitats in restored tidal habitats provide long-term habitat for significant numbers of foraging & roosting shorebirds & waterfowl? • To what extent will increased tidal habitat increase fish and harbor seal survival, growth and reproduction? • Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? • A6: Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds? <u>Restoration Techniques</u> • E8: Will gypsum inhibit the re-establishment of vegetation and relict tidal channels within the ponds? If so, what cost-effective treatments are available for treating gypsum? • E8: Can effective pond and panne habitat be constructed and, if so, can it be maintained through natural processes over the long-term? • A6: To what extent do wave breaks increase pond sedimentation rates? • A6: To what extent do ditch blocks enhance the re-establishment of relict dendritic channel networks within restored marshes?
Reversible muted tidal deepwater ponds	A8 (Limited exchange of tidal water through an armored notch in the perimeter levee between A8 and upper Alviso Slough provided muted tidal action and deep (>2 ft) water depths in Ponds A8, A5 and A7).	<u>Applied Studies</u> • Will sediment movement into restored tidal areas significantly reduce shallow water habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? • Will restoration activities always result in a net decrease in flood hazard? • Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? • To what extent will increased tidal habitats affect survival, growth and reproduction of native species, especially fish and harbor seals?

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Reconfigured managed pond with islands with public access	SF2, A16 (Pond reconfigured to include shallowly flooded cells with isolated islands.)	<u>Applied Studies</u> • To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? Specifically, what are the effects of island density and shape on bird nesting use and reproductive success? How do vegetation types, density and distribution affect island use by nesting birds? • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short or long timescales? <u>Restoration Techniques</u> • Which management methods are most effective and cost-effective for controlling vegetation? • Can we feasibly (cost-effectively) manage water for discharge requirements and create high quality bird habitat? • Which management methods are most effective and cost-effective for controlling predation?
Reconfigured managed pond to sustain a salt pond system with public access	E12/13 (Ponds reconfigured into cells that provide a gradient of salinities and water depths.)	<u>Applied Studies</u> • Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? • Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short or long timescales? <u>Restoration Techniques</u> • Which management methods are most effective and cost-effective for controlling vegetation? How effective is high salinity in discouraging vegetation growth? • Can we feasibly (cost-effectively) manage water for discharge requirements and create high quality bird habitat?

Action Type	Phase 1 Action	Applied Studies and Restoration Techniques Questions
Public access	Bay Trail spine from Sunnyvale to Stevens Creek Viewing opportunity and interpretive display at Bayfront Park	Applied Studies • Will landside public access significantly affect birds or other target species on short or long timescales? • Will public access features provide the recreation and access experiences the public wants over short and long timescales?
Regional effects	Regional ecological and social impacts associated with implementing the South Bay Salt Pond Restoration Project	Applied Studies • Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? (Modeling required) • What is the effect of pond management, including increased pond flows and associated managed pond effects, on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay? • Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales? • What are the costs and benefits associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?

FIGURE 9. Phase 1 Actions



E. Future Actions and Long-term Uncertainties

Future Actions. Future phases of the South Bay Salt Pond Restoration Project will integrate habitat restoration and management with flood protection and wildlife-compatible public access, which is the mission of the Project. Future actions will be based, in part, on the evaluation of adaptive management information collected in previous phases. Information collected in Phase 1 from monitoring and applied studies on bird response to management, methyl mercury, and public access-wildlife interactions will be instrumental in determining the extent and location of future tidal restoration.

Ultimately, future actions will be determined by evaluating this information in light of a number of decision criteria. Many of these criteria will be the same as those used in developing Phase 1, which were:

- Availability of funding
- Likelihood of success
- Ease of implementation
- Visibility and accessibility
- Opportunities for adaptive management
- Value in building Project support
- Certainty of investment
- Flood protection

For actions after Phase 1, the same criteria will be applicable, but others will be relevant as well, including the following:

<u>Readiness to proceed</u>

This criterion is similar to ease of implementation. Under this criterion, actions would be favored that are most timely for the particular implementing agency in completing the necessary planning and design. This criterion would not outweigh certain others, particularly those described below.

<u>Ability to utilize results from earlier applied studies and other new knowledge</u>

Under this criterion, projects that utilize the results of earlier applied studies would be favored, either in applying new design concepts based on earlier results or developing new information or knowledge to add to the knowledge base from earlier results. Also, it would take into account any other new knowledge that becomes available to the Project.

<u>Dependency on precedent actions</u>

Some actions cannot be implemented until specific precedent actions occur. A good example is that many ponds cannot be opened to unrestricted tidal action until a suitable flood protection levee is constructed. In fact, after Phase 1, there are few opportunities to open ponds to unrestricted tidal action without precedent flood protection actions.

<u>Dependency on adaptive management progress</u>

The basic layout of tidal and pond habitats in the 50% tidal:50% managed pond and 90% tidal:10% managed pond alternatives presumes a progressive conversion of ponds to tidal habitats over time. The two alternatives are laid out to represent a continuum, a progression over time from 50%:50% to 90%:10% provided that monitoring results confirm that the Project Objectives are being achieved. The implicit assumption in this construct is that ponds that are managed ponds would not be converted to tidal action until after:

a) the 50:50 mix of tidal and pond habitats is achieved, and
b) monitoring has confirmed that further conversion of ponds to unrestricted tidal action is acceptable.

Flood Management Requirements

Many flood management actions proposed as part of the Salt Pond Project, such as levee construction, may wait for completion of the South San Francisco Bay Shoreline Study. The Shoreline Study process will be used to determine the specific elements of one or more projects that may be authorized for construction under by the federal government. The advantage of the Shoreline Study process to the Salt Pond Project is that it will carry the analysis to project-level detail and may result in a substantial Federal cost share for those elements contained within the federally-authorized project(s).

However, the Shoreline Study is not expected to be complete for several years. As a result, the Project partners are evaluating candidate actions for early implementation in the Alviso Pond complex by the Santa Clara Valley Water District in cooperation with the FWS and the State of California. The value to the Project of early implementation in this manner is that it provides necessary flood protection coupled with further tidal habitat restoration actions. In fact, the opportunities for creating additional tidal habitats after Phase 1 are severely limited until adjacent flood protection levees are constructed.

For the Ravenswood Pond complex, tidal habitat restoration will be closely linked to flood protection. In particular, the Highway 84 approach from the west to the Dumbarton Bridge and the PG&E substation are potentially at risk from flooding if outboard levees are breached, as well as the Belle Haven neighborhood of Menlo Park.

For the Eden Landing complex, the southern area (between Old Alameda Creek and the Alameda County Flood Control Channel) will be evaluated for a combined tidal habitat restoration and flood protection project led by the Alameda County Flood Control and Water Conservation District.

Public Access Needs

A number of the public access projects that are included in Phase 1, such as completion of Bay Trail spine segments, can proceed independently of changes in habitat. Many of the Bay Trail spine segments can and will be built when funds are available on existing or temporary levees that are ultimately proposed to be replaced with well-engineered flood protection levees. When the flood protection levees are constructed, it is the Project's intention that new and improved trail segments will be constructed on the levees, either on top of the levee or on a bench along one of the levee side slopes. Spur trails into the habitat areas or looped around managed ponds will be considered for construction as habitat development occurs and as additional information becomes available regarding the compatibility of trail uses with species use of the developed habitats.

The resulting application of these criteria will make implementation of actions in the future a varied mixture of activities at different times. A good example would be the set of actions following Phase 1. One may be the construction of a flood protection levee, another could be the development of an additional viewing area, and a third could be refinement of a Phase 1 applied study. These could be somewhat separated in time and space across the Project Area and be unrelated to each other, yet for other valid considerations they could be the most desirable set of actions to follow Phase 1.

Future actions are expected to open significant acreages of pond to tidal action in order to initiate development of significant areas of tidal habitat for California clapper rail and salt marsh harvest mouse and to allow large-scale testing of sediment dynamics and supply questions. These goals argue for restoring tidal action to an entire slough complex. The location of these ponds will depend on results with respect to the factors listed, above, as well as where flood protection work occurs. Possible locations include:

* Ponds along Old Alameda Creek in the Eden Landing complex
* Ponds along Alviso Slough in the Alviso complex
* Ponds along Guadalupe Slough in the Alviso complex
* Ponds along Ravenswood Slough in the Ravenswood complex

Long-term Uncertainties. As the Project moves into the future, understanding external factors affecting the Project will be extremely important. Climate change may be one on which all others hinge. The range and magnitude of climate change effects are not easy to predict. However, it is certain that change will occur. Some of the expected effects of climate change that are relevant to the Project include:

- sea-level rise, which will affect marsh development and flood risk;
- increasing air temperatures, which will influence insect populations, such as mosquitoes;
- changes in ocean and bay surface temperatures, which will affect primary productivity and plankton communities, the basis of the Bay food web;
- changes in freshwater storage and flow, which could change freshwater flow amounts and rates into the South Bay;
- melting permafrost in the arctic, which will affect the nesting success of many migratory birds and could reduce the number of birds migrating to the San Francisco Bay; and
- changes in storm patterns and intensity, which along with sea level rise, flood risk changes and freshwater flow changes, may impact the amount and location of urban settlement around the Bay.

While current estimates of sea-level rise have been factored into the evaluation of the Project alternatives in the *EIS/R* (2007), new model results based on revised sea-level estimates will be important throughout the Project's life. Model predictions of sediment dynamics, marsh development, primary productivity, bird use of South Bay habitats and human demography will all be affected by climate change. And, there are likely to be other significant forces that will impact the Project. One obvious factor is increasing urbanization and changes in human demographic patterns around the Bay. Others are the impact of earthquakes and oil spills. In addition to these, there will be factors that are currently not anticipated.

How will the Project deal with these changes? The adaptive management approach provides a process for continually examining the system, anticipating change, and responding to changes, if, when, and where they occur, based on thorough evaluation of the information and options available. Using information collected and well-developed models, Project Managers can assess, not only system response to Project activities, but can detect changes not resulting from Project actions and can predict changes to the system. Applied studies can be used to assess the causes of these responses and help Project managers understand when the corrective actions can and cannot effectively change or mitigate a negative trend. Evaluating the Project's performance includes trying to anticipate factors that may affect the Project, putting monitoring, applied studies, and modeling in place to try to detect changes due to those factors, and developing potential management responses if unacceptable changes occur. For example, although Project Managers cannot stop sea-level rise, based on estimates they may decide to restore tidal action only to certain parts of the Project area that can be armored with flood protection appropriate to protect against expected storm surges.

The future is uncertain and the direction and extent of change is often unpredictable. Project data and modeling will be employed to improve predictive and response capacities. Ultimately, the adaptive management process will be the way that the Project Managers will learn of and deal with changes to the system due to their actions or due to factors beyond their control.

Part 4. IMPLEMENTATION MANAGEMENT: Institutional Structure and Procedures

A. Organizational Structure

Adaptive management cannot be implemented without an effective decision-making structure that completes the loop between information development and the use of that information in decision-making. The institutional structure for decision-making described here is designed to achieve these four functions:

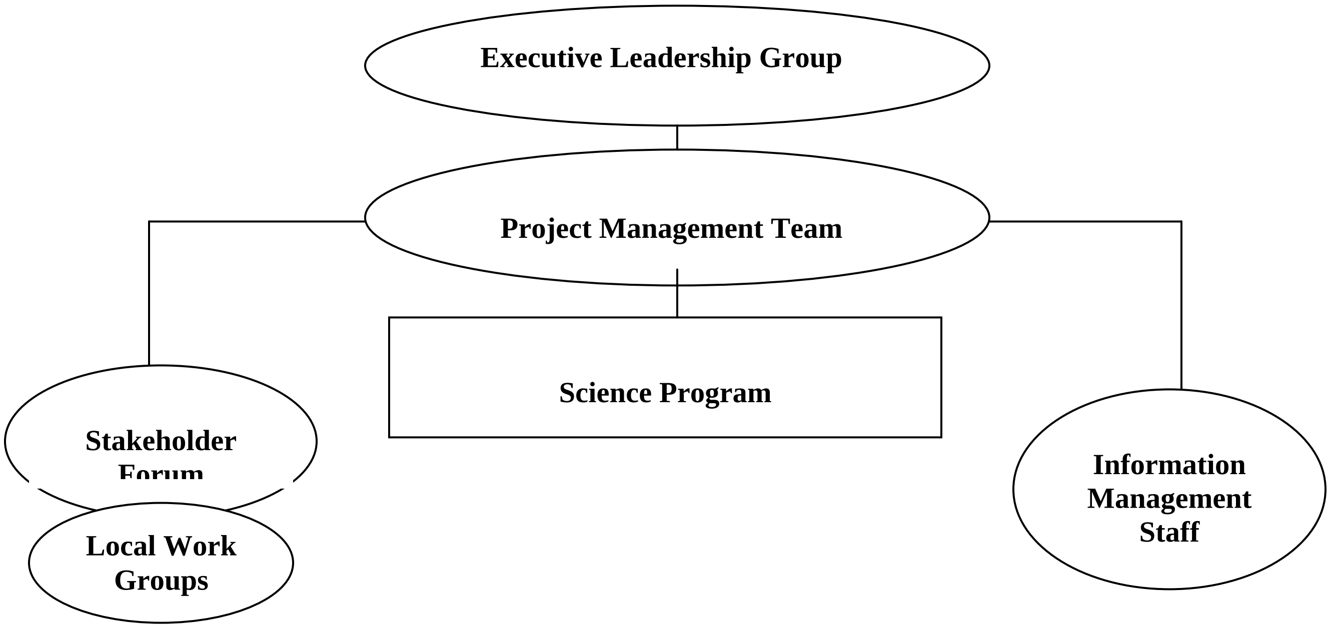
1. Generate science-based information for managers (from monitoring and studies);
2. Convert information into effective management decisions;
3. Involve the public to help provide management direction; and
4. Store and organize information for use by the decision-makers and the public.

Figure 10 shows the organizational structure that will be used to carry out these functions. This structure includes two primary elements, the Project Management Team (PMT), comprised of the USFWS, DFG, SCC, and other involved organizations, which is responsible for decision-making and taking action on those decisions, and the Science Program, comprised of science directors and contractors, which is responsible for data generation and interpretation. The science managers that direct the Science Program will be members of the PMT. Collectively, the PMT and the Science Program managers will evaluate: a) progress toward Project Objectives and restoration targets, b) monitoring and applied study priorities, c) corrections needed to current phases, and d) design of future phases. The PMT is ultimately responsible for all decisions that are implemented.

This structure evolved through a collaborative effort by the Project participants involved during the planning phase and is designed to allow a smooth transition from planning to implementation. The Project scientists and managers reviewed adaptive management programs in other ecosystem restoration projects (CERP, 2004, Flanigan, 2004; Glen Canyon Adaptive Management Plan, 2001) and found that every adaptive management program is structured differently to address the unique ecological and social features of the system. Society has not yet perfected the social, economic, and institutional components of adaptive management needed in specific contexts (Gunderson et al., 1995; Holling, 1978; Walters, 1997). However, one clear lesson from other ecosystem restoration projects is that institutional arrangements themselves need to be flexible and adaptive, as most attempts to institutionalize adaptive management into a standard template have failed (Walters, 1997). The structure and processes described here are expected to evolve over time to meet the Project's needs.

Another lesson is that adaptive management cannot succeed unless participants in the decision-making structure communicate effectively with each other to share information and take action in a timely manner. When different groups or functions remain in "boxes" or "silos" separated from other parts of the structure, decision-making breaks down. Mechanisms to ensure communication include integration of the science managers into the PMT, regular meetings of the Stakeholders attended by PMT members, transparent peer-review procedures, and vehicles for providing information to all project participants and the public, including regular reports from the PMT and Science Program, newsletters, and a Project website.

FIGURE 10. Adaptive Management Organizational Structure and Functions



Executive Leadership Group Functions:
* Provide decisions on overall direction of the Project and use of funds
* Make final decisions on issues involving competing interests between agencies or other big picture issues

Project Management Team Functions:
* Determine changes to current Project phases
* Determine movement along tidal action continuum
* Review and approve Applied Studies and Monitoring recommended by the Science Program
* Determine management actions relative to Triggers
* Evaluate and make changes to Targets and Triggers
* Issue RFPs for research and monitoring
* Set up and respond to Project reviews
* Develop and let contracts for all Project work
* Direct public outreach
* Develop/provide Project funding
* Report Project progress to funders and public

Stakeholder Forum and Working Group Functions:
* Provide community feedback to PMT
* Comment on recommendations from SMT
* Comment on draft decisions from PMT

Science Program Functions:
* In conjunction with the ELG and PMT, generate funds for Science Program implementation
* Interpret results from studies and monitoring for PMT
* Recommend and prioritize Applied Studies, Modeling, and Monitoring needs
* Assess movement along tidal action continuum and recommend actions for future phases and changes to current phases
* Implement adaptive management process when Management Triggers are reached
* Recommend changes to Targets and Triggers
* Set up peer-review for studies, monitoring, RFP, and associated reports
* Develop RFPs for studies, modeling, and monitoring
* Integrate with Information Management Staff
* Hold Science Symposia
* Coordinate research groups (“Science Consortium”)
* Produce science reports and publications

Information Management Staff Functions:
* Store and manage data
* Conduct simple data analysis
* Provide data to PMT, the public, and others
* Prepare annual trends reports

B. Roles and Responsibilities
Each group in the Organizational Structure in Figure 10 has multiple functions in developing the information for decision-making, providing information to Project Managers and the public, and making and implementing decisions based on that information.

Executive Leadership Group. The Executive Leadership Group (ELG) is comprised of the heads of the Project Management Team agencies, consisting of the State Coastal Conservancy, the landowning and management agencies, local flood control districts, the Army Corps of Engineers, and Project funders. This group has overall authority for how funds are spent in Project implementation. The ELG coordinates directly with the PMT on high-level decisions. The ELG will meet one or possibly two times per year, depending on the need, to discuss current and proposed management actions and activities in future Project phases.

Project Management Team. The Project Management Team (PMT) will be the decision-making body for implementation and adaptive management. The PMT will be led by an Executive Project Manager and will include representatives from the FWS and the California DFG (the land management agencies), the State Coastal Conservancy (SCC), the local flood control districts (especially the Santa Clara Valley Water District and the Alameda County Flood Control and Water Conservation District), the ACOE, and the Lead Scientist and Monitoring Director. It will operate on a consensus basis, as it has during the planning process. Regulatory agency staff will be invited to participate in PMT meetings; they will be kept apprised of Project activities and will be contacted directly when their attendance is essential. Agencies should include staff involved with issuing and overseeing regulatory approval who can provide "early warnings" to the PMT on regulatory issues. If necessary, decisions will be elevated to the Executive Leadership Group.

The PMT provides leadership for the implementation process and is responsible for many components of the effort, especially determining the management and restoration activities required to meet the Project Objectives. The land management agencies will use the PMT as a forum to coordinate and cooperate for the benefit of the overall Project, but will retain their independent land management authority. A Memorandum of Understanding (MOU) among the PMT agency members will define the roles and responsibilities of the members with respect to achieving the Project Objectives and implementing adaptive management. The Executive Project Manager will assist the PMT in achieving their goals.

Two additional functions of the Project Management Team are obtaining funding for implementation and adaptive management, including funding for the Project including the Science Program, and providing for public participation and outreach. Funding is critical to ensuring that adequate long-term, stable financial support is provided to achieve the Project Objectives. This work includes researching and developing close and long-term relationships with potential funders and incorporating a rigorous proposal and reporting process. To achieve these goals, Project Management Team members will work with other stakeholders, including representatives from environmental or community groups, public works agencies, private foundations, and local businesses or industry, to conduct public outreach and development.

The PMT will lead the effort to identify and secure funding for implementation, including funds for science (applied studies, monitoring, and modeling), adaptive management, and management of the organizational structure. In 2007, the Project Managers and scientists estimated the cost of the program of monitoring, applied studies, and modeling laid out in the Adaptive Management Summary Table at approximately $3 million/year. This figure does not include administrative costs, such as funding the science managers. It is likely that the Project will need to budget at least 10% of its funds for the Science Program, although costs will change depending on the Project's science needs. There are several opportunities for funding that will be pursued including, but not limited to, state bond money, local benefit assessment districts or other local funding devices, federal appropriations to the FWS or ACOE, funds from private foundations, corporations, and individuals, and funds for mitigation or in lieu of fines from public and private entities. Funding for applied studies can, in part, be achieved through coordination with universities and research groups. The SCC will work with its non-profit arm, the Coastal Conservancy Association, to manage private funds. In addition, the Conservancy has the authority to accept and disburse public and private funds.

Outreach efforts to bring the public into the Project will engender support and long-term stewardship and increase the public's overall awareness of their role in protecting the environment. Outreach may include a quarterly or semi-annual newsletter in English and other important languages summarizing the Project's work, field trips, and opportunities for public involvement. Television and radio spots may also be useful in informing the public-at-large about the Project. Getting people actively involved in the Project will require a number of techniques. For example, tours of the Project area are popular but, also, "virtual public access" available on the Project website will allow people to "visit" the site even if they cannot travel. Virtual access can also let people see things that are normally inaccessible; for example, "nest cams", video cameras set up at nest sites that broadcast to the website, are popular ways to see nature in action. Technical workshops and/or public science talks will be popular with some. Many restoration projects also have active volunteer organizations that help publicize and manage aspects of the Project or collaborate with other local organizations to do this. While managing volunteers takes staff and money, the good will they convey and actual work they do can be very beneficial for the Project. The PMT will define geographic sub-areas in the South Bay, establish local Work Groups for those areas, and involve these groups and the Stakeholder Forum in the design, implementation, and monitoring of on-the-ground activities.

Key activities of the PMT include:

- Planning and implementing overall restoration and management, flood protection, and public access design;
- Making decisions about changing current Project phases/actions, determining future actions, revising restoration targets and triggers, meeting regulatory requirements, and all other operations of the Project, based on Science Program findings, Stakeholder input, and other relevant information;
- Providing regular reports to the Stakeholder on Project progress and future plans, and to regulatory agencies on compliance requirements;
- Overseeing budgeting and funding;
- Managing and implementing the contracting and RFP processes;
- Maintaining relations among state and federal legislative and local governments, communities, business, agencies, NGOs, and others;
- Developing community restoration and monitoring participatory activities;

- Conducting Stakeholder Forum and Work Group meetings;
- Coordinating with the Information Management Team to provide information to the public via the Project website and other methods; and
- Conducting outreach activities to raise the visibility of the Project.

In addition, the PMT should facilitate these important tasks as early as possible in Phase 1:

- Quantify restoration targets, as needed.
- Develop monitoring plans.
- Develop methods for resolving disputes about technical and social issues, and disagreements about potential management actions; and
- Develop a schedule and procedures for external review and assessment of the Project's decision-making and information generation systems to improve the effectiveness of adaptive management.

As part of the decision-making process, the PMT will be apprised of current results of studies and monitoring carried out by or related to the Project. The Science Program managers and the Executive Project Manager will be responsible for making sure that results and their interpretation are presented to the PMT in a timely fashion. The PMT will use the results to make four types of decisions:

- *Day-to-day decisions*: These are operational decisions made primarily by the landowners that will be consistent with the EIR/S, AMP, other restoration plans, regulatory requirements, and any operations and maintenance plans that are developed.
- "*Emergency Action" decisions*: These are actions, often related to operations and maintenance, requiring quick response, such as an unanticipated levee failure or unexpected violation of a regulatory requirement.
- *Decisions regarding management triggers*: These are decisions based on PMT agreement that a management trigger has been tripped and would be the initiation of the process to evaluate all existing information and subsequent evaluation of potential management actions.
- *Future action decisions*: These are decisions to initiate a future action, either a restoration plan action or a new or modified applied study. These decisions would incorporate review of existing information, consideration of potential modification of the actions consistent with that review, and in the case of restoration actions, would require environmental review tiered off of the programmatic EIS/R. The PMT will develop guidelines for how to make decisions based on the totality of the South Bay response to Project actions.

Whenever appropriate, the Stakeholder Forum and Local Work Groups will provide input to the PMT before decisions are made (other than day-to-day and "Emergency Action" decisions). They will participate in annual meetings and reviews of the Project's progress as delineated in Section C, below. PMT decisions will be documented in the Project's annual report and in action summaries of its meetings.

The PMT's decisions will be based primarily on the following factors:

- Available information as provided by the Science Program and other sources;
- Status of progress towards achieving the Project Objectives;
- Available funding and any institutional constraints associated with the funding source;
- Input from Stakeholders;
- Assessment of the risks of taking various actions as well as not taking action; and
- Regulatory considerations and constraints.

Science Program. The Science Program will be directed by two science managers, the Lead Scientist and Monitoring Director, and will include an array of contractors hired to complete specific tasks. The Lead Scientist and Monitoring Director, supported by a Program assistant, will determine and manage the work to be done by the Program. They will be members of the PMT and will ensure long-term continuity in the Science Program. The contractors will be hired to conduct all work identified by the science managers, including collecting and analyzing monitoring data, conducting applied studies, writing reports that analyze and synthesize monitoring and applied studies information for use by the PMT, and conducting peer-reviews of science products and the Science Program itself.

The goal of the Science Program is to bring the best and most relevant science to decision-makers and the public in a timely fashion. The Science Program will provide the PMT with a scientific basis for adaptive management decisions on current and future Project actions as well as assisting with the development of restoration targets, and measuring Project success. The primary objectives of this Program are to develop priorities for applied studies and monitoring for the Project; to ensure that information from the Project's applied studies and monitoring is synthesized, interpreted, and published in appropriate media for use by the PMT, other scientists, and the public; to develop, implement adaptive management processes; and to implement peer-review processes for Science Program projects and products as well as for the overall Project. The science managers will need to ensure that the best research organizations and qualified researchers are engaged in order for the Project to be successful.

The Lead Scientist is the overall science manager for the Science Program and will perform these functions:

- Generate local, national and international interest, and local and regional investment in the Science Program;
- Ensure Science Program efforts are credible, legitimate and relevant;
- Encourage the best scientists available to work on issues of interest to the Project;
- In concert with the ELG and PMT, identify and foster funding opportunities to support the Science Program.

Specific responsibilities of this position are to:

- Promote and build the visibility of the Science Program and the Project;
- Represent the Science Program to funders, academic institutions, at meetings, and other public venues;

- Seek funding and research opportunities to support the Science Program, including opportunities for formal partnerships with local Bay area academic institutions and researchers as well as opportunities through federal and state programs, e.g. Sea Grant and others
- As a member of the PMT, provide updates on Science Program activities and advise the PMT on all aspects of the Project connected to science, especially adaptive management decision making, changes needed in current Project phases, and design of future actions;
- Oversee the applied studies process, including the generation of syntheses of information and the production of peer-reviewed products/reports;
- Oversee adaptive management processes, such as when management triggers are tripped;
- Set up and oversee peer-review and expert panels/processes for Science Program products and the Program itself, as well as other aspects of the Project needing expert input, such as refining restoration targets, adaptive management workshops, and Project reviews;
- Develop competitive proposal processes for applied studies and synthesis reports, and establish peer-review panels to evaluate study proposals and reports;
- Convene scientists and research institutions ("Science Consortium") and encourage them to undertake research in the South Bay that cannot be funded by the Project;
- Hold Science Symposia, or other such venues, to highlight South Bay research;
- Attend Stakeholder Forum and Local Work Group meetings;
- Report on Science Program progress to the ELG and funders.

The Monitoring Director is responsible for developing and overseeing the operation of a system-wide monitoring program, including identifying monitoring parameters, developing monitoring protocols, and overseeing a competitive proposal process to hire consultants or research teams to collect the data. Specific responsibilities of this manager are to:

- Implement the process for identifying monitoring parameters and developing protocols;
- Ensure data are collected, analyzed, and published in useful peer-reviewed formats in a credible and timely fashion;
- Develop competitive proposal processes for monitoring work;
- Evaluate the monitoring data, as required (monthly to yearly), to determine progress toward restoration targets and management triggers;
- Ensure that those collecting data provide, on an established schedule, information and advice about data collection results and system conditions;
- Coordinate with the Information Management Staff on monitoring data storage, analysis, reporting, and presentation for the public and the Project Managers;
- Provide findings and recommendations to the PMT;
- Attend funder, stakeholder, and other meetings as needed;
- Help generate funds for the science program;
- Prioritize and recommend monitoring programs;
- Coordinate with other monitoring programs;
- Achieve a balance between time needed for contractor QA/QC and delivery of timely and accurate data.

These two science managers will work together in a cooperative effort to integrate their tasks. Together they will set the direction for the Science Program and assess whether the cumulative data collected are adequate to meet the Project's needs. They will determine what products need to be produced by the Science Program and ensure that contractors provide those products. This oversight will require they review the quality of work produced by contractors. Joint tasks will also include assessing whether management triggers have been tripped; prioritizing research questions and monitoring needs; providing recommendations for adaptive management and Project implementation to the PMT; ensuring reports that interpret the results of studies and monitoring are prepared, peer reviewed, and published in appropriate formats for all audiences. Advising the PMT will require that the science managers synthesize the reports produced by the Science Program in a form usable by the PMT.

The Science Program will be supported by a Program Assistant who will be responsible for various administrative and research tasks. In particular, this assistant will help set up meetings, coordinate the peer-review process, and organize workshops, and symposia. Other tasks will include helping the science managers establish contacts with researchers and consultants, assisting with RFP production and collecting information from other restoration and management projects to ensure that the Project has the most up-to-date and comprehensive information available. Other relevant projects, especially those around the Bay, must be included in the on-going information synthesis. Examples of such projects include the Napa Salt Ponds Restoration Project, CALFED Restoration Program, and the Hamilton Army Airfield Restoration.

The job of the science managers is to direct the work of the Science Program. The actual work--including collecting and analyzing monitoring data, undertaking applied studies, synthesizing the data generated, preparing peer-reviewed reports, and peer-review itself—will be conducted by contractors, especially research scientists and consultants. The contractors will be chosen on the basis of demonstrated skills and relevant experience through competitive proposal processes designed to bring the best scientists and experts to the Project for the specific tasks at hand (Appendix 4). The contractors associated with the Project at any one time will be determined by the particular work that needs to be done; a wide range of experts will contribute to the Project over time. On occasion, directed or sole-source contracts will be let (Appendix 4), but typically work will be subject to an open and fully competitive process.

The science managers are responsible for implementing peer review of the Science Program and its products. This process ensures that the work meets standards of scientific rigor. Most large restoration programs incorporate independent review panels, comprised of qualified individuals who are not participants in the long-term monitoring and research studies. These panels include peer reviewers and science advisors, and also protocol evaluation panels to assess the quality of research, monitoring, and science being conducted through the adaptive management program; they provide recommendations for further improvement. The entire Project, including the science and decision-making arms, will undergo review by experts external to the Project on a regular basis. For the first few years, the Project may be reviewed every other year. After that, 5-year reviews may be adequate.

In addition to peer review, monitoring and research will also require review and permitting by the landowners (DFG and FWS) and, in some cases, by regulatory agencies, such as the FWS Endangered Species Office. Work done through universities will require authorizations from human and animal care committees, when appropriate.

Stakeholder Forum and Local Work Groups. Substantial public involvement is essential for support and stewardship of long-term restoration projects and is one of the four functions of the AMP institutional structure. The Stakeholder Forum and Work Groups are designed to provide ongoing, publicly-derived input to the PMT on major components of the restoration plan and adaptive management actions. This input will be used by the PMT to help guide management direction. The Stakeholder Forum will remain as it was constituted in the planning process, composed of approximately 30 core stakeholders with demonstrated, ongoing interest in South Bay ecosystem restoration, representing the following sectors:

- Local Business and Adjacent Landowners;
- Environmental Organizations;
- Public Access /Recreation Interests;
- Public Infrastructure;
- Community Advocates and Institutions;
- Flood Management;
- Public Works/Public Health; and
- Local or State Elected Officials.

Local government staff and elected officials will be invited to join the Stakeholder Forum. Each year, one meeting of the Forum will be dedicated to an Annual Report from the PMT focusing on project accomplishments, progress toward Project Objectives, updates to restoration targets and triggers, lessons learned, progress on local projects, and plans for the upcoming year. Additional Stakeholder Forum meetings will be held as needed for topics such as the Shoreline Study progress, implementation of the Adaptive Management Plan, significant scientific findings, and when unusual monitoring activity results in a management trigger.

Local Work Groups, associated with each pond complex, will be established and will meet two to three times per year at Project milestones. Additional Work Group meetings may be held as needed. These Work Groups will be open to everyone, including Stakeholder Forum members, with a special emphasis on inclusion of local elected officials or staff. The local land managers and flood control districts will participate and a State Coastal Conservancy representative will chair the meetings. The Project Management Team will also make use of other existing groups. For example, the Lower Alameda Creek Task Force could be asked for feedback on plans for the southern half of Eden Landing, and the Alviso Water Task Force could provide feedback regarding the areas around Alviso.

A significant, but often overlooked component of adaptive management is social learning, in which all players interact with and learn from each other (Van Cleve, et al. 2003). One obvious avenue for social learning is educating the public about the science and policy of the restoration project (Parson and Clark, 1995). Providing Stakeholders with clear summaries of monitoring and research information will help them understand the ecosystem. Social learning also means that the PMT will respond to concerns voiced by the diverse population comprising the South Bay area, and will incorporate transparent and genuine ways of responding to public comments. Sincere efforts by the PMT to listen and respond to concerns raised by the

Stakeholder Forum, Local Work Groups, and individuals and groups not already involved in the Project will help to build trust and provide a solid foundation for decision-making over the 50-year lifespan of the Project.

Information Management Staff. This group will be responsible for data storage and access, including monitoring and/or GIS data and is the link among the data collection groups, the PMT, and the public. The Information Management Staff will work with the Science Program managers to provide data and reports to the PMT and to ensure that data from monitoring efforts are made widely available. This group will organize and maintain an Information Repository, which will store and archive the Project's documentation, including decisions, agendas, reports, and monitoring data. To support the Project's mission to distribute information, the Information Management Staff will manage the Project's website. This group will coordinate with other agencies and organizations involved in data management in the South Bay. The Information Repository and management systems should include:

- clear data and metadata transfer and input policies and standards;
- policies and procedures for data validation;
- mechanisms to ensure data integrity and security;
- policies and procedures for public information access and outreach;
- database software and database models to facilitate storage and retrieval; and
- tools to facilitate basic data analysis as determined by the PMT.

Resources in the Information Repository will be organized in a manner that makes clear the level to which the data have been analyzed. One archive approach might categorize information as follows:

- general information—press releases, fact sheets, information summaries, abstracts;
- publications—reports, agreements, printed materials; peer-reviewed articles;
- status and trends—high-level interpretations, graphs, charts;
- maps—watershed profiles, bay atlas; and
- raw data—real-time monitoring, preliminary studies, raw monitoring data.

Documentation would make clear that raw data are high-quality, but have not been interpreted; they will not generally be useful to the public or PMT. One exception is real-time monitoring data, which come from systems that provide easily understood data for immediate dissemination on a website. Data converted to maps they are more easily interpreted and some of this graphical work may be conducted by the Information Management Staff. Complete analysis occurs at the publication level in reports generated by the Science Program. General information is the most accessible level, providing information from previous levels in forms that are clear and understandable to the public and the PMT.

C. Interactive Processes

The Project participants will use a number of methods to coordinate their activities to provide information in a timely manner to the PMT.

Direct Connections. The PMT and Science Program will be integrated, as the Lead Scientist and Monitoring Director will be members of the PMT. When appropriate, regulatory representatives will attend PMT meetings to have direct dialog on regulatory issues. The PMT members, including the science directors, will attend Stakeholder Forum and Work Group meetings to give updates on Project progress and listen to public input. The Science Program managers and other PMT members will work directly with the Information Management Staff to design data storage, analysis, and display methods, as well as public outreach tools.

Reports and Meetings. At a yearly meeting, the PMT will present the Project's progress to the Stakeholder Forum and Local Work Groups and will solicit comments on management directions, when appropriate. This information will go into a yearly report to the public. It is also the task of the PMT to generate reports, as required, by regulatory agencies such as the Regional Water Quality Control Board and the FWS Endangered Species Program.

Science Program reports, for use by the PMT in developing management direction, will be produced through a transparent peer-review process. Specifically, approximately once per year, the Science Program will ensure that summary reports presenting and interpreting the information generated since the last review are generated. Reports will make recommendations for future applied studies, monitoring, and management. At a Project meeting separate from the one between the PMT and the Stakeholders, contractors and the Science Program managers, to the extent they are involved, will present their findings and management interpretations to a peer-review panel. The Stakeholders and Work Group members will be encouraged to attend this meeting. This mechanism accomplishes peer review of Science Program products while providing transparency. It allows the public to learn about the work the Project has produced and the hear comment from peer-reviewers on that work.

Perhaps once or twice a year the Lead Scientist will convene a "science consortium", bringing together researchers and institutions to encourage them to undertake research in the South Bay that the Project cannot fund. These consortiums would inform scientists about research opportunities relevant to the Project, encourage scientific collaborations, and identify ways that the Project might assist researchers, such as by providing letters of support or helping to secure permits. Every two to three years the Science Program managers will host a Science Symposium designed to highlight results of current research relevant to the Project.

Some of the data for the Science Program reports will come from the Information Management Staff, which will provide a yearly summary, and perhaps more frequent mini-reports, describing the data available (old and new), giving basic analysis of monitoring and research data, and reporting on public outreach systems and outcomes.

Stakeholders and other members of the public will have multiple opportunities during the year to provide feedback to the PMT. In addition to the PMT and Science Program meetings described above, the Stakeholder Forum will meet additional times during the year, as required. Additional meetings will occur only if an issue requires comment from the full range of

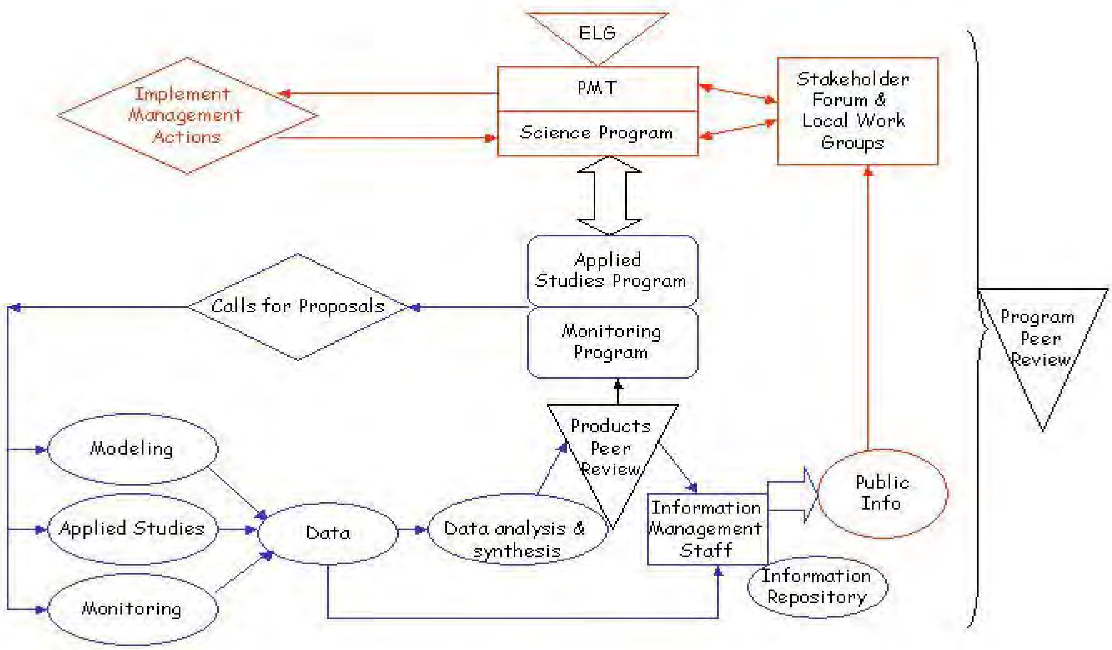
Stakeholders. The Project managers expect Local Work Groups to meet more frequently than the full Forum during the year to talk with the PMT about local Project activities.

Activity Cycles. The public will be informed of Project activities, such as management actions related to management triggers, and invited to provide input, when possible. As described in Part 3, there will be rapid- and slow-response processes in response to management triggers. For slow-response management triggers, the Stakeholders will be involved, through meetings, reports, and email, before management actions are taken. However, for rapid-response management triggers and unanticipated events, decisions and actions will need to occur quickly. The PMT will have developed a suite of responses, in advance, to deal with such issues and typically actions will be chosen from this suite. For other triggers, such as those associated with listed species, the management actions will be prescribed in advance by the regulatory agencies. Stakeholders will be informed through the Project website and email alerts when the PMT has taken rapid action on a trigger. Stakeholders will have the opportunity to discuss what occurred and provide input to the PMT on potential changes to future situations. When a suite of actions is predetermined, the Stakeholders will be informed of these and will be involved in their development, to the extent possible.

Within the Science Program, there are also different cycles of activity. Yearly, the science managers will determine whether the data collected are adequate to meet the Project's monitoring needs and will refine the Project's applied studies and monitoring needs. Calls for proposals for applied studies and monitoring will typically be posted on a yearly basis. Also yearly, the Science Program managers will evaluate the monitoring, modeling, and applied studies reports from the contractors to determine progress toward restoration targets. Applied studies and overall monitoring findings will be evaluated and reported approximately yearly at the public Science Program meeting, as described above. Figure 11 shows how data collection and decision-making are integrated.

Some monitoring data must be screened more regularly to assess whether management triggers are reached. To provide information in a timely manner to the PMT, the Monitoring Director will have an evaluation schedule for different parameters. For example, dissolved oxygen data may need to be reviewed monthly for problems, bird data may need evaluation seasonally, and sediment changes data every 5 years. The data collectors, Monitoring Director, and appropriate PMT members will review the data as required. If warranted, the Monitoring Director and Lead Scientist will meet with the rest of the PMT to determine whether a management trigger has been reached.

FIGURE 11. Adaptive Management Data Collection Processes



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APPENDIX 1: Descriptions for Applied Studies Design

In this Appendix, the Science Team members give detailed guidance to Project Managers and future researchers on potential hypotheses and study designs that could be used to address the Applied Study questions listed in Table 2. These descriptions should serve as a starting point for researchers preparing proposals in response to calls for proposals or designing research for the Project that they will fund through means separate from the Project. Descriptions for Applied Study Questions 6 and 7, on bird use of saline habitats and islands, are given in Appendix 5. Descriptions for Applied Studies 9 (California clapper rail use of tidal habitats), 13 (pond management effects), and 14 (non-native *Spartina* effects) are not included as questions 9 and 13 did not have Science Syntheses to draw upon and research approaches to question 14 will be dependent on other agencies, such as the Invasive *Spartina* Project.

Applied Studies Question 1: Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems within the 50-yr project time frame?
David Schoellhamer, Science Team Member

Background/Rationale

Project objective 1 is to create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration and support increased abundance and diversity of native species in South San Francisco Bay. Desired species primarily utilize either tidally-influenced aquatic habitats or vegetated marsh habitats. In order to create these habitats, the Project must introduce tidal action to existing nontidal submerged salt ponds. The levees around the ponds will be breached to connect the ponds to the estuary and allow the water level in the ponds to vary with the tides. Pond volume below mean tide level, the approximate elevation needed for vegetation colonization, is 31 to 33 million m^3, over 99% within the Alviso ponds. The five most subsided ponds contain one-half of this volume. Thus, the bed elevation of subsided ponds must be raised before it can be colonized by marsh vegetation. Natural deposition of sediment is the most cost effective method to accomplish this. Placement of dredged sediment is a faster alternative but increases costs and regulatory impediments. Once established, vegetation helps the marsh develop by trapping additional sediment and providing organic material. As land subsides and sea level rises, sedimentation is needed to maintain the elevation of the marsh relative to sea level. The net rate of sedimentation will determine whether and when some project objectives will be met.

Natural sedimentation within the ponds will be dependent upon:

- Sediment supply from local tributaries and Bay waters.
- Transport of sediment from the Bay and sloughs into the ponds by tidal currents.
- Deposition and retention of sediment in the ponds.

The rate of sediment supply from local tributaries and Bay waters to the ponds and sediment demand of restored ponds must be known to answer the question. USGS has measured the existing bathymetry of the ponds, so the highest priorities are to gain a better understanding of sediment supply and deposition and retention within restored ponds. Of immediate importance is to continue tributary sediment load measurements because annual variability is large and recent data are scant which can lead to inaccurate estimates of sediment supply. The null hypothesis is that sediment supply is not sufficient to create and to support emergent tidal marsh ecosystems within the 50-year project time frame.

Applied Study Design Concepts
The goal of these studies should be to develop predictive capabilities that can be used by the Project for evaluating how far up the adaptive management staircase the project can go and the likelihood of success of future restoration phases. This would essentially improve upon the South Bay Geomorphic Assessment undertaken at the beginning of the Project. The following major elements are likely to be needed:

1) Measurement of sediment supply from the watershed and Bay waters to the Project area.
2) Analysis of measurements to develop simple algorithms of how precipitation, tributary discharge, tides, and wind affect sediment supply. Estimated cost for the USGS to operate 6 riverine stations and 3 tidal stations and analyze the data is $750,000 per year.
3) Measurement of accretion and vegetation colonization in ponds restored by the ISP and early Project phases.
4) Analysis of pond measurements to develop algorithms or models of deposition and vegetation colonization of restored ponds. Estimated ballpark costs of items 3 and 4 ranges from $100,000 for a graduate student or post doc, involvement of advising professor, and supplies, up to $300,000 per year for a larger University or agency effort.
5) Development of numerical models of watershed sediment supply, Bay sediment supply, and restored pond evolution. A key component is developing hydrologic and climate scenarios to drive the models. The models would use the algorithms from steps 2 and 4 and would be calibrated and verified by hindcasting pond evolution using data collected in steps 1 and 3. Estimated ballpark cost is $200,000 per year for 3 graduate students and involvement of advising professor up to $410,000 per year for a larger University, agency, or 2005 ECOFORE proposal effort.

Because of uncertainties in the models and in developing future hydrologic and climate scenarios, the Project may find that comparing the difference in model results between different restoration scenarios is more useful than evaluating the result of a single restoration scenario.

Sediment supply from tributaries is affected by watershed hydrology and sediment supply from South Bay is affected by suspended sediment concentrations and salinity in Central Bay, which are determined by flows from the Central Valley. Thus, the spatial scale of the study is the watershed of San Francisco Bay and Bay waters. It may be possible to represent processes outside of the Project area by parameterization, surrogates, or algorithms.

Measurements of sediment supply, pond accretion, and vegetation colonization are needed to develop robust predictive models and should be undertaken during the ISP and phase 1. As more data and analyses of the data become available over years to decades, the accuracy of models will improve.

Management Response
Progress up the adaptive management staircase can continue if sediment supply is sufficient for colonization of desired vegetation. If sediment supply is insufficient, then use of fill, perhaps dredged material, is required to continue progress up the staircase. Another alternative may be to alter design of restored ponds to increase deposition. Otherwise progress up the staircase is impossible and unrestored ponds will have to be operated as managed ponds. If results are inconclusive, managers will have to decide whether to stop restoration or to continue restoration and monitor and evaluate pond evolution to determine if an additional restoration phase is desired.

Applied Studies Question 2: Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay?
David Schoellhamer, Science Team Member

Background/Rationale
Although restoration actions are designed to increase habitat quantity and quality, they also have the potential to destroy valuable existing habitat. For example, one effect of breaching a pond to a tidal slough or Bay is to increase the tidal prism of South Bay and the slough. Tidal prism is the change in water volume between low and high tide for a given region. Restoration essentially undoes what the original diking of tidal marsh did: reduce tidal prism and allow remaining tidal channels to fill with sediment. If tides were reintroduced to an area equal to the area of the Alviso ponds (9.4 km^2), the tidal prism south of the San Mateo Bridge would increase by about 10%. When the tidal prism increases, tidal velocities must increase to accommodate the new prism. Increased velocity can cause erosion of existing marsh or tidal flats and scour of subtidal channels. Marsh and tidal flats are critical habitat for shorebirds and waterfowl, are integral in nutrient cycling and food web dynamics, and protect the shoreline from erosion. Indirect impacts from restoration actions are also possible, including changing plankton dynamics through changes in vertical and horizontal mixing in the water column.

For geomorphic responses, the null hypothesis is that restoration does not alter the geomorphology of existing South Bay tidal habitats and adjacent subtidal channels. Studies would measure change of the area and characteristics of existing habitats.

For ecological responses, the null hypothesis is that restoration does not alter the ecological functions of existing South Bay tidal and subtidal habitats. Studies would measure change in the diversity and abundance of species that use these habitats in South Bay.

Applied Study Design Concepts
Geomorphic studies would measure change of the area of tidal marsh in the slough providing tidal connection to restored ponds and in South Bay, change of slough channel bathymetry, change of mudflat bathymetry in South Bay, and change of subtidal bathymetry in South Bay. Geomorphic response to breaching can not be accurately predicted so studies will require flexibility. The most likely scour location is at or adjacent to the breach. Scour may start at the breach and progress through the slough toward the Bay or the slough and mudflats may scour uniformly. It may take years to decades for a new dynamic equilibrium to emerge or scour may never be measurable away from the breach. A cause and effect relation may be difficult to establish between restoration and scour far from a breach, especially if part of the path to the breach is not scouring. In addition to scour, coarsening of bed material and deposition where currents are unable to support increased sediment in suspension are possible. Initially, bathymetry and bed material size should be measured before breaching and annually. Frequency and specific location of measurements can be refined in response to initial data analysis. Recent LIDAR and bathymetry surveys cost the Project $558,000, so with analysis the estimated cost is $650,000 to $750,000 per survey.

The geomorphic studies would provide a measure of the transformation of existing habitat caused by restoration. The effect of habitat change on ecological function would be determined by studies of species that use these habitats and of other functions of interest, e.g., nutrient cycling. Use of habitats should be measured before breaching and if a habitat is being lost to determine if density increases or remains constant. Species that utilize habitats that are likely to diminish or are diminishing as well as target resident species should be the priority for measurement. Establishing cause and effect will probably be more difficult than for geomorphic studies. Measurements at control sites not affected by restoration will be necessary.

Habitat quality may also be affected by changes in geomorphology and suspended sediment concentrations. For example, a habitat quality change not necessarily indicated by geomorphic studies are increased vertical and horizontal mixing in South Bay caused by increased tidal prism and decreased turbidity. Phytoplankton dynamics in South Bay are dependent on mixing; increased vertical mixing would remove them from the photic zone and expose them to benthic grazing and increased horizontal mixing would transport more phytoplankton from shallow water where there is net production to deeper channels where there is a net loss of phytoplankton. Restoration areas are sediment sinks that may reduce turbidity and increase the depth of the photic zone. Studies of mixing and plankton production in areas with and without breaches or before and after breaching would be appropriate. Estimated ballpark costs range from $100,000 per year for a graduate student or post doc, involvement of advising professor, and supplies, up to $1,000,000 for a large University or agency study, depending on the scope.

Management Response

Progress up the adaptive management staircase can continue if the null hypotheses are upheld. If the null hypotheses are refuted, possible management responses are to:

- Evaluate whether the Project causes a net loss of habitat or whether local loss is offset by habitat gain elsewhere.
- Place dredged materials to accelerate restoration and reduce new tidal prism
- Place dredged materials to maintain mudflats
- Time breaches (seasonal, wet years) for maximum initial deposition
- Phased breaches to increase tidal prism more slowly
- Locate breaches to minimize damage to sloughs most susceptible to erosion
- Limit additional tidal prism by keeping ponds isolated or developing muted tidal ponds
- Construct temporary or permanent barriers to control which channels have increased tidal prism
- Connect adjacent sloughs to create a zone of flow convergence and sediment deposition
- Slow or stop progress up the staircase

If results are inconclusive, managers will have to decide whether to stop restoration or to continue restoration and monitor and evaluate habitat evolution to determine if an additional restoration phase is desired. Given that the geomorphic and ecological response may take decades, this is a likely outcome.

Applied Studies Question 3: Flood Hazard Uncertainty (part of Sediment Dynamics)

Dilip Trivedi, South Bay Salt Pond Restoration Project, Science Team Member

Introduction

The Science Team identified three Applied Studies questions to address Sediment Dynamics, a Key Uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective (PO# 2) is to *"Maintain Or Improve Existing Levels Of Flood Protection In The South Bay Area."* To achieve this, we must first identify the existing level of flood protection, and then analyze post-restoration conditions to assess the effects of the project. Since the primary metric of flood hazard is elevation of water levels in the vicinity, predictions of future water levels is necessary. Both, short-term as well as long-term, water levels need to be determined to assess flood hazard potential.

The specific uncertainty, as developed by the Science Team (Applied Studies Question #3), along with a brief explanation of the importance, is described as follows:

> ***Will restoration activities always result in a net decrease in flood hazard ?*** *Increased tidal prism will scour slough channels within a relatively short time frame (months to years) and reduce flood hazard. Changes in tidal elevations and prism in sloughs occurring over months to years may potentially increase flood hazard.*

Background/Rationale

The restoration project envisions opening up some of the diked salt ponds to tidal action. This implies that the levee along the landward edge of those salt ponds will be improved/rehabilitated to sustain tidal as well as wind-induced wave action, such that flood hazard to local communities will not increase. The subject of this Applied Studies discussion is flood hazard resulting from changes in flow within the sloughs and channels which connect to the Bay through the project area. It is important to quantify the impacts of the restoration project on tidal hydrology and water quality in these lower reaches of the creeks. Both, short- and long-term changes need to be considered because the creeks will most likely have a delayed morphologic response to significant changes in tidal prism such as those expected from the restoration project.

Most of the creeks in the project area offer just enough conveyance capacity to convey the design flood flows (100-year in most cases). This was documented in earlier reports (Moffatt & Nichol 2003a, SCVWD 2002). Some creeks, which do not offer this protection, are being modified to contain the design flood flows and the projects are in various stages of development. Changes in tidal water levels in these creeks, even minor, will change the amount of conveyance and may affect the level of flood protection to adjacent communities. Since water levels in the vicinity are a function of fluvial flows from upstream watersheds, astronomical tides, bathymetry, and bed characteristics, each of these elements need to be known for existing as well as future conditions.

<u>Uncertainties</u>

The Project Key Issues document authored by the Science Team had already recognized that the following questions needed to be answered to assess the hydrological impacts of the restoration project:

- what is the hydrology and current pattern in the South Bay as they exist today, and how have they changed over time ? ;
- how will South Bay hydrology change over 50 years in response to human activities and natural processes ? ;
- how will the hydrology in ponds, sloughs and South Bay react to natural changes, as well as human-induced changes (such as ISP, restoration and other changes), over the next 50 years ?

Some of this is already being conducted as part of the environmental review phase. The flood hazard related uncertainties are tied in to hydrological modifications that will occur as a result of the restoration project, primarily due to the combination of fluvial flows and tidal stage. Moving the edge of the Bay farther landward (upstream within the local creeks), as envisioned for the restoration project, may affect the hydrology of the creeks and stability of the levees due to higher currents, scour, and changes in "backwater" elevation. Since the restoration will be phased over several years, assessing the impact of each phase, as well as cumulative impact is necessary.

Applied Study Concepts

Determining the backwater effect within the creeks and potential scour at the base of the flood control levees requires analyzing existing and future hydrological conditions. This is a deterministic effort which can be completed utilizing hydraulic models. Simulations should be conducted for all creeks draining through the project area (Coyote Creek, Guadalupe River, Stevens Creek, Mountain View Slough).

Work should be coordinated with local flood control districts which have conducted Flood Insurance Studies. Output from ongoing SBSP model studies will be needed to model flood stages within the creeks. These parameters include future tidal water levels and allowable future channel dimensions to simulate future conditions. Water levels and velocities should be determined for existing and future conditions, with the emphasis being on storm conditions.

For budgeting purposes, this kind of analysis could be performed using models similar to the existing Flood Insurance Studies models. An allowance of about $200,000 may be sufficient to run the different simulations, assuming that channel surveys and model results from the SBSP restoration project hydrodynamic analysis is available.

Management Options

If it is determined that the backwater elevation increases upstream of the pond levees, due to breaches through slough levees, project design features may have to investigate alternatives for breach locations/dimensions. If it is determined that the base of the flood control levees will scour sufficiently to affect the stability of the levees, mitigation schemes may have to be developed to prevent channel headcutting.

Applied Studies Question #4: Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? Ecosystem changes and effects must be measured and compiled over time to understand the overall implication of South Bay restoration on migratory birds. Some factors that could affect bird numbers are changes in suitable habitat for particular species, disease and predation rates, food availability, and nest competition.
Nils Warnock, PRBO Conservation Science, South Bay Salt Pond Restoration Project Science Team Member

Background/Rationale

The Science Team identified six Applied Studies questions to address Bird Use of Changing Habitats, a key uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective is to provide adequate habitat to support pre-ISP numbers and diversity of waterbirds using the South Bay while increasing numbers of tidal marsh birds such as California clapper rails that have historically used the Bay.

Bird use of San Francisco Bay, particularly in the South Bay is high. Birds counts on San Francisco Bay from 1964-1966, showed highest densities of birds in salt ponds, followed by tidal flats, open water, and tidal marshes (Bollman and Thelin 1970). Single day counts of waterbirds in the salt ponds during winter months can exceed 200,000 individuals (Harvey *et al.* 1992), and single day counts during peak spring migration have exceeded 200,000 shorebirds in a single salt evaporation pond (Stenzel and Page 1988). Takekawa et al. (2000) reported that the South Bay salt ponds supported up to 76,000 waterfowl (up to 27% of the Bay's total waterfowl population) including 90% of the Bay's Northern Shovelers, 67% of the Ruddy Ducks, and 17% of the Canvasbacks. Depending on the year, 5-13% of the federally threatened U.S. Snowy Plover Pacific Coast population breeds at San Francisco Bay, mainly in the South Bay salt ponds (Page *et al.* 1991, Strong et al. 2004). In some years, >20% (1,500 – 2,500 pairs) of the Pacific Coast Forster's Terns may nest in the salt ponds of the South Bay (Strong et al. 2004b).

However, various modeling efforts and expert opinion have suggested that there is the potential for significant declines in some bird populations, particularly waterbirds, if significant amounts of salt pond habitat are converted to vegetated tidal marsh habitat (Takekawa et al. 2000, Stralberg et al. 2003). For instance, Takekawa et al. (2000) estimated that if 50% of the South Bay's salt ponds were converted to tidal marsh, that 15% of the 76,000 waterfowl that use those salt ponds could be lost. Despite the documented importance of San Francisco Bay salt ponds to populations of Pacific Flyway waterbirds, few guidelines exist for state and federal wildlife agencies on how to actively manage a significantly smaller amount of salt pond habitat in the South Bay than currently exists to achieve the maximum abundance and diversity of birds using the habitat while keeping maintenance costs and efforts to a minimum. Answers to these questions rely in part on understanding bird use patterns in and around the salt ponds.

This description gives background to one (Applied Study Question #4) of the six key applied studies identified for the key uncertainty, Bird Use of Changing Habitat - "Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?"

Study Design Concepts

Applied studies to this key uncertainty will primarily be addressed in the other five applied studies questions (ASQ #5-9):

5) Will shallowly flooded ponds or ponds constructed with island or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner?
6) Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?
7) Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner?
8) Will inter-marsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?

9) How do California clapper rails and/or other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?

Answering AS Questions 5-9 will go a long way in addressing AS Question #4, whether the restoration will be able to maintain and improve the carrying capacity of birds in the South Bay. However, key to answering AS Question #4 will be to having an adequate bird monitoring program in place for the restoration project.

Monitoring bird populations in the South Bay

- Study Population: all bird species using the restoration area
- Study Sites: This monitoring will need to encompass several spatial scales including a) the restoration area, b) the South Bay, and c) San Francisco Bay.
- Parameters Measured: Numbers, species diversity, reproductive success, survival; predicted densities (these densities will be generated from modeling exercises on what numbers and diversity of birds are predicted in different restored habitats)
- Study Design: various monitoring designs depending on parameter being measured; Modeling of predicted bird densities in restored habitats to follow methods established by Stralberg et al. (2003).
- Time Frame for Study: monitoring of restoration area should be conducted monthly for the foreseeable future; efforts should be expanded to South Bay and whole Bay scales at some annual interval (every 1-3 years).
- Estimated Study Cost: Monitoring efforts to be split by various organizations and agencies but critical to compile to a central data base including centralized, periodic synthesis of data. Costs - $100,000-250,000/year

Management Options

The results of this monitoring will provide specific data to land managers and other interested parties on trends and predicted densities of focal bird species in the restored area. These data will be compared with trends of bird populations in the South Bay and the entire Bay. These data will serve as triggers for applied management actions. If targets are not met, specific information gathered from AS questions 5-9, can be used to increase carrying capacity of specific habitats to help species of concern.

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Applied studies Question 5: Will shallowly flooded ponds or ponds constructed with island or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner?

Cheryl Strong, San Francisco Bay Bird Observatory, Science Team Member
Caitlin Robinson, San Jose State University, MS Graduate Student
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background/Rationale

Project Objective 1 states that the South Bay Salt Pond Restoration Project will maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees. One of the main concerns of the restoration plan is how to maintain the current numbers of migratory and wintering waterbirds that utilize the salt ponds for foraging and roosting within a smaller number of managed ponds. If ponds can be managed specifically for wildlife habitat such as bird use, then less acreage of managed ponds may need to be maintained. This would: 1) allow for more tidal marsh acreage to be restored, 2) minimize the amount of human intervention and maximize the amount of natural processes within the system, and 3) reduce the cost of long-term management in the project area.

San Francisco Bay salt ponds support hundreds of thousands of shorebirds during the winter and migratory months, the largest numbers of which are found on South Bay mudflats and shallow salt ponds (Goals Project 2000). Yet dry salt ponds have also become important nesting habitat for the federally threatened Western Snowy Plover. Plovers require a unique set of habitat characteristics: they lay their eggs on dry or drying salt ponds, and feed on the high concentrations of brine flies that swarm along the edge of these ponds in highly saline water (Goals Project 2000). If a set of ponds could be managed for shorebirds September to March, then for nesting plovers April to August, we could reduce the footprint of ponds necessary to maintain numbers.

To collect reliable information on this question, we recommend testing the following three null hypotheses. These hypotheses for Western Snowy Plovers and migratory shorebirds can be tested together in one carefully designed experiment:

Ho_1: Ponds managed for Western Snowy Plover by lowering water levels in the spring and summer will not increase the plover nesting density and hatching success.

Ho_2: There is no relationship between ponds constructed with islands or furrows and Western Snowy Plover nest site selection.

Ho_3: The same ponds above (Ho_1) will not support the pre-ISP diversity and abundance of shorebirds when flooded during the winter/migrating period.

- Time Frame for Study: At least three years of data are required to detect significant results for all of the hypotheses above. SFBBO will monitor plover nest success (Ho_1) least through 2007. Plover nest site selection (Ho_1) study currently underway in 2006 (C. Robinson under direction of L. Trulio and with SFFBO); data collection expected through summer 2007. Shorebird surveys (Ho_3) are currently conducted bi-monthly by USGS through 2006.
- Ballpark cost estimate: $25,000-50,000/year (not including USGS surveys or maintenance of furrows and islands).
- Study Sites: Ho_1 and $Ho_{3:}$ Managed ponds: E6A, E6B, E8 E8A and E8X;
- Control ponds: E1C, E4C, E5C, E11, E12 and E14. No ponds have been selected for Ho_2 as of yet, but could include E16B, E15B.

Study Design

Objective 1: Locate snowy plover nests and determine productivity in managed and control ponds. March-August, all snowy plover activity on the pond will be identified to determine foraging and nesting use of the ponds. Surveys will take place approximately once/week and all foraging and nesting birds marked on maps. Nesting birds will be followed as per SFBBO/FWS protocols: nests identified and return visits at approximate 1-2 times/week to determine nest fate.

Objective 2: Locate snowy plover nests and determine productivity in ponds with and without created islands or furrows. March-August, all snowy plover activity on the pond will be identified to determine foraging and nesting use of the ponds. Surveys will take place approximately once/week and all foraging and nesting birds marked on maps. Nesting birds will be followed as per SFBBO/FWS protocols: nests identified and return visits at approximate 1-2 times/week to determine nest fate. All nests will be located with GPS and distance to (or location one) furrow or island will be determined.

Objective 3: Identify shorebird diversity and abundance, and percentage of birds feeding in pond. Using existing survey protocols, ponds will be divided into 250m x 250m grids for mapping in ArcView. All birds will be counted August-April, within 3 hours of high tide, identified to species, determined to be foraging or roosting, and recorded in a grid square. Data will be entered into spreadsheets and added into the grid coverage by abundance. Low water levels must be maintained (5-15 cm) in order to create foraging habitat for small to medium shorebirds. The same ponds will be used as stated in Objective 1. These ponds have been monitored for shorebird use by USGS; these data can be used as "pre-management" data to compare.

Management Responses:
If fewer ponds can support large numbers of wintering/migrating shorebirds as well as successfully nesting plovers, then the PMT can consider movement up the Adaptive Management staircase. Local land managers will need to balance water quality issues with the drying of ponds for the summer months. Pond intakes may need to be closed to prevent flooding of plover nests and/or broods. If this is the case, then these ponds may not be able to reopen to discharge into the bay waters without significant fresh or bay water input after the nesting season has ended. We assume that mammalian predator management will continue in order to help maintain nesting success for plovers. If ponds cannot be managed to successfully maintain habitat for both wintering/migrating shorebirds and nesting plovers, then the Project Management Team will need to reassess the area of dry/seasonal wetlands created within the South Bay landscape before movement up the staircase can be considered.

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Applied Studies Question #8: Will inter-marsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?
John Takekawa, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
To meet the South Bay Salt Pond Restoration Project goal of "no net loss" of waterbirds, adequate habitat must be available within and outside the project site to meet their needs. As ponds become vegetated and change to marsh, birds that currently use ponds heavily could face a population-limiting decline in suitable habitat. Ponded areas and panne habitats within transitional or mature marshes could provide interim or even long-term habitat for some salt pond species. However, not all species may use inter-marsh and panne habitats equally. Furthermore, because such habitat is likely to be less abundant than existing salt pond habitat, waterbird densities comparable to those on salt ponds would be necessary to have a significant impact on local populations. To determine whether these habitats could supplement pond habitat, we need to know the potential total area of these habitats as well as:

1. What species or foraging guilds most use inter-marsh pond and panne habitat and how does the species composition of these habitats compare to that of salt ponds?
2. What are the mean seasonal densities of birds using inter-marsh pond and panne habitat?

We recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concept
Both these questions could be addressed with surveys of developing and developed marsh habitats. Bird surveys should use data collection methods similar to those used on salt ponds so that the data are comparable.

- Study Sites: Developed and developing marshes around San Francisco and San Pablo Bays, including Tolay Creek and Napa-Sonoma Marshes pond 2A.
- Parameters Measured: Complete area counts of birds, identified to species and placed within 250-m survey grids. Behavior and microhabitat data recorded.
- Study Design: Complete counts divided by high and low tide at each site.
- Time Frame for Study: At least one year of monthly counts are needed to assess seasonal variation in site use by migratory birds.
- Estimated Study Cost: Dependent upon the number of sites and frequency of monitoring. Two biological science technicians working half to full-time could survey several sites monthly. Ballpark cost estimate: $40,000-$80,000

Management Options
The results of this study will provide important information to land managers on habitat value of inter-marsh ponded areas and panne habitats to waterbirds that currently use salt ponds. This information can be used to assess habitat needs of waterbirds and determine which ponds should be managed as open water areas and at what depth and salinity.

Applied Studies Question 10: *Will increased tidal habitats improve survival, growth and reproduction of native species, especially fish and harbor seals?* The extent to which restoring the dominant tidal marsh habitat will affect native fish, including the steelhead, and harbor seals, who feed on them, is unknown.
Gillian O'Doherty, NOAA Restoration Center, South Bay Salt Pond Restoration Project, Science Team Member

Introduction
One of the Project Objectives (PO) of the South Bay Salt Pond Restoration Project (Project) is to restore and manage habitats for the benefit of species and ecosystem functioning. As part of the Adaptive Management approach the Science Team has identified Key Uncertainties associated with the Project and has formulated Applied Studies Questions to guide research and management. The Science Team identified a single Key Uncertainty/ Applied Studies question for all of the effects of the on non-avian species, specifically identified as estuarine fish, anadromous fish and marine mammals. Restoring tidal access and saltmarsh is predicted to be of net benefit to these species, however human activities, including changes to physical habitat, hydrology, and increased public access, can also have negative effects on species and habitats. The potential impacts of some of the proposed restoration activities on the fish and marine mammals are unknown and must be studied to reduce the uncertainties involved with achieving the PO. The results of these studies will be used to guide actions as the Project progresses.

The following description for the "Effects on Non-Avian Species" Key Uncertainty gives some background as well as general study design concepts and potential management responses to the information generated by the studies.

Although the Applied Studies Question asks about effects on fish survival, growth and reproduction we recommend focusing on diversity and abundance, distribution, growth rates and some limited aspects of reproduction. Effects on survival will be logistically impossible to measure. The Applied Studies Question also refers exclusively to tidal marsh while fish can be expected to benefit from all increased access to tidal areas, marsh channels, bays or shallow open water habitats. Finally the Applied Studies Question refers to estuarine fish, anadromous fish and marine mammals as one but for clarity the effects on estuarine fish, salmonids and marine mammals will be addressed separately.

Estuarine fish

Background/Rationale

Project Objective #1 states that the South Bay Salt Pond Restoration Project will restore and manage habitats for the benefit of species and ecosystem functioning. A primary step in achieving this objective is to identify the effects of the proposed changes to physical habitat of the species that use the area currently and will likely use the restored area. Fish populations in the South Bay are currently not well understood and the impacts of some restoration and management activities are unknown.

The major information gaps relative to the Project are:

1. What native estuarine fish species can be expected to use the project area before, during and after restoration?

2. Will an increase in available tidal habitat increase the abundance of native fish?
3. Will water control structures significantly impact the ability of fish to benefit from managed ponds and muted tidal areas?
4. Is restored habitat of similar value to fish assemblages in terms of growth, feeding and reproduction as reference habitats?
5. Will there be significant negative impacts from Project activities or increased public access?

Study Design Concepts

Some specific ideas on study designs for each question are as follows.

<u>What is the abundance and diversity of native estuarine fish in the project area before, during and after the restoration? Will there be significant negative impacts from Project activities?</u>

- <u>Study Population:</u> Fish populations using the Bay south of the Dumbarton Bridge for all or part of the year, particularly fish that use the marshes and shallow water areas adjacent to the Project.
- <u>Study Sites</u>: Previously restored and undisturbed native marshes; salt ponds; sloughs in the South Bay including Eden Landing 49 acre mitigation marsh, Cogswell Marsh, Faber Tract and Bair Island. Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures.
- <u>Parameters Measured</u>: Seasonal abundance and diversity; length and/or size in order to determine life-stage.
- <u>Study Design</u>: Sampling during the spring, summer and fall in shallow open water, un-vegetated tidal areas and salt marsh channels. Standardized sampling methods need to be

developed from current work for all future work. Ideally, sampling would occur monthly from spring through fall, at least four sampling dates are suggested with emphasis on spring and summer to capture juvenile use of shallow water habitats. In previous studies sampling has occurred in March, June, July and September.
In addition a large amount of data form the Marine Science Institute exists and could be digitized and analyzed to provide a more complete picture of fish assemblages and trends in the South Bay.

- Time Frame for Study: The initial work to establish a baseline is ongoing. Monitoring should continue throughout the Project life.
- Estimated Study Cost: Ballpark cost estimate: $30- 75K/ year for data collection and basic analysis. Cost of digitizing MSI records $10-30K.
- Comments: NOAA Fish Model Study in previously restored marshes is underway as is USGS study of salt ponds and adjacent sloughs. Future studies should build on this work and concentrate on developing standardized sampling methods; identifying areas of special concern, particularly nursery habitats; identifying limiting factors to fish populations and identifying fish assemblages that use discrete habitat types.

Are the growth rates of fish within the project area within normal limits and do they change over time?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures.
- Parameters Measured: length to weight ratio, age.
- Study Design: Collect length and weight data from fish captured in the abundance and diversity studies. Collect otoliths and/or scales from a subset of fish. Data would be compared to literature or previous studies to determine if growth rates were within normal limits. Trends would be monitored
- Time Frame for Study: Starting immediately and continue through the life of the Project.
- Estimated Study Cost: $40K/ year. This study could be carried out by a graduate student with appropriate input.

Is the fecundity of fish within the project area within normal limits and does it change over time?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: Former salt ponds that have been restored to full tidal action and former salt ponds that are accessible only via water control structures..
- Parameters Measured: Fecundity.
- Study Design: Collect target species during spawning periods to determine fecundity. Data would be compared to literature or other studies to determine if fecundity is within normal limits.
- Time Frame for Study: Once yearly sampling for each species indefinitely.
- Estimated Study Cost: $20K/ year. This study could be carried out by a graduate student with appropriate input.

Are the restored areas functioning similarly to natural areas in terms of prey availability?

- Study Population: Surfperch and native flatfish; other indicator species as identified by USGS and NOAA studies.
- Study Sites: 1) Former salt ponds that have been restored to full tidal action within the project area 2) former salt ponds that have been restored to muted tidal action or otherwise utilize water control structures and 3) natural salt marsh areas in SF Bay (or data from literature)
- Parameters Measured: prey composition and prey availability.
- Study Design: Sample invertebrate populations and collect and gut contents from fish captured within the Project area and compare to data from historical salt marsh or long term restoration projects or data from the literature.
- Time Frame for Study: Study would be carried out periodically in newly restored areas and as salt marsh becomes fully vegetated.
- Estimated Study Cost: $25K. This study could be carried out by a graduate student with appropriate input.

What is the effect of increased public access on recreational fishery species?

- Study Population: fish targeted by recreational anglers in the Project Area.
- Study Sites: Fishing areas that are currently legally accessible and new fishing areas that are made accessible during the Project.
- Parameters Measured: Composition and size of catch.
- Study Design: Identify angling spots and conduct creel surveys to determine fishing pressure.
- Time Frame for Study: Creel surveys could be conducted every 2-3 years to track general trends in angler usage and catch.
- Estimated Study Cost: $15K for several study dates.

Management Options

The results of the first study will provide information that can be used to gauge the success of the Project in enhancing native fish species and ecosystem functioning and protecting existing populations. It will provide data on fish use of restored and managed areas and can be used to improve management of these areas to maximize benefits and reduce impacts to fish.

The second, third and fourth studies will provide more data on how various species use the marsh and what kind of benefits the newly restored habitat is providing to native fish species. The final study will provide data on the impact of an increased recreational fishery and may lead to management changes in terms of access.

Salmonids:

Background/Rationale

Steelhead and fall run Chinook salmon are present in the Project area. Threatened steelhead in the Project Area belong to the Central California Coast Distinct Population Segment. An increase in saltmarsh habitat is expected to benefit steelhead and Chinook populations in the area by providing improved estuarine rearing habitat for juveniles and improved migratory conditions for juveniles and adults. However, some management or restoration activities have the potential to negatively affect steelhead populations including water discharges from managed ponds,

increased fishing pressure, or incidental take associated with restoration activities and monitoring. The major information gaps relative to the Project are:
1. To what extent will salmonids use the newly restored tidal marsh?

Study Design Concepts.

To what extent will salmonids use the newly restored tidal marsh?

- Study Population: The steelhead and Chinook salmon that spawn and rear in streams flowing into south San Francisco Bay, which might use the marshes and shallow water areas adjacent to the Project as they migrate to and from the Pacific Ocean.
- Study Sites: Coyote, Guadalupe, and Alameda creeks.
- Parameters Measured: Spatial and temporal distribution of salmonids through the Project area.
- Study Design: Apply acoustic tags to salmonid smolts migrating from tributaries flowing into south San Francisco Bay. The tags should be compatible with those currently being used to tag salmonids in a large multi-agency study to determine the spatial and temporal distribution of juvenile salmonids migrating from the Sacramento River. The dredging community is part of that study and has not only indicated interest in tagging salmonid smolt from south San Francisco Bay, but also has already purchased a large number of monitors which could be used as part of this proposal. By using similar equipment, the movement of the tagged smolts through the Project area and out of the bay could be monitored.
- Time Frame for Study: The larger salmonid study that is currently underway in the San Francisco Bay region is planned for the spring of 2007-2009. Therefore, if it is essential to tap into their expertise as well as potential access to their equipment, it would not be until the late winter/early spring of 2010. However, if adequate funds could be obtained, then it is possible that a consultant or student (UC Davis is part of the study) could conduct the proposed study, realistically beginning in the spring of 2008. Continued studies would be based on adequate funding.
- Estimated Study Cost: Each monitor cost ~$1,100 and has a range (radius) of 200 meters. Each tag costs ~$300. Some acoustic tags can be tracked with a mobile tracking unit (boat mounted). Otherwise the monitors are stationary and must be downloaded periodically. The tags that can be placed inside juvenile salmonids have a battery life of ~30-60 days, depending on the ping rate.
- Comments: Tagging of ESA-listed species will have to be in compliance with Federal and State permits (NMFS and CDFG).

Management Options
This study would be part of a larger, San Francisco Bay wide look at smolt movement and survival. It would allow smolts to be tracked as they moved through the Project area and migrated out of the Bay. It would provide improved data on migration timing and residence time in the Project Area and would improve the ability of managers to plan activities so that they do not negatively impact salmonids.

Marine Mammals:

Background/Rationale

Harbor seals are present throughout the South Bay, which they use to haul out, for reproduction and for feeding. An increase in tidal habitat is expected to benefit harbor seals by increasing the fish populations on which they feed. There is also the potential for restoration activities such as increased public access and changes in tidal prism to negatively impact populations. The major information gaps relative to the Project are:

1. Do restoration activities negatively affect harbor seals from growth, reproduction or survival, in particular use of historical haulouts and pupping areas?

At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concepts

This work should be coordinated with research conducted on potential public access impacts on harbor seals, which is Applied Studies Question #16. Some specific ideas on study designs for each question are as follows.

<u>Do restoration activities displace harbor seals from feeding, resting or pupping areas?</u>

- ❑ <u>Study Population:</u> Harbor seals in the restoration area or that use adjacent areas to rest, feed or reproduce.
- ❑ <u>Study Sites</u>: Mowry Slough and adjacent pupping and haulout areas
- ❑ <u>Parameters Measured</u>: Numbers of seals using the haulouts for resting. Annual pup production.
- ❑ <u>Study Design</u>: Surveys in the spring and during pupping and rearing seasons.
- ❑ <u>Time Frame for Study</u>: Counts should begin immediately to establish a baseline for population and should continue annually for 10-15 years to monitor potential long-term effects of mercury contamination.
- ❑ <u>Estimated Study Cost</u>: $15K/ year.

Management Options

The results of the study will determine if the Project may be negatively impacting harbor seal numbers through disturbance or changes to the larger ecosystem. Further studies have been proposed as management actions if this is determined to be the case.

Applied Question # 11: Will the scour of Alviso Slough resulting from tidal marsh restoration of associated salt ponds increase the bioavailability of methymercury?
Josh Collins, SFEI Wetland Scientist and Science Team Member

Background and Rationale
The cross-section area of a tidal marsh channel at any point along its length is a function of the volume of water (i.e., the tidal prism) that usually passes that point in the channel during ebb tide (Dyer 1995). If the tidal prism decreases, the channel will get smaller. If the tidal prism increases, the channel will get larger (Dedrick 1979). A change in cross-section area can result from a change in channel width, depth, or both (Collins et al 1987; Coates et al.1989; Leopold et al. 1993).

The reclamation of tidal marshland (i.e., the construction of levees and other structures to isolate the marshland from the tides) represents a loss of tidal prism for the channels that drained the marshlands before they were reclaimed. One result of large-scale reclamation of tidal marshland is therefore a major decrease in the size of the remaining tidal channels. For example, the reclamation of tidal marshland along Alviso Slough in South Bay to create salt ponds caused the slough to narrow and shoal (Dedrick 1993). Conversely, the proposed restoration of these lands as tidal marsh will increase the tidal prism of Alviso Slough, causing it to scour and enlarge. The amount of scour can be predicted from empirically-derived correlations between tidal channel size and tidal prism (Orr and Williams 2002), and from models that relate increases in tidal prism to increases in shear stress against the channel bed, which causes scour.

Sometime during the first quarter of the 20th century, the Guadalupe River was diverted into Alviso Slough (Collins and Grossinger 2005). The Guadalupe watershed contains abundant mercury ore (cinnabar of HgS) that was mined intensively within the watershed as the tidal marshes were being reclaimed. It is likely that the sediments that have accumulated in Alviso Slough during and since the period of mining and reclamation bear large amounts of mercury (Beutel and Abu-Saba 2004).

Mercury (Hg) is dangerously toxic to wildlife and people. The organic form of mercury (methylmercury or MeHg) is an especially powerful neurotoxin that readily accumulates in food chains. Minamata disease, or methyl mercury poisoning, is characterized by peripheral sensory loss, tremors, and loss of memory, hearing, and vision (NRC 2000). Methymercury can be created from elemental mercury under low levels of oxygen (anoxia) in the presence of organic carbon and sulfate-reducing bacteria (NRC 2000, Wiener et al. 2003). These conditions exist in the sediments of tidal marshes and other estuarine environments.

The scour of Alviso Slough can increase habitat for aquatic resources, decrease the need for dredging (Goals Project 1999), and help sustain the adjoining tidal marsh. But the circulation of mercury-bearing sediments in Alviso Slough due to its scour might increase the risk of mercury accumulation in associated food webs. A study of the distribution of mercury within the predicted scour zone of Alviso Slough is therefore warranted.

Study Design Concepts

- □ Study Population: The sediments of the tidal reach of Alviso Slough that are likely to be scoured due to the restoration of adjoining tidal marshland, based on scour predictions provided by the Project Consultant Team.
- □ Study Site: Alviso Slough between the Alviso Yacht Club and San Francisco Bay.
- □ Parameters Measured: depth below sediment surface, total mercury, methylmercury, reactive mercury, total carbon, sulfur, Ph, conductivity, magnetic susceptibility, soil density, grain size.
- □ Study Design: The measured parameters will be profiled over depth in each of 15 5-cm diameter sediment cores 2-m long taken with a piston-corer; one core is taken at each of three stations for each of five cross-channel transects evenly spaced along the Study Site; the stations at each transect represent the left bank, mid-channel, and right bank of the scour zone. All cores will be photographed and x-rayed. Half of each core will be archived for further study if needed.
- □ Time Frame for Study: One-time study conducted in fall-winter 2005-06.
- □ Estimated Study Costs: $60,000-$70,000

Management Options

This study will determine whether or not the scour of Alvisio Slough due to the restoration of adjoining tidal marshland is likely to increase the bioavailability of mercury. If large loads of mercury are discovered within the zone of predicted scour, then the managers of the slough and adjacent lands will have alternative responses, including:

(a) conduct additional studies to further elucidate the extent of the potential problem (this might involve taking more cores to better describe the distribution and quantities of legacy mercury, and/or linking the core studies to sediment transport studies to assess the fate of any mobilized mercury);

(b) Adjust the amount of tidal marsh restoration to prevent the amount of scour that might mobilize the legacy mercury (the mercury may be concentrated at great enough depths that some marsh restoration and concomitant scour is allowable);

(c) remove the mercury-bearing sediment that is likely to scour and place it away from the biosphere (it may be possible to use the sediment with a safety cap to help fill deeply subsided salt ponds slated for tidal marsh restoration);

(d) proceed with tidal marsh restoration and monitor for increased bioaccumulation in sentinel species (provides no preventive measures, however);

(e) not restore tidal marsh along Alviso Slough (precludes major land use objective).

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Applied Question # 12: Will tidal marsh restoration increase MeHg levels in indicative wildlife of managed ponds and tidal marsh?
Josh Collins, SFEI Wetland Scientist and Science Team Member

Background and Rationale

Mercury (Hg) is dangerously toxic to wildlife and people. The organic form of mercury (methylmercury or MeHg) is a neurotoxin that readily accumulates in food chains. Minamata disease, or methylmercury poisoning, is characterized by peripheral sensory loss, tremors, and loss of memory, hearing, and vision (NRC 2000). Methymercury can be created from elemental mercury under low levels of oxygen (anoxia) in the presence of organic carbon and sulfate-reducing bacteria (NRC 2000, Wiener et al.2003). These conditions exist in the sediments of tidal marshes and other estuarine environments (Marvin-DiPasquale et al. 2000, Marvin-DiPasquale and Agee. 2003).

The potential exists to inadvertently increase the risk of mercury (Hg) accumulating in South Bay fish and wildlife through hydrological modification of salt ponds as part of the South Bay Salt Pond Restoration Project (Project). Concentrations of Hg in sediment and water tend to be greater in South Bay due to past local mercury mining (Beutel and Abu-Saba 2004). The Alviso Pond and Slough Complex are especially worrisome because they contain more Hg than most other areas of South Bay (Conway et al. 2004, SFEI 2005) and because they are slated for early hydrologic modification by the Project.

Bayland managers need to know how their actions affect the risk of mercury bioavailability and toxicity. The risk can be assessed most directly by monitoring Hg in 'biosentinel' wildlife species that represent habitat conditions that typically result from the planned management actions. Coupling such a monitoring effort to studies of MeHg production and biological uptake is essential to understand how management actions can be adjusted to reduce the risk of Hg toxicity.

Study Design Concepts

- □ Study Population: Selected "biosentinel" species of invertebrates, fish, and birds that indicate local bioaccumulation of mercury. The candidate species must have a small home range, be easily collected, and be residential within a habitat type or feature that is targeted for restoration or enhancement by the Project.
- □ Study Site: The geographic scope of the study changes over three phases. Phase 1 is restricted to the major habitat types of Pond A8 and Alviso Slough plus ambient sites of these same habitat types. Phase 2 expands to encompass a survey of these habitat types in the South Bay. Phase 3 focuses on South bay locales of special interest identified during Phase 2.
- □ Parameters Measured: Phase 1 involves sampling mercury in selected sentinel species and characterizing the mercury in their habitats. The parameters for wetland habitats include total mercury, methylmercury, reactive mercury, total carbon, sulfur, Ph, conductivity, soil density, and grain size. The parameters for aquatic habitats include unfiltered total mercury, methylmercury, TSS, dissolved carbon, temperature, Ph, sulfur, and conductivity. Maps will be made of all habitat types surveyed.
- □ Study Design: The regional strategy for solving the mercury problem calls for an integrated program of monitoring plus focused research driven by questions and hypotheses that explicitly reflect the information needs of resource managers (Wiener et al. 2002). The proposed work would start by helping the Project Management Team define the mercury problem in practical terms, The work would then proceed to develop cost-effective indicators of the problem, survey its magnitude and extent (beginning with Pond A8 and its adjacent tidal habitats), test for correlations between the problem and manageable environmental factors, initiate research to understand the primary environmental factors most strongly influencing the observed correlations, and help translate these findings into recommended actions to either prevent or correct the problem.

  The work would be conducted in three phases over three years. The approach is scalable, however, and could be used to monitor any management action at any spatial scale from one local habitat patch to the South Baylands as a whole.

The conditions of existing pond and tidal habitat types will be surveyed as analogues for what could be maintained or restored in the pond complexes based on different management scenarios. For example, the tidal habitats to be surveyed in Phase 1 represent the habitats predicted for PondA8 restoration. The existing pond habitats to be surveyed represent the expected future conditions of Pond A8 if it is not restored to tidal marsh. The comparisons are based on sentinel species that are common to tidal and non-tidal habitats. For example, the same sentinel fish species will be sampled in Alviso Slough and Pond A8.

Phase 1 would:

- Develop sentinel species indicators of Hg exposure for Alviso Slough water column, pond water column, slough bottom, pond bottom, tidal marsh panne/pond margin, tidal marsh channels, tidal marsh vegetated plain;
- Assess the mercury problem for the habitat types listed above based on Hg concentrations in the associated sentinel species;
- Characterize the habitats in terms of their propensity to produce MeHg.

Phase 2 would:

- Expand the sentinel species survey to encompass more of the South Baylands. This phase provides a picture of the spatial variability in mercury problem within and between bayland habitats in South Bay.

Phase 3 would:

- Initiate focused research to better understand the linkages between Hg contamination in sentinel species and bio-goechemical indicators for specific habitat types in selected areas, based upon the results of Phase 2;
- Help translate the scientific understanding of the Hg problem into habitat designs and management options that minimize the problem.

□ Time Frame for Study: fall 2005 through winter 2008.

□ Estimated Study Costs: $750,000

Management Questions

Phase 1 of this study will initially determine the relative risks of mercury toxicity represented by different habitat types resulting from different management options for Pond A8. For example, if the ratio between the ambient slough benthic risk and the Alviso Slough benthic risk (based on the benthic sentinel species) is less than the ratio between the ambient slough benthic risk and the Pond A8 benthic risk, then the managers could assume that sampling breaching the pond would not result in a net increase in benthic risk. The same analyses will proceed for the other habitat types. If the restoration of Pond A8 is indicated to increase the net risk of mercury toxicity, then the managers might consider other options than simply breaching the pond, including:

(a) not breaching the pond;

(b) capping the sediments in the pond or removing them before restoring the pond to tidal action (this pertains to the condition that existing benthic conditions in the pond represent relatively high risk due to legacy mercury loads in the pond);

(c) breaching the pond but excluding any tidal habitats, such as marsh panes, small channels, or densely vegetated marsh plains, if their ambient conditions tend to represent relatively high risk;

(d) dredge Alviso Slough (this pertains to the condition that a relatively high risk of mercury toxicity in Alviso Slough is due to its legacy mercury load, and that the scour of these sediments and their possible transport into Pond A8 after it is breached represents a net increase in risk for restored tidal habitats in Pond A8).

Phase 2 of this study will profile the relative risk of mercury toxicity among the habitat types resulting from different planned management actions throughout the South Bay. This profile will provide the managers with a number of options, including:

(a) Assessing the importance of the risk of mercury toxicity relative to other stressors, such as gull predation, flood hazards, biological invasions, and accelerated sea level rise;

(b) Prioritizing the restoration or maintenance of habitat types and habitat features based on their relative contributions to the local and regional risk of mercury toxicity;

(c) Targeting research to explain the conditions of highest risk, and/or to establish threshold of mercury concentration among the sentinel species that correspond to significant biological harm

This option would be translated into Phase 3 of the study, which is designed to address the primary information needs of the managers based on the Phase 2 profile of South Bay conditions.

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Applied Studies Question 15: Will California gulls, ravens, crows, and native raptors adversely affect (through predation and/or encroaching on nesting areas) nesting birds in managed ponds?
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Background/Rationale
Project Objective 1 states that the South Bay Salt Pond Restoration Project will maintain current migratory bird species that utilize existing salt ponds and levees as well as support increased abundance and diversity of native species. Without adequate control and prevention measures, nuisance species such as the California Gull could hamper these objectives through displacement or predation of desired species. California Gulls are opportunistic feeders; their numbers have exponentially increased in the Bay area since first nesting in the early 1980's; over 30,000 now nest in the South Bay (Strong *et al*. 2004, and SFBBO unpub. data). Other species such as Common Ravens and American Crows have also increased in the Bay area in the last few decades largely due to their ability to exploit human-dominated landscapes in general and their ability to successfully nest in power towers and other structures above or adjacent to salt ponds (Josselyn *et al*. 2005, SFBBO unpub. data). Native raptors such as the Northern Harrier are expected to increase with tidal marsh restoration (MacWhirter and Bildstein 1996) and are known predators of the endangered Western Snowy Plover (Page *et al.* 1995). All of these species can be difficult to control in the environment and are likely to impact nesting birds within the restoration project to some extent. Although some level of predation and displacement occurs in all ecosystems, the consolidation of nesting gulls, shorebirds and terns into fewer ponds may increase levels within the restoration landscape to unacceptable levels.

To collect reliable information on this question, we recommend testing the following null hypotheses. Because of differences between the species, there are three hypotheses listed, one for each species or group below.

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

> Ho_{1A}: Displacement of the California Gull colony at the Knapp pond will not reduce the number and/or location of other nesting bird species in the South Bay.
>
> Ho_{1B}: The movement and diet of California Gulls during the nesting season does not change, and therefore has no effect on the number and/or location of other nesting bird species in the South Bay.

Ho_2: Increased tidal marsh restoration will not increase predation of shorebirds and terns by corvids or other tower nesting species.

Ho_3: Increased tidal marsh restoration will not increase predation of shorebirds and terns by Northern Harriers or other marsh nesting raptors.

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

> **Ho_{1A}: Displacement of the California Gull colony at the Knapp pond will not reduce the number and/or location of other nesting bird species in the South Bay.**

Relocation Dynamics of the Knapp Pond California Gull Colony

Background:
The largest California Gull colony in the Bay, ~20,000 birds, is located on a dried salt pond known as the Knapp pond (Pond A6), located near Alviso. Restoration of tidal action to the Knapp pond is currently proposed in Phase I, and is likely to cause the displacement of all or part of this colony. Nesting space may be available on salt pond levees elsewhere within the South Bay (where some gull colonies already exist), but nesting space in the long term will be limited by future tidal restoration, and at least some of the Knapp California Gulls may relocate to islands or levees currently used for nesting by other species. Relocation of 20,000 California Gulls to nesting sites elsewhere in the South Bay areas could potentially have a serious effect on terns and shorebirds as a result of their exclusion from nesting locations and an increase in predation. Given the imminent breaching of the Knapp pond, it is important to identify: (1) where the Knapp pond gulls will relocate; (2) approximate numbers expected to relocate to various parts of the estuary; and (3) the proximity of these sites to those of important nesting areas of Forster's Terns, Caspian Terns, American Avocets, Black-necked Stilts, and Western Snowy Plovers.

Applied Study Design:
1. The first step would be to color band a large sample of the Knapp gulls (>500 birds) in one part of the colony in one year. Color banding will require boom netting before egg-laying has begun so that we will not cause relocation of many banded birds in the initial year of banding.

2. In the year following banding, all gulls with territories in the boom netted section of the Knapp colony will be excluded from their site using wire or repellant over that area of the colony, preventing landing and nesting. Wire/repellant will be installed before the gulls have begun to reoccupy nest sites.

3. During normal colony reoccupation (March-April), a team of biologists will survey for color banded Knapp gulls that have relocated to other suitable nesting habitat in the Bay.

4. Using data on the locations of nesting terns, recurvirostrids, and plovers collected by SFBBO, PRBO, and USGS, the proximity of the relocated Knapp gulls to important breeding areas of other species (and thus, the potential threat to these species) will be determined.

5. We expect an immediate response from gulls within the second year of the study if enough are displaced from the Knapp colony. The banding/displacement may be expanded in subsequent years to bolster predictions of the effects of gull displacement on other South Bay nesting birds.
Management Responses:
If the displacement of the Knapp colony does not reduce the number and/or location of other nesting bird species in the South Bay, then the PMT should consider movement up the Adaptive Management staircase. Monitoring should continue to determine that gulls do not begin to affect other nesting species.

If the displacement of the Knapp colony does reduce other nesting bird species in the South Bay, then the Project Management Team may need to think about reducing the number of gulls or consider not moving up the Adaptive Management staircase. Various methods have been used to reduce the size of gull colonies, including allowing vegetation to cover over nesting and roosting sites, limiting roosting near landfills, using monofilament to cover the nesting site, scaring tactics, oiling eggs, and lethal control. All of the tactics may need to be used over a period of time (even years) to reduce the number of gulls and/or limit their nesting success. Limiting the amount of garbage at dumpsters, in parking lots, and at landfills may also help. Some of these methods would require permits from the USFWS that may be difficult to obtain.

Estimated Budget: $100,000

Ho_1: California Gull colony changes during tidal marsh restoration will not displace or reduce nesting shorebirds and terns.

> **Ho_{1B}: The movement and diet of California Gulls during the nesting season does not change, and therefore has no effect on the number and/or location of other nesting bird species in the South Bay.**

<u>California Gull foraging and breeding dynamics in the South Bay</u>

Background:
We will examine the breeding and foraging movements, distributions, and abundance of California Gulls throughout the South Bay salt ponds and associated landfills and determine the relative contribution of landfills to gull diet. These results will facilitate management decisions regarding colony placement, active gull management, and restoration of specific salt ponds for the South Bay Salt Pond Restoration Project.

Applied Study Design:
The study area will be the salt ponds in the San Francisco Bay National Wildlife Refuge complex and surrounding landfills. Radio-tracking will occur primarily in pond A6 (Knapp). Gull surveys will occur throughout the salt pond complex, including primary nesting sites in ponds A6, A9, 3A, M2, B2, and A1 and landfill foraging sites at Newby Island, Palo Alto, and Tri-Cities.

Objective 1. Monitor the current nesting and foraging distributions and abundance of California Gulls throughout the South Bay salt ponds and associated landfills.

We will conduct monthly gull surveys from March 1 to September 1 at each gull colony and landfill following existing protocols (Takekawa *et al.* 2001a,b; Strong *et al*. 2004). We will identify gulls to species, enumerate, and record gull activity as breeding, roosting, or foraging. Nesting gull surveys will be conducted once yearly during peak nesting (Strong *et al.* 2004). Gull distribution and densities will then be mapped using ArcView GIS (ESRI 1996). <u>This study is in progress through SFBBO and USGS.</u>

Objective2. Examine the movements of California Gulls from nesting to foraging sites using telemetry to determine their relative use of landfills and other habitats as foraging sites.

We will use radio or satellite telemetry to track the movements of California Gulls from nesting sites to foraging areas. In early spring, we will capture gulls using rocket nets (Dill and Thornsberry 1950) or nest traps set at colony sites. We will mark 30 California Gulls with U.S. Fish and Wildlife Service leg bands and a transmitter either attached to the leg or to a backpack harness (Belant *et al.* 1993, Takekawa *et al.* 2002, Ackerman 2004). We will then track gulls daily (if radio-tagged) using trucks equipped with dual 4-element Yagi antenna systems (Gilmer *et al.* 1982) or download locations on a regular basis (if using satellite transmitters).

Objective 3. Examine California Gull diet using stable isotope analysis of eggs and chicks, assess how the diet changes throughout the breeding season, and determine the relative contribution of landfills to sustaining gull populations as well as gull predation on locally breeding waterbirds.

We will use stable nitrogen, carbon, and sulfur isotope analyses to assess the relative contribution of anthropogenic food items (i.e. landfills) to gull diets (Hebert *et al.* 1999). Up to 45 eggs and 200 feather samples from chicks will be collected from California Gull colonies. Up to 50 reference samples will be collected to represent available diet items. We will establish baseline isotopic signatures of prey from the most likely foraging habitats, including food items common to landfills (chicken, beef, pork), and the bay and saltponds (fish [e.g., topsmelt and gobies], invertebrates [e.g., brine shrimp, snails], and nesting bird eggs and chicks [e.g., American Avocets]). We will also assess how diet changes over the course of a breeding season (Belant *et al.* 1993, Duhem *et al.* 2005) by examining differences in nitrogen, carbon, and sulfur values between eggs and chicks. We expect that shorebird eggs and chicks may become a more important component of gull diets later in the season (Ackerman, USGS, unpublished data), thus the isotope values would reflect a greater degree of marine nutrient input. <u>This study is partially funded for 2007 through USGS.</u>

Management Responses:
If the movement and diet of California Gulls during the nesting season does not change, and has no effect on the number and/or location of other nesting bird species in the South Bay the PMT can consider movement up the Adaptive Management staircase. Monitoring should continue to determine that gulls do not begin to negatively impact other nesting species.

If the movement and diet of California Gulls does change during the nesting season in a way that negatively affects other nesting species, then the PMT may need to think about reducing the number of gulls in the South Bay. (See above.)

Estimated budget: $85,000-150,000

Ho_2: Increased tidal marsh restoration will not increase predation of shorebirds and terns by corvids or other tower nesting species.

Ho_3: Increased tidal marsh restoration will not increase predation of shorebirds and terns by Northern Harriers or other marsh-nesting raptors.

American Crows, Common Ravens, and Native Raptor Management

If numbers of gulls, corvids, and native raptors negatively impact other nesting birds to a significant degree then a bay-wide avian predator control program will need to be implemented and likely maintained in perpetuity. Mammal control is contracted with Wildlife Services in the South Bay overall, but avian control currently exists only in the CDFG property of Eden Landing Ecological Reserve.
Various landscape-level factors may also reduce the impact of these species on nesting plovers and other birds if enacted on a broad scale.

Landscape level control:

1. limiting open food and water access, including landfills and dumpsters
2. power tower modification within pond and marsh areas
3. business park/housing development modifications to limit trees near the edge of ponds and marsh
4. removing perches within the pond and marsh areas
5. restoration design to limit Northern Harrier nesting habitat (tidal marsh channels) adjacent to plover or other shorebird nesting habitat (Note that this might conflict with recommendations to have vegetated areas near shorebird and tern nesting sites to give chicks a place to hide from gulls.)

If in the likely event that avian predator management becomes necessary on a large scale, there are various management techniques that can be used in addition to or in place of lethal control. For corvids, these include behavior modification (repellents, sterilants, conditioned taste aversion), and habitat modification (tower modification or removal, perch site removal, modification of anthropogenic food and water sources). While short-term solutions such as lethal removal and behavior modification may be necessary in some circumstances to avoid local population declines of threatened or endangered species, more effective methods for controlling corvid populations in the long run, and that may also benefit entire ecosystem function, are habitat restoration and modification of anthropogenic food and water sources. Because a number of landfills in the South Bay are in close proximity to restoration locations, management actions that deter corvids from eating garbage including installation of overhead wiring, use of chemical repellents, scare tactics, and covering waste with at least 15 cm of soil or a synthetic cover, could help reduce corvid population levels (Josselyn *et al.* 2005).

Because Northern Harriers are included in the "support increased abundance and diversity of native species" restoration design should be attempted before lethal control is implemented.

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Applied Studies 16, 17, and 18: Descriptions for the Public Access Key Uncertainty
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Introduction
The Science Team identified three Applied Studies questions to address Public Access, a Key Uncertainty in achieving the Project Objectives for the South Bay Salt Pond Restoration Project. One primary Project Objective (PO# 3) is to provide adequate, high quality access for visitors to the restoration area. To achieve this, we must understand the local public's recreational interests and, currently, there is little information of local origin. To anticipate public access demand, it is important to track the public's interests and needs, as these will change over time.

The Project also has the primary objective to restore and manage habitats for the benefit of species and ecosystem functioning (PO #1). Research indicates that human disturbance, including public access, can have negative effects on species and habitats (see Trulio, 2005 for a review of this literature). Thus, the public access and ecological Project Objectives may, to some extent, be in conflict. The potential impacts of public access on many important South Bay species and habitats are unknown and must be studied to reduce the uncertainties involved with achieving both Project Objectives.

The following descriptions for the three Public Access Applied Studies questions give a background for each question as well as general study design concepts and potential management responses to the information generated by the studies.

Applied Studies Question #16: Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background
Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. The Project plans boating oriented features such as kayak and small boat launches, which are expected to increase recreational boating traffic. In addition, the Water Trail, a designated water route for recreational boaters, is being developed and sites within the Project will be destination points along this route. Personal watercraft, such as jet skis and wave runners, with their shallow drafts, can access "wilderness areas" previously inaccessible to motorboats (National Park Service 1998). Boating generated by the Project has the potential to negatively affect waterbirds and harbor seals.

There is a very large body of literature on the effects of human disturbance on species. Researchers agree that breeding birds are very sensitive to human disturbance, whether the disturbance is from trail use, boats, or research (Carney and Sydeman 1999, Burger and Gochfeld 1993, Keller 1991, Burger 1981). Studies of watercraft effect found that disturbances from boats can result in nest abandonment and reproduction failure of breeding adult waterbirds (Burger 1998; Erwin, et al. 1995). In general, nesting birds exhibit abnormal behavioral, growth, or reproductive effects (Mikola et al. 1994; Rodgers and Smith 1997), while foraging birds move away from areas of high boating activity with varying degrees of habituation (Burger 1998; Kaiser and Fritzell 1984). Due to high-density nesting habits, colonial breeding birds are particularly susceptible to boating disturbances. Rodgers and Smith (1995, 1997) studied the impacts of outboard boating, canoeing, and walking on several species of colonial waterbirds in Florida. The distance at which the birds flushed depended on the species, disturbance source, habituation, and colony type.

As with breeding birds, researchers found watercraft type affects non-breeding birds in different ways. Rodgers and Schwikert (2002, 2003) showed that waterbirds flushed at significantly longer distances when approached by faster and noisier propeller-driven airboats compared to slower, quieter outboard motorboats. In addition, larger birds flushed sooner than smaller species, no matter what the boat type, probably due to their slower take-off times. In general, the faster and louder the approach, the sooner birds will flush and the larger the waterbird the sooner it will flush. A study at Aquatic Park in Berkeley, CA found ducks, flushed in response to a kayak in the 30-70 m range, depending on species and size of group (Avocet Research Associates 2005). Rodgers and Schwikert (2003) also found that there was high variation in flushing distances within species; habituation may be one reason for this variation.

In San Francisco Bay, recreational boating is a major source of behavioral changes, particularly haul-out patterns, in the Pacific harbor seal (Farallones Marine Sanctuary Association 2000). The effects of disturbance range from mild to severe, from a hauled-out seal raising its head at the sound of a disturbance to being struck and killed by boats. Harbor seals are vulnerable to "harassment by persons on shore and boaters and kayakers from [San Francisco] Bay" and "will flush from haul-out sites at 300 meters" (Lidicker and Ainley 2000). Kayakers can cause greater disturbance to resting seals than powerboat operators because of their tendency to travel close to the shoreline. Kayakers also create disturbances at a greater distance from the seals than do powerboat operators (Suryan and Harvey 1999). Subsequent disturbances, however, have a greater rate of recovery. Suryan and Harvey (1999) suggest two possible explanations: 1) seals become more tolerant of boating disturbances; or 2) seals that are most affected by the initial harassment have already moved on to another haul-out site. Females will remain in the water until the danger passes before returning to their pups. This is important where haul-out sites, and particularly pupping sites, are few in number (Suryan and Harvey 1999). Because harassment increases seals' energy expenditure by decreasing haul-out period, harassment has the greatest impact on nursing pups and molting adults, when haul-out is most critical (Suryan and Harvey 1999).

The literature indicates the need for two studies of boating effects on wildlife:

1. What is the effect of boating generated by the Project on waterbirds, especially non-nesting birds?
2. What is the effect of boating generated by the Project on harbor seals during pupping and non-pupping seasons? (This research should be coordinated with research on harbor seals connected with Applied Studies Question #10.)

Study Design Concepts
At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.
These two studies are very different from each other and will require different research methods.

1. <u>What is the effect of boating generated by the Project on waterbirds, especially non-nesting birds?</u>

Study Design Concepts

- <u>Study Population</u>: Study boaters both within and near the Project area. Study waterbirds, especially migratory species—both shorebirds and waterfowl--found in the Project area.
- <u>Study Sites</u>: Compare areas frequented by boaters to control sites, where boaters are absent or rare. Study both open bay and slough sites.
- <u>Parameters Measured</u>: Flight initiation distance in response to boaters; species richness and abundance in boater and non-boater areas; effects on nesting birds, such as nest success rates (if boaters are approaching nesting areas).
- <u>Study Design</u>: Choose at least 3 boater-use and 3 control sites within or near the Project area, south of the San Mateo Bridge, in each habitat type (open Bay, slough). Collect data 2 or more times per month for two full years. Some control data should be taken at area planned for facilities before the facilities are put in, to do a Before-After-Control-Impact (BACI) study. Analyze data by species, bird group size, season, etc. in response to boater group size and activity.
- <u>Time Frame for Study</u>: Baseline data collection should begin before boating facilities are constructed and before the Water Trail is officially designated. Some or all of this data may have been collected by USGS. Then, begin the two-year boater site-Control study approximately a year after boating features are installed.
- <u>Estimated Study Cost</u>: Study will require a team effort by experienced researchers. Tentative cost estimate: $100,000 for entire study.

2. <u>What is the effect of boating generated by the Project on harbor seals during pupping and non-pupping seasons?</u>

- <u>Study Population</u>: Study harbor seal population south of the San Mateo Bridge, which is typically divided into groups that haul at known locations, including Bair Island, Alviso Slough and Mowry Slough. Study boaters and seals using these areas.
- <u>Study Sites</u>: Harbor seal haul-out and pupping sites in the South Bay.
- <u>Parameters Measured</u>: Immediate behavioral responses to boaters; number of seals in boat-use versus Control areas; movement of seals around the South Bay in response to boaters; tidal cycle and seasonal responses to boaters.
- <u>Study Design</u>: Some parameters, such as immediate behavioral responses, can be achieved with an observational study of unmarked animals. Capturing, marking and using radio-telemetry will be needed for other studies, such as movements around the South Bay.

- Time Frame for Study: Study can begin now to provide basic locational and behavioral information; study for 2-3 years. Repeat this work after boating facilities are completed. Conduct marking/radio-telemetry after boating facilities completed; study for 1-2 years.
- Estimated Study Cost: Observational study of immediate behavioral responses has been initiated by Kathy Fox, Master of Science student, Department of Environmental Study, San Jose State University. Tentative cost estimate: $20,000. Radio-telemetry study tentative estimated cost: $100,000.

Management Options

The effect of public access on wildlife is one of the most contentious aspects of the Project. Providing high-quality public access and recreation is critical to the goals of the Project and also for general public support. But, managers must be sure access is designed and provided in such a way that species are protected. Research is needed to give managers relevant information to achieve both goals.

Both studies will give managers information on the extent of boating effects on sensitive species. Information on flush/response distances will allow managers to estimate the amount of habitat that is compromised by boating activities. Managers may seek to limit the area of impact and/or ensure that enough undisturbed habitat is provided. Information on seasonal sensitivities will allow managers to protect wildlife at sensitive times of the year, through education and seasonal area closures.

The waterbird study will give managers valuable information on different responses of species and guilds in roosting and foraging habitat, which can be used to protect specific areas and in educational materials. Harbor seal telemetry will fill a major data gap—How do seals move about and use the Bay and do they move in response to human disturbance? This critical information will give managers insight into the overall habitat needs of the harbor seal population, once again for protecting habitat, directing boating to minimize impact and educating the public.

Findings will be used to design public access so that it does not have significant impacts on the target species. Design may include keeping public at an appropriate distance from wildlife, permitting only certain recreational activities, excluding public access with significant impacts altogether, or allowing public access with significant impacts in certain proscribed areas while maintaining large refuges with no public access.

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Applied Studies Question #17: Will landside public access significantly affect birds or other target species on short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background
Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. The FWS and DFG are dedicated to providing high-quality recreational opportunities as part of the Restoration Project. However, the potential for conflict exists between the goals of restoring and managing habitat for wildlife (Objective 1) and providing public access (Objective 3) (Delong 2002). Researchers agree that breeding birds are very sensitive to human disturbance, whether the disturbance is from trail use, boats, or research (Carney and Sydeman 1999). In their review of human disturbance of nesting colonial waterbirds, Carney and Sydeman (1999) found scientific research and visitors (recreationists and ecotourists) had a range of impacts on a number of nesting species. Studies of landside recreational activities and non-breeding shorebirds, waterfowl and colonial waterbirds show that bird responses vary based on a number of factors, such as proximity of approach, directness of approach, species, time of year, habituation, location, speed of movement, and type of recreational activity. Direct approaches by people on foot are very disruptive causing flight and reduced foraging times in a many shorebird species compared with undisturbed birds (Thomas, et al. 2003, Burger and Gochfeld 1993). Burger and Gochfeld (1991) also found that pedestrians always disturbed shorebirds if they approached birds directly, but there was no significant disturbance from walkers a path. Some species are more sensitive than others. Pease et al. (2005) and Klein, et al. (1995) found that ducks exhibited significant negative responses to birding, walking and bicycling. Other studies (Josselyn et al., 1989; Rodgers and Schwikert, 2003) have found that larger birds flush at much greater distances in response to human presence than smaller birds. Gill et al. (2001) studied the abundance of black-tailed godwits (*Limosa limosa*) at four coastal estuaries in England and found no effect of human activities, including footpath use, on bird numbers. Habituation is also an important factor. For example, Ikuta and Blumstein (2003) found birds were significantly more sensitive to disturbance at the low human use sites, suggesting birds became habituated to humans in the high traffic areas. In their study of trail use effects around the San Francisco Bay, Trulio and Sokale (in review) found, overall, no consistent difference in bird numbers, species richness or foraging behavior of between trail and non-trail sites dominated by shorebirds at three locations around the San Francisco Bay. Tangential trails with no fast or loud vehicles and the dominance of small shorebirds may have contributed to these results.

The literature indicates a need for these specific studies:

1. What is the effect of trail use on waterfowl? Many trails are planned adjacent to ponded habitat, but we have no information on how waterfowl might respond to those trails.

2. What is the effect of trail use on California clapper rails? We also have no data on the effects of trail use on California clapper rail habitat use and breeding. Wildlife agencies assume the effect is negative, but there are no data to support that assumption.

3. At what distance should nesting islands must be placed from trails for various species to avoid impacts? Nesting birds are very sensitive to human disturbance, but the distance at which that impact is negligible is unknown.

4. What is the response of shorebirds at sites before trails exist compared to after they are opened? Studies of shorebird response to trails before and after trails are introduced would add to our knowledge of trail effects on shorebirds.

Study Design Concepts
1. What is the effect of trail use on waterfowl?
- ❑ Study Population and Sites: Waterfowl in the South Bay, especially those in ponds designated for public access, as well as at non-public access sites.
- ❑ Parameters Measured: Bird buffer distances, sustained changes in abundance and/or species richness, impacts to bird survival, availability and quality of impacted and non-impacted habitat
- ❑ Study Design: For buffer distances, study the distances birds are distributed from levees not used for public access and those that are. Calculate the amount of area that is impacted, i.e. from which birds are excluded, when disturbed by people.
- ❑ Time Frame for Study: 1-2 years

- Estimated Study Cost: Tentative cost estimate: $20,000. This study is underway by Heather White, Master of Science Student, Environmental Studies Department, San Jose State University.

2. What is the effect of trail use on California clapper rails? This study would need to be designed in conjunction with US Fish and Wildlife Service Refuge and Endangered Species staff.

3. At what distance should nesting islands must be placed from trails for various species to avoid impacts? See Pond A16/SF2 experiment for this design.

4. What is the response of shorebirds at sites before trails exist compared to after they are opened? See Pond E12/13 experiment for this design.

Management Options

Findings will be used to design public access so that it does not have significant impacts on the target species. Design may include keeping public at an appropriate distance from wildlife, permitting only certain recreational activities, excluding public access with significant impacts altogether, or allowing public access with significant impacts in certain proscribed areas while maintaining large refuges with no public access.

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Applied Studies Question #18: Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?
Lynne Trulio, South Bay Salt Pond Restoration Project, Lead Scientist/Science Team Member

Background/Rationale

Project Objective #3 states that the South Bay Salt Pond Restoration Project will provide public access opportunities compatible with wildlife and habitat goals. A primary step in achieving this objective is to clearly understand the public's needs and wants for visitor access to the restoration area. The Project's land managers, US Fish and Wildlife Service and the California Department of Fish and Game, allow a range of recreational activity on their lands including hunting, fishing, wildlife viewing, research, photography, environmental education, and interpretation. The Restoration Project is planning to provide a range of public access opportunities in its Phase 1 Project, such as hunting, non-motorized trails, kayak launches, interpretive stations at the Eden Landing salt works and other sites, and overlooks.

Many recent studies of recreational pursuits show increased interest in some activities and declines in others. The 2001 report of National Survey of Fishing, Hunting, and Wildlife-Associated Recreation shows that by 2001 the popularity of these activities had increased from 1996 levels (US Department of the Interior 2003). In California, public survey polls conducted in 1987 showed that outdoor recreation was important to 44% of Californians. This percentage increased to 62% in 1997 (California Department of Parks and Recreation 2002).

In California, participation in all trail activities increased significantly in the last 15 years; bicycling doubled and hiking increased by 50% from 1987 to 1992 (California Department of Parks and Recreation 2002). California's population is expected to grow from its current level of 34 million to 45 million by 2020, further fueling the demand for recreational opportunities. California Department of Parks and Recreation (2002) reports that popular recreational activities of significance to the Restoration Project include recreational walking, driving for pleasure, trail hiking, general nature and wildlife study, bicycling on paved surfaces, visiting historic sites, attending outdoor cultural events, and picnicking at developed sites. Recreational trends show increasing interest in nature study and wildlife viewing, especially among two growing demographic groups, Hispanics and seniors, and a general continued interest in motorized recreation, such as "all terrain vehicles" (ATVs) and personal watercraft. Two traditional recreational uses, hunting and fishing, continue to decline in popularity.

While many questions about public access demand could be studied, two information gaps relative to the Project stand out:

6. What are the public access interests of San Francisco Bay Area residents and visitors?
7. Do the features that the Project provides meet the public's needs in the short and long-term?

At this point in the Project, we recommend specific hypotheses or research questions be designed to address these two questions.

Study Design Concepts

Both these questions could be addressed with well-designed public surveys. The two studies should use compatible data collection methods so that the data compliment each other. Some specific ideas on study designs for each question are as follows.

<u>1. What are the public access interests of San Francisco Bay Area residents and visitors?</u>

- ❑ <u>Study Population</u>: Regional scale needed. Sample the population south of the San Mateo Bridge, but could expand to the greater Bay area. Randomly sample overall population and recreationists; sample residents and tourists/visitors
- ❑ <u>Study Sites</u>: Recreational and non-recreational facilities
- ❑ <u>Parameters Measured</u>: Demographic parameters (age, ethnicity, residence, etc.); Types of recreation/public access engaged in, where and how often; Types of recreation/public access desired; Knowledge of restoration and the Project, in particular; Willingness to support restoration and associated public access
- ❑ <u>Study Design</u>: Survey administered to study population; stratified random sample design
- ❑ <u>Time Frame for Study</u>: Can be administered any time; a year or less of data collection should be adequate. Should be repeated every 5-10 years
- ❑ <u>Estimated Study Cost</u>: Could be undertaken by a qualified graduate student with direct involvement of major professor. Tentative cost estimate: $30,000-50,000

<u>2. Do the features the that Project provides meet the public's needs in the short and long-term?</u>

- ❑ <u>Study Population</u>: Sample visitors to the Project's different public access features.
- ❑ <u>Study Sites</u>: Recreational and non-recreational facilities within the Project area
- ❑ <u>Parameters Measured</u>: Demographic parameters (age, ethnicity, residence, etc.); Project public access features used most often and why; Opinions of the public access provided by the Project; Types of recreation/public access desired; Types of recreation/public access engaged in, where and how often; Willingness to support restoration and associated public access

- ❑ <u>Study Design</u>: Survey administered to study population; include weekdays and weekends
- ❑ <u>Time Frame for Study</u>: Administer during Phase 1, after public access features have been available for at least a year; collect data over all four seasons and during weekdays, weekends and holidays. Should be repeated with each new Project phase and after major changes, of any sort, to existing phases.

- Estimated Study Cost: Could be undertaken by a qualified graduate student with direct involvement of major professor. Tentative cost estimate: $30,000-50,000

Management Options
The results of the first study will provide specific and local information to the land managers on recreational trends and desires of Bay Area residents. This information should be used to adjust existing public access opportunities in the Project area and for designing valued public access features into future Project phases that *anticipates* demand.

The second study will give managers information on how visitors to the Project's public access amenities might use and view those features. Specifically, if some features are not well-used or of interest to the public, they might be converted to features that are attractive. Features that are popular should be increased, if wildlife impacts and funding make this possible. Of course, this information will be very valuable in designing the public access features of future phases.

The information collected by these studies must be acted upon in a *public manner*. If the public is happy with the access that the Project is providing, the Project should celebrate this achievement in public outreach tools, such as newsletters, the website, press releases, and the like. If the public seeks changes, the Project should make those public access changes if possible, based on wildlife needs, funding, etc.; if the changes are not possible, the PMT should make efforts, though meetings and public outreach tools, to explain why requested changes cannot be made. Public responses to people's needs and interests will promote support of the Project and for future phases. Not to address public access demands is to risk negative public sentiment that could prevent movement of the Project up the Adaptive Management staircase.

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Applied Studies 19, 20, and 21: Descriptions for the Social Dynamics Key Uncertainty
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Introduction
The overall goal of the South Bay Salt Pond Restoration Project's planning process is to develop a scientifically-sound, publicly-supported plan. Clearly, an effective planning process requires an understanding of the public's needs and attitudes toward restoration, particularly of this project's proposed improvements. But in addition what is also necessary is an understanding of the ways in which population change, urban development, and political shifts interact with ecological restoration to affect management decisions. Current public attitudes and the potential influence of longer term social, political, and economic shifts on the restoration project comprise key uncertainties that challenge the potential effectiveness of adaptive management and proposed restoration.[1]

Though the uncertainties stemming from social dynamics are most clearly related to the Project Objective focused on human interactions (PO#3), all the Project Objectives have political, economic, or social aspects that may make adaptive management difficult and challenging. Indeed, some have argued that without an understanding and incorporation of social elements, ecosystem management projects may be "even worse than doing nothing."[2] In terms of public access (PO#3), rapid growth and change in population near the project sites may affect public satisfaction with the project because of added demand for access, or in contrast because of changes in public interest associated with the restoration project, public support may wane or increase.

The Project Objectives associated with public service delivery (PO #2, 5, 6) have clear political and economic elements, related to jurisdictional governance issues (such as responsibility and accountability) and the distribution of costs and benefits associated with restoration efforts. Even the more ecological Project Objectives (PO #1, 4) are significantly affected by social dynamics, particularly in terms of the pressures brought by population growth in the region (e.g., groundwater demand, stormwater run-off, solid waste creation and services, and degraded air quality associated with increased traffic congestion), global economic forces (e.g., cargo ship traffic) and climate change (e.g., increasing urbanization and deforestation world-wide).

Though many researchers are assessing the possible influence of varying social dynamics on habitats and environments, the particular character of social, political, and economic change in the South Bay, and its relationship to environmental quality and management remain largely unclear. These uncertainties should be studied and clarified to ensure that adaptive management will be able to respond to what are likely to be significant shifts in population and politics over the 50-year project timeline.

Three Social Dynamics questions have been identified as needing in-depth scientific investigation for the project to meet its objectives. The following descriptions provide a background for each question, general study design concepts and potential management responses that address the study results.

Applied Studies Question 19: Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
Stated public support for the restoration project is a necessary, though not sufficient, requirement for successful passage of ballot initiatives associated with new public funding sources such as tax assessments and bonds. Stated support is not sufficient since behavior (such as voting for an initiative or bond measure) and stated attitudes are not necessarily directly linked. Attitudes and behavior have been shown in many cases to have weak correlations, but research building on the

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[1] Young, T.P. (2000), "Restoration ecology and conservation biology," in Biological Conservation 92: 73-83 makes the argument that habitat degradation is significantly defined by global population growth rates, land use and abandonment, and public awareness of the importance of biodiversity.
[2] Carpenter, S., W. Brock, and P. Hanson (1999). "Ecological and social dynamics in simple models of ecosystem management," Conservation Ecology 3(2): 4. [online] URL: http://www.consecol.org/vol3/iss2/art4/ (last accessed 6 February 2006).

Theory of Reasoned Action[3] has suggested that those with stronger opinions and attitudes (compared to neutral or weak attitudes) tend to behave in line with their stated attitudes.[4]

Some researchers have argued that an environmentalist ideology is the most important predictor of support for environmental regulations or laws.[5] Others have argued in contrast that environmentalist ideologies are less important than income and occupation in explaining voting for ballot initiatives associated with environmental regulations. In one study, [6] individuals who were lower income and employed in the construction, extractive industries (farming, forestry), and manufacturing were usually opposed to environmental ballot initiatives. This suggests that voting behavior for environmental ballot initiatives might be driven by a "'self-interest' theory of environmental demand"[7] rather than primarily by a collectivist view on environmental protection. In other words, though restoration projects tend to be communicated to various stakeholders and interest groups through an environmentalist ideological framework, what might be as important if these results hold for initiatives proposing funding for restoration projects, are the income and occupational characteristics of potential voters and other important stakeholders.

Part of the challenge in gaining and sustaining public support is the very long time span of the restoration project. One issue related to this challenge is the relative lack of evidence clearly indicating the effectiveness of an adaptive management approach. There are few examples of adaptive management projects that have been in place long enough or been systematic enough to provide evidence. One adaptive management project in northwest Australia on ground fisheries, to show "practical results in fisheries management" required a decade of implementation – US examples (e.g., U.S. Forest Service's consensus management plan for coastal forests in California, Oregon, and Washington; Plum Creek Timber Company's habitat conservation plan; US Department of Interior's Glen Canyon Dam habitat project in the Grand Canyon) have tended to not be as systematic as the Australian case.[8]

Communicating the importance and benefits of the project to various interests requires that there is trust both in the information used to describe the project and in the institutions relaying the information.[9] Barriers to building and sustaining trust include intergovernmental conflict (such as specific agencies' desire to control data, and efforts to maximize "biological or economic yield" through single species management) and the "domination" of policy surrounding the project by single/few stakeholders, clients, or funders.[10] Trust and credibility might be enhanced by shifting "from traditional, expert-driven" processes to more community-based assessment and monitoring efforts.[11]

To determine what strategies might be most effective in promoting public support of the project, what is needed is a clearer understanding of the degree of support for the project, the characteristics (e.g., demographic, ideological, etc.) associated with support, and possible competing issues or needs dominating public discourse and voting behavior.

Study Design Concepts

The study measures the degree of support (both stated and behavioral) by relevant individuals, communities, and groups critical to successful planning (e.g., vocal support during public

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[3] Ajzen, Icek and Martin Fishbein (1980). Understanding Attitudes and Predicting Social Behavior, Englewood Cliffs, N: Prentice Hall.

[4] See review in Takahashi, Lois M. (1998). Homelessness, AIDS, and Stigmatization: The NIMBY Syndrome at the end of the Twentieth Century. Oxford, England: Oxford University Press.

[5] Samdahl, Diane M. and Robert Robertson (1989). "Social Determinants of Environmental Concern: Specification and Test of the Model," Environment and Behavior 21(1): 57-81.

[6] Kahn, Matthew E. and John G. Matsusaka (1997). "Demand for Environmental Goods: Evidence from Voting Patterns on California Initiatives," Journal of Law and Economics 40(1): 137-173.

[7] Ibid, p. 140.

[8] Lee, K. N. (1999). "Appraising adaptive management," Conservation Ecology 3(2): 3. [online] URL: http://www.consecol.org/vol3/iss2/art3/ (last accessed 6 February 2006).

[9] Kunreuther, Howard, Fitzgerald, Kevin, and Aarts, Thomas D. (1993). "Siting Noxious Facilities: A Test of the Facility Siting Credo," Risk Analysis 13(3): 301-318.

[10] Pinkerton, E. (1999). "Factors in overcoming barriers to implementing co-management in British Columbia salmon fisheries," Conservation Ecology 3(2): 2. [online] URL: http://www.consecol.org/vol3/iss2/art2/ (last accessed 6 February 2006), pp. 6-8.

[11] Corburn, Jason (2002). "Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community-Based Cumulative Exposure Assessment," Environmental Management 29(4): 451–466; quote on p. 464.

hearings), funding (e.g., voters for assessment or bond measures), and implementation (e.g., sustained support through initial and later phases of the project). The most important issue is the degree of public support (where public is broadly defined, including residents, businesses, advocacy groups, but with a focus on likely voters) for funding for implementation.

- Study Population: Scale depends on funding mechanism, likely cities and counties, with special focus on jurisdictions adjacent to project sites. Two populations are appropriate given resources for study. For very limited resources, focus on South Bay state legislators/aides and local elected officials. If larger pool of available resources, population would consist of South Bay residents, especially likely voters.
- Study Sites: For elected officials, conduct short telephone interview; for likely voters, conduct focus groups (if limited resources) or telephone/web-based survey.
- Parameters Measured: For elected officials, assess perception of public support for restoration project. For focus groups and/or survey, measure demographic parameters (age, ethnicity, gender, residence, occupation, income categories, etc.); environmental ideology; knowledge about restoration and location/ecological condition of specific project sites; perception about benefits and costs of project.
- Study Design: For elected officials, semi-structured interview with interview guide. For focus groups, selection of 8-12 unrelated individuals for discussion, semi-structured discussion facilitated by trained researcher, taped for further analysis. For telephone survey, questionnaire administered via telephone or Internet (though this will bias the sample toward better educated, wealthier voters), stratified random sample design.
- Time Frame for Study: Should be conducted at several points prior to funding mechanism's critical juncture (e.g., election day for ballot measure, public comment period for plan, etc.). Several points in time will provide opportunities for developing public education, social marketing, or advocacy campaign for public support of project. Data collection should be limited to relatively short time frame (2-3 weeks for focus groups or survey) to reduce external influences on measures (i.e., a longer time frame runs the risk of having important social, political, or economic events occur during data collection, which would reduce the comparability of data for the sample portion contacted prior to and after the significant event).
- Estimated Study Cost: For elected officials, requires individual familiar with elected officials and their aides who could access these individuals in a timely manner. Ballpark cost estimate: $50,000. For focus groups, requires facilitator/analyst, transcriber (of audiotapes), cash incentives for participants ($50-$100 each), incidentals (food, transportation, childcare, etc.); assuming between 3-5 focus groups conducted twice prior to the critical funding mechanism, ballpark cost estimate: $50,000. For the telephone/web-based survey, which is the most expensive option, a very rough estimate would be $150,000-$200,000.

Management Response
While the project generally does not seem to be a hot-button issue in terms of opposition and there seems to be general support for habitat restoration in the Bay Area, there are factors that may impede public and political support, such as competing funding initiatives and very local community concerns. Researchers have also cautioned that even if opposition or conflict are not encountered in planning phase, care should be taken to ensure that controversies and concerns are investigated as conflict can flare during implementation and management phases.

The results of this study would provide managers with current information on the level of support, the characteristics of supporters and non-supporters, and the potential reasons for lack of support. With this information, project managers will be better able to craft public education, social marketing, or advocacy campaigns to increase public support (both stated and behavioral) of the project.

Applied Studies Question 20: What are the benefits and costs associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
For management decisions to be made and for public support to be attained, in addition to the ecological and biotic dimensions of restoration, science will likely need to also focus on the political, social, and particularly the economic value of the project. Clarifying the economic

dimensions places this project in the context of and in comparison to other public concerns (i.e., the trade-offs involved in focusing public and private resources on this project versus other noteworthy issues).

Researchers tend to view the environment as a collective or public good, and efforts to restore sites are seen as collective or communal activities.[12] But if the potential benefits and costs are to be measured and communicated to the public and specific interest groups, one necessary step is to take a more pragmatic approach by clarifying the value of the restoration project. Determining the value of the restoration project, however, is a complex endeavor. Cost-benefit analysis provides a quantitative means of assessing the appropriateness or feasibility of options by comparing the costs (including opportunity costs) with benefits accruing to specific actions. Benefits accrue to individuals/communities/businesses (private benefits) or to the public at large (public benefits); the same is true for costs.

> It [cost-benefit analysis] attempts to express all beneficial consequences of an action ($B) and all costs or detrimental consequences ($C) in monetary terms, usually discounted to net present values. Alternative actions are then ranked according to the ratios ($B/$C) or the differences ($B - $C) of benefits and costs. Cost-benefit analysis has the advantages of appealing to a widely-held goal, financial efficiency, and of incorporating different parties' assessments of costs and benefits. It has the disadvantages of not dealing with uncertainty, of obscuring rather than illuminating trade-offs among non-financial objectives, and of offering little help in structuring negotiations.[13]

As this quote indicates, this approach should be used with caution because cost-benefit analysis steers managers and decisionmakers "to adopt only those limited investments in environmental practices which can yield monetary [and by extension programmatic, political, or biotic] benefits within an economic time frame."[14]

Productive activities (e.g., building a bridge or transportation system) as well as publicly perceived negative actions (e.g., polluting) have been assessed using cost-benefit analysis. In one cost-benefit analysis of the private and public benefits and costs associated with conservation programs, for example, the largest benefits were "increases in the value of market sales of farm commodities and reductions in commodity deficiency payments from the Commodity Credit Corporation (CCC)" while the largest costs were "direct CRP [Conservation Reserve Program] costs and increased consumer food costs."[15] Another study analyzed the trade-offs between the costs and benefits of lake pollution (over-enrichment of lakes), and found that the potential benefits from polluting included the profits gained by farmers or developers, while costs included not being able to use the lake's water as a source for drinking water, farming or manufacturing, or for recreation.[16]

While cost-benefit analysis can help to identify the varied economic dimensions of ecologically-focused projects, it does not eliminate issues of inequity or different values concerning the environment, nor does it necessarily make conflicting values more transparent. As one researcher found in an analysis of watershed management in the Pacific Northwest:

> there are also obvious (although generally unacknowledged) asymmetries in the distribution of the costs and benefits of environmental protection between these various constituencies – between, for example, different types of users of resources at the local

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[12] Light, Andrew and Eric Higgs (1996). "The Politics of Ecological Restoration," Environmental Ethics 18: 227-247.

[13] Maguire, Lynn A. and Lindsley G. Boiney (1994). "Resolving Environmental Disputes: A Framework Incorporating Decision Analysis and Dispute Resolution Techniques," Journal of Environmental Management 42: 31-48; quote on p. 32.

[14] Sharma, Sanjay and Harrie Vredenburg (1998). "Proactive Corporate Environmental Strategy and the Development of Competitively Valuable Organizational Capabilities," Strategic Management Journal 19: 729-753; quote on p. 730.

[15] Feather, Peter, Daniel Hellerstein, and LeRoy Hansen (1999). "Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP," Report prepared for the Economic Research Service of the US Department of Agriculture. Washington, DC: US Department of Agriculture; quote on p. 6.

[16] Carpenter, S., W. Brock, and P. Hanson (1999). "Ecological and social dynamics in simple models of ecosystem management," Conservation Ecology 3(2): 4. [online] URL: http://www.consecol.org/vol3/iss2/art4/ (last accessed 6 February 2006).

level, and local and more distant ‘publics’.[17]

Consequently, cost-benefit analysis must be conducted in a rigorous and transparent manner, but should not be used in lieu of a larger and inclusive process of discussion, negotiation, and management of varied interests.

Study Design Concepts
The study measures the local and regional costs and benefits, in monetary terms, associated with the project sites. The costs and benefits should include biotic and habitat dimensions, as well as impacts on local and regional economies, air and water quality, and potential effects on transportation and infrastructure.

- Study Population: Local and regional scales. Study would include local and regional economies, ecosystems, infrastructure and transportation systems, and other relevant factors.
- Study Sites: South Bay region, with an emphasis on municipalities and jurisdictions adjacent to the project sites.
- Parameters Measured: Costs and benefits should include biotic and habitat dimensions, as well as impacts on local and regional economies, air and water quality, and potential effects on transportation and infrastructure.
- Study Design: Secondary analysis of existing data (demographic, transportation, infrastructure, etc.) using appropriate projections (e.g., population, industrial sector change, etc.) and econometric modeling techniques. Potential primary data collection for important factors with limited existing information. May require integration of multiple distinct models.
- Time Frame for Study: Study relies primarily on secondary analysis, but may require primary data collection and analysis (and incorporation of model results into larger integrated model). Could probably be completed within 12 months. Should be completed prior to implementation of project, preferably initiated during planning process.
- Estimated Study Cost: Economic analyses are generally quite expensive. Because this study may also require primary data collection and integrated model development and analysis, a ballpark cost estimate has a wide range: $200,000 - $300,000 (if no data collection, only secondary analysis, projections, and integrated model development); $400,000+ if primary data collection needed.

Management Response
Cost-benefit analysis would provide an economic valuation of the project, and would help to clarify the benefits and costs locally and regionally so that varying stakeholders could better understand the short- and medium-term impacts of the project. The results of a cost-benefit analysis using an integrated model (e.g.,, with population projections, monetary valuation of biotic and habitat restoration, etc.) would clarify to cities, government agencies, advocacy organizations, and residents the trade-offs involved in the project in monetary terms (making comparisons to other proposals and projects more feasible). Though cost-benefit analysis has inherent within it biases (see above discussion), such analysis also provides a solid baseline from which discussions and negotiations can be initiated.

Applied Studies Question 21: Will negative impacts associated with population growth and development adjacent to the project sites and beyond be successfully managed over the long timescale at the regional scale?
Lois M. Takahashi, South Bay Salt Pond Restoration Project, Science Team Member

Background/Rationale
The project’s 50-year time frame means that a myriad of complex and challenging issues will affect the ability of project managers to adapt to changing circumstances. Population size, the activities associated with human presence (such as agriculture, recreation, and economic activities such as local, regional, and international commerce), and the transformation of land use/cover associated with population growth and human activities are all elements that will affect

[17] Singleton, Sara (2002). “Collaborative Environmental Planning in the American West: The Good, the Bad, and the Ugly,” Environmental Politics 11(3): 54-75; quote on p. 68.

the project in significant ways.[18] Human settlement and population growth constitute primary challenges to effective management of the project – "urbanization has been identified as a primary cause, singly or in association with other factors, for declines in more than half of the species listed as threatened or endangered under the U.S. Endangered Species Act."[19]

Planning and implementation of ecosystem restoration projects, however, tend not to engage with planning and action associated with urban and regional development, creating a large level of uncertainty for the project's longer-term outcomes.[20] In addition, researchers still know little about ecosystem restoration challenges in urban, suburban, and exurban locations – the focus of researchers has instead largely been on "lands with a relatively small human presence, often dominated by resource extraction and agriculture."[21]

There are two conceptual approaches to understanding the impacts of human presence on the environment. The first approach assumes that population growth has negative impacts on environmental conditions. Those who advocate such a neo-Malthusian approach believe, simply put, that more people use more resources. From this perspective, population growth is part of a larger system where "materials and energy" flow through "the chain of extraction, production, consumption, and disposal of modern industrial society."[22] Population growth globally is consequently seen as associated with increasing energy demand, which, in turn, increases air pollution from fossil fuel combustion, local and transboundary water and ocean pollution due to effluents, and climate change resulting from "greenhouse" gases.[23] The second approach begins with the argument that neither population nor poverty alone is the most important cause for environmental impacts from human presence. Instead, a "land use/land-cover change" approach focuses on "the alteration of the land surface and its biotic cover,"[24] combining social science through a focus on land use and with natural science through a focus on the physical landscape and biota. Sources of land cover change should be seen as the result of "peoples' responses to economic opportunities, as mediated by institutional factors,"[25] or in other words, "changing consumption and behavioral patterns."[26]

No matter the perspective used to think about the potential long-term environmental impacts associated with development in the South Bay, what is clear is that adaptive management of the restoration project will require information and analysis about the size, composition, and density of populations and development and their impacts on the project sites over the 50-year time frame. The South Bay is no exception to global trends toward land cover change and environmental degradation. For example, economic growth in the region associated

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[18] Vitousek, Peter M., Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo (1997). "Human Domination of Earth's Ecosystems," Science 277(25 July): 494-499.

[19] Miller, James R. and Richard J. Hobbs (2002). "Conservation Where People Live and Work," Conservation Biology 16(2): 330-337; quote on p. 332.

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with global trade will bring continued environmental change. For example, nonnative species associated with ballast water discharge from cargo ships[27] will likely increase given increased activities at Bay Area ports and economic development and trade with Pacific Rim nations, especially China. Land use patterns, such as urbanization (and in the South Bay, suburbanization and densification), and changes in land cover, such as intensification of agriculture or densification of housing development, contribute to local, regional, and global environmental degradation in various ways, including reducing biotic diversity, exacerbating climate change at the local, regional, and global levels, worsening soil degradation, and reducing the ability of ecosystems to provide services that benefit populations.[28]

Study Design Concepts
The study develops long-term (50-year time frame) projections of population, employment, and development in the South Bay, and potential effects on habitat and biota at the project sites. The projections and evaluation of environmental impacts should include biotic and habitat dimensions, stemming from population change (e.g., projections of population size, composition, and density), the activities associated with population change (e.g., projections of employment centers, housing, retail/commercial, and industrial development), and the negative environmental impacts of population change and human behavior (e.g., air and water pollution, land cover change). The study will develop an integrated model using projections of human settlement and public service/infrastructure system change, and provide scenarios or potential portraits of impacts on the project's habitat and biota (given projections, estimates, or targets of the restoration project).

- Study Population: South Bay region (human settlement, economic activity, and habitat/biota).
- Study Sites: South Bay region, with an emphasis on municipalities and jurisdictions adjacent to the project sites.
- Parameters Measured: Projections of population size, composition, and density; projections of change in employment, housing, and commercial markets; change in transportation, infrastructure, and other public systems important to the quality of the project's habitat and biota; impacts on biota and habitat associated with these changes.
- Study Design: Goal is to develop projections of impacts for 50-year project time frame. Secondary analysis of existing data (demographic, transportation, infrastructure, etc.) using appropriate projections (e.g., population, industrial sector change, etc.). Primary field data collection for habitat and biota (using data collected through monitoring proposed for adaptive management. Simulation models of impacts from population, market activity, industrial sector shifts on habitat and biotic quality/health.
- Time Frame for Study: Study relies primarily on secondary analysis, and large integrated model should be updated every 5-10 years. The first model could probably be completed within 24 months. Updates of the model will probably take less time, perhaps 10-12 months. Initial study results would be most useful prior to implementation, but would also provide useful information for ongoing evaluation of project.
- Estimated Study Cost: This is a complex study, requiring an interdisciplinary team (ecologists – especially specialists on biota and habitat impacts from human presence, and social scientists – especially demographers, economists, geographers). Ballpark cost estimate: $300,000+.

Management Response
Because ecosystem restoration projects (and other environmental policies and programs) are long-term in nature, there are a multitude of political, economic, and social uncertainties along with the ecological uncertainties that will continue to affect long-term outcomes. Though there have been some efforts to use socio-demographic projections as background for environmental

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management,[29] conceptual and empirical models of the interactions between urban development and ecosystem restoration are rare. The results from this study are quite important to show stakeholders, decisionmakers, and the public at large the potential interactions between ongoing development and the Project Objectives. Though the results of this study would be largely based on projections and simulations, this study would still provide a tangible portrait of the project's potential impacts and an opportunity to clarify ecological interactions with social dynamics at the local and regional scales.

[29] For example, see Struglia, Rachel, Patricia L. Winter, and Andrea Meyer (2003). "Southern California socioeconomic assessment: Sociodemographic conditions, projections, and quality of life indices." Gen. Tech. Rep. PSW-GTR-187. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Integrative, Mechanistic Model (Proposal for Model Development)

Tidal Marsh Restoration in San Francisco Bay: Evaluating External Effects under Uncertainty

Investigators:
Mark Stacey, University of California-Berkeley
Thomas Powell, University of California-Berkeley
Oliver Fringer, Stanford University
Jeff Koseff, Stanford University

Historically, marshlands were ubiquitous around the San Francisco Bay estuary, with large portions of South San Francisco Bay, San Pablo Bay and Suisun Bay fringed by tidal marsh habitat. Over the past century, these marshes have been “reclaimed” for development, mostly having been put into production as salt ponds. Recently, restoration of these habitats to recover ecosystem function is being pursued at an accelerating pace. The largest single effort in this regard is the South Bay Salt Pond Restoration Project (SBSPRP), which involves the acquisition of more than 15,000 acres of salt ponds by the state of California and the federal government. In the North Bay, the CALFED process has established momentum for marsh restoration in the Sacramento-San Joaquin Delta, with restorations being discussed for tracts along Dutch Slough, Van Sickle Island and many others. Other examples of restoration projects throughout the estuary include Bair Island near Redwood City, and several projects around the perimeter of San Pablo Bay including the Napa Salt Ponds, Cullinan Ranch and Hamilton Field. In each case, the restoration of tidal wetlands will be coupled with the physical and ecosystem dynamics of the adjoining estuary, and the success of the restoration project, as well as the condition of existing estuarine ecosystems, will be shaped by that interaction.

While the goal of restoring native habitats and associated ecosystem function is certainly laudable and carries great benefits, restoration of tidal marsh habitat at the scale that is being pursued is not without its risks. These risks include effects both within the project domains and external effects of the projects on other, existing, habitats. Within the project domain, negative outcomes would include an incomplete recovery of marsh habitat (due to, say, insufficient sediment supply or a lack of vegetation recruitment) or poor quality habitat, which could be due to the detailed spatial structures of the restored habitat and its connection with adjoining habitats, the mobilization of contaminants at the site or other perturbations to the habitat that reduce its ecosystem function.

The uncertainty that surrounds the prospects for restoration success is compounded by uncertainties in the driving natural and anthropogenic processes, particularly at the decadal timescales of interest. Climate change (and variability) is likely to alter oceanic conditions, both through sea level rise and changes in the temperature and biota associated with oceanic waters. Further, the hydrology of the watersheds surrounding the estuary is likely to adjust in response to climate change, including the amount and timing of freshwater flows and the associated sediment supply. In an urban setting like San Francisco Bay, sediment supply will also be altered due to shifts in land use over the decadal timescale of interest. Finally, policies that govern how humans interact with the restored habitats will be dynamic, and create additional uncertainty for the success of the projects.

While much of the analysis to date has focused on the uncertainties associated with the success of the restoration projects, of equal, if not greater, importance are the risks to exterior habitats (beyond the project boundaries) that are created by the restoration process. Due to subsidence of much of the land considered for restoration, the restored areas are expected to accrete sediment for an extended period as they build themselves up to approach marsh elevations. As a result, during the restoration process, the overall sediment budget for the estuarine system will be altered by the presence of large “sinks” of sediments along the perimeter (at the restoration sites). To assess the impact of restoration on existing habitats, sediment transport pathways must be evaluated, including the prospects for scour or accretion in existing habitats. This consideration is also important in evaluating the quality of the restored habitats, due to the presence of sequestered contaminants at depth in many existing habitats (e.g., Mercury in San Pablo Bay). The movement of these sediment-associated contaminants into marshes may lead to increases in their transformation to bio-available forms, due to effects of vegetation on the level of oxidation of marsh sediments (Marvin-DiPasquale et al. 2000, 2003). In order to effectively analyze and predict sediment transport in the system, including the perturbation created by restoration, the adjustment of the system, including tidal forcing and salinity transport in addition to sediment suspension and deposition patterns, must be critically evaluated.

While changes to the patterns of suspended sediment concentration and transport are likely to be relatively quick to appear, other external impacts are more likely to develop over time. For example, the creation of extensive marsh habitat along the estuarine perimeter constitutes a major ecological change for the system. Already, the interaction of salt pond habitats with the estuary has led to the introduction of new species not traditionally associated with South San Francisco Bay (Cloern, 2006). The eventual adjustment of the estuarine ecosystem to the presence of fringing wetlands may not be complete for decades and is filled with tremendous uncertainty. Any predictive analysis of this trajectory, however, will require a basic understanding of transport and turbidity in the estuary, which are the emphasis of the work we are describing here.

In order to accurately analyze and predict the progression of habitat restoration in the face of both internal and external uncertainties, as well as the external impacts of the restoration activity, a modeling tool must be developed and applied that can accurately resolve tidal dynamics, transport and sediment suspension and deposition. These processes force us to consider a wide range of spatial scales. At the small scale, the interactions of tidal and wind-forced motions with the local bathymetry are likely to dominate the analysis of the net sediment movement into the restoration site (Ralston and Stacey 2006), as well as the scour and deposition of sediments in existing habitats in the vicinity. At the same time, though, the analysis must be able to address the estuary-scale dynamics, including exchange between the major subembayments in the estuary (South Bay, Central Bay, San Pablo Bay, Suisun Bay) and between the estuary and the coastal ocean. This combination of requirements necessitates the use of a numerical tool that can provide great detail (high resolution) at local scales of interest, but can also address questions and concerns at the scale of the estuary as a whole. Temporally, while the primary concerns and uncertainties involve the procession of restoration and the adjustment of the estuary at the timescale of years to decades, short timescale processes due to tidal and wind forcing dominate the net sediment and salinity transport that will determine the longer timescale trajectory of the system. Together, we require a flexible numerical tool that can accurately and efficiently simulate tidal and wind motions at the local scale of the restoration projects, but can also expand to the estuary as a whole.

On its own, however, a numerical tool does not constitute a modeling system. To be clear, observations of the system, including the local topography and the local influence of tides and winds on flows, mixing and transport of sediment and other scalars, are required to both calibrate the numerical tool and to confirm our physical understanding of the processes being simulated. To make this description of an integrated modeling system more specific we can consider the question of how Coyote Creek and the intertidal habitats along its perimeter are scoured (or otherwise modified) by the activities of the SBSPRP. In this case, any modeling efforts must be certain to accurately capture shear stresses and sediment transport at the scale of Coyote Creek and the adjoining Sloughs. At the same time, if we were interested in how the SBSPRP as a whole modifies the annual sediment budget for the San Francisco Bay Estuary, the detailed tidal dynamics of perimeter sloughs become less important. This example illustrates the need for careful calibration and verification of a modeling tool *at the spatial and temporal scales of interest.* The distinction here is between a *numerical* modeling exercise and an *approach* to modeling an environmental system. Numerically, a model can be expanded to include any domain or the grid can be reduced to resolve any feature; this does not make it an effective model for all processes being simulated.

The modeling system that we aim to develop relies on a flexible three-dimensional hydrodynamic and sediment transport model (SUNTANS, see Fringer et al. 2006) to predict how restoration actions will interact with the existing estuarine system, including changes in local tidal dynamics, salinity and suspended sediment concentrations. The flexibility in the numerical approach allows for highly resolved studies in and around particular restoration sites, while not compromising complete Bay coverage (through a variable grid spacing). While our initial modeling efforts will focus on the tidal and wind-forced dynamics, and their influence on transport of salinity and suspended sediments, this modeling approach provides a necessary foundation on which other, cross-disciplinary modeling efforts can be built. For example, modeling the mobilization of metals and their transformation into bioavailable forms would rely heavily on an understanding of how sediment moves through the system due to the strong association of these contaminants with sediments. Ecologically, primary productivity in the estuary is sensitive to the extent of penetration of light into the water column, so understanding and predicting how the turbidity (suspended sediment concentration) will adjust following restoration activity is a necessary first step. In each case, we aim to provide the physical "infrastructure" on which interdisciplinary models can be layered.

At the same time, it is critical that the numerical analysis be coupled with observations of physical processes (forcing and resulting flows and transport) and bathymetry at the scales of interest. The observational needs will vary between projects due to the existence of other observational efforts. In the far South Bay, for example, detailed studies of lower Coyote Creek (March-May 2006) and the flows through an Island Pond Breach (September-November 2006) are likely to provide an excellent foundation for calibrating and verifying a numerical model for the interaction of the region south of the Dumbarton Narrows with the SBSPRP. At a larger scale, the development of an ocean observing system, which is expected to extend into the Bay (CeNCOOS, see http://www.cencoos.org/), along with previous transect observations (Fram et al. 2006), provide an important foundation for considering ocean-estuary exchange. During the early stages of development, these observations will need to be somewhat extensive, as the details of slough-mudflat exchange and other small-scale, local, processes have not really been explored sufficiently to establish our physical understanding. With each successive application of the modeling system, however, fewer physical process-based observations will be required, perhaps only involving a detailed survey of the local bathymetry and a few basic calibration-oriented data sets.

While the mechanistic details of the development of this modeling system are beyond the scope of this short summary, we would like to note a few of the applications that the model will allow us to consider. First, the interannual variability in the sediment supply for the restoration projects can be considered by resolving the annual cycle of sediment deposition and redistribution, with consideration of the potentially important influence of extreme events. Secondly, long-term shifts in climatic forcing and land use can be addressed by considering how changes in oceanic conditions (rising sea level as well as shifts in oceanic conditions) and hydrologic forcing (riverflow timing and magnitude as well as sediment loading) affect the restoration projects and interact with those projects to define the long-term adjustment of the estuarine ecosystem.

Detailed Description of Activities and Associated Budget

Considering a three-year research time horizon, we now describe briefly a specific set of research activities that are motivated by the general discussion in this document. First, we will pursue an analysis of sediment transport in the region south of the Dumbarton Narrows (the Far South Bay) and the influence of annual variability in sediment supply. This activity would consist of both numerical development as described in this document and continued analysis of data sets collected in conjunction with the SBSPRP; the first examines the detailed dynamics of Coyote Creek adjacent to early breaches in the project (the Island Ponds) and the second data set examines flows and transport through a breach in detail. The data analysis would be focused on both developing an understanding of the basic physical processes that dominate sediment transport and establishing a reliable calibration and verification data set for the numerical activity at the scale of interest. Next, we will pursue modeling and analysis of a second site of similar scale to the Far South Bay modeling exercise. The specific choice of a site would be based on what data is available for calibration and verification purposes, most likely a San Pablo Bay restoration site. Finally, in both of these modeling exercises, we will evaluate the performance of the model in Central Bay using existing measurements of currents, salinity, temperature and suspended sediment (Fram et al. 2006). This final exercise is motivated by our interest in using our modeling approach to examine the effects of restoration at the scale of the entire estuary; the Central Bay data sets provide a rigorous test of the model's ability to extend to those spatial scales. To summarize these activities:

- Transport analysis and modeling South of the Dumbarton Narrows, including annual variability
- Transport modeling at a second restoration site to be determined (likely to be San Pablo Bay)
- Evaluation of model performance in Central Bay near the Golden Gate.

A rough budget for these activities, based on a three-year time horizon is $750,000 or about $125,000 per year for each institution (UC-Berkeley and Stanford). This estimate of the budget includes 1 graduate student researcher at each institution, salary support for each PI to contribute during summer months, and allowance for miscellaneous supplies and expenses related to computational facilities, publications and travel.

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APPENDIX 2. Sequencing of Applied Studies, South Bay Salt Pond Restoration Project
Authors: Lynne Trulio, Lead Scientist, and Science Team
Dated: July 24, 2007

This memo provides an approach and rationale to sequencing the Applied Studies the Science Team has developed during the planning phase of the South Bay Salt Pond Restoration Project. Sequencing is important because, although all the studies we have identified are essential to the Project, some are on the critical path for research. This approach has three tiers:

Sequence 1 includes studies to be implemented at the beginning of Phase 1 or before, either because they address a direct threat to our ability to achieve Project Objectives, because Phase 1 provides ideal conditions to study the question, or the findings are essential to implementing future actions.

Sequence 2 includes studies to be initiated some time in Phase 1, but more fully in conjunction with future Project actions. Phase 1 conditions are not ideal for addressing these questions, but some data can begin to be collected in Phase 1.

Sequence 3 includes studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected.

Sequence 1: Studies to be implemented at the beginning of Phase 1 or before, as Phase 1 actions are conducive to answering these questions.

AS 5: **Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds?**

AS 6: **Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?**

AS 7: **To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner?**

Rationale for AS 5, 6 and 7:

- The extent to which the current diversity and abundance of birds can be supported in a smaller footprint of actively managed ponds will be an important determinant in how much tidal marsh can be restored while still meeting Project Objectives. This information is critical for designing future Project actions.
- Conditions in Phase 1 are conducive to answering these questions as much of the Project area will still be managed ponds that can be manipulated to test the importance of different factors in attracting and supporting different bird species.

AS 11: **Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species?**

AS 12: **Will pond management increase MeHg levels in ponds and pond-associated sentinel species?**

Rationale for AS 11 and 12:

- Since the early stages of planning, the Project proponents have realized that Project actions have the potential to increase bioavailable mercury in the Bay. This issue has the potential to hinder the Project's ability to meet Project Objectives for sediment and water quality, and ecosystem health.
- There are major gaps in our understanding of this human and ecosystem-related issue and, as a result, research began in the planning stage. Studies continuing into Phase 1 will assess the effects of Project actions, both pond management and tidal restoration, on mercury uptake to the food web. Tidal restoration in A8 is being designed specifically to assess tidal restoration on mercury uptake.
- As part of the MeHg studies, data collection should begin on AS 2 (see Sequence 2 below). Pond A8 provides an ideal opportunity to study this question in sloughs.

AS 13a: **What is the effect of pond management on water quality and species both inside the ponds and outside in the sloughs and bay adjacent to pond discharge points?**

Rationale for AS 13a:

- Potential effects of operating the ponds under the Initial Stewardship Plan (ISP) have not been studied and little is known about the effects of pond management on conditions inside the ponds and directly outside. As a result, managers have had to deal with water quality problems since ISP management began. Lack of research on this topic could impede meeting Project Objectives for water quality and overall ecosystem health.
- Potential effects of pond management on entrainment of salmonids in ponds, pond discharges on receiving water species, and harbor seal populations, which are relevant to AS 10, should be studied in Phase 1.
- Understanding conditions created by pond management is of immediate importance in Phase 1 as most of the Project area will continue to be managed as ponds.

AS 15: **Will California gulls, ravens and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds and restored areas?**

Rationale for AS 15:

- The exponential increase in the California gull population in the South Bay is an immediate threat to Project Objectives focused on preserving nesting species and protecting listed species.
- An Adaptive Management Working Group for this issue has identified a number of studies that must be implemented before Phase 1 begins, as the Phase 1 actions will evict approximately 24,000 gulls from pond A6.

AS 17: **Will landside public access significantly affect birds or other target species on short or long timescales?**

AS 18: **Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales?**

Rationale for AS 17 and 18:

- Two of the Project's missions to protect wildlife and enhance public access may be in conflict for some species and some types of access, and this issue is of great concern to stakeholders. Phase 1 includes an array of land-side public access elements, especially trails, near a range of habitats, which facilitates the study of land-side public access effects on wildlife.
- Adaptive Management for the Project includes a process for collecting and analyzing data on public access and wildlife interactions as well as on public satisfaction with access features. Collection of data is critical in Phase 1 since conclusions from the analysis will guide the type and amount of public access that could occur in Phase 1 and future phases.

AS 19: **Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales?**

Rationale for AS 19:

- Funding is now, and will continue to be, a major challenge to implementing the Project and its adaptive management process. Money will need to come from a wide range of sources, including local residents, but we have little information on how to reach a range of constituents and secure their support. This may be one of the greatest threats to achieving the Project Objectives.
- By collecting this information in Phase 1, Project managers can design fund-seeking approaches that will provide money for future phases. Some approaches, such as ballot measures, will need significant time to develop and should be started as soon as possible.

Sequence 2: Studies to be initiated some time in Phase 1, but implemented more fully in conjunction with future Project Actions that better support addressing the questions.

AS 1: **Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame?**

AS 2: **Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay?**

AS 3: **Will restoration activities always result in a net decrease in flood hazard?**

Rationale for AS 1, 2, and 3:

- Relatively little area will be opened to tidal action in Phase 1, which does not afford much opportunity to study these questions. One exception is opening A8 to tidal action, which affords an opportunity to collect data on AS 2 in sloughs. Future actions are expected to open large numbers of ponds along specific sloughs, which will provide optimal conditions for answering these questions, especially AS1 and 3.
- However, the Island Ponds and ponds open to tidal action in Phase 1 do allow initial study of these questions and research has begun, especially on AS1 and 3. Research conducted in Phase 1 will form the basis for research in future phases.

AS 14: **Where not adequately eradicated, does invasive *Spartina* and hybrids significantly reduce aquatic species and shorebird uses?**

Rationale for AS 14:

- This research depends on the results of the Invasive Spartina Project, which is currently in process. The results may not be known for some time. If the Invasive Spartina Project cannot control invasive *Spartina*, AS 14would become necessary.
- However, even now, the USGS is conducting research on the response of clapper rails to invasive and native *Spartina*. Any research conducted now will provide a basis for understanding species' responses to different types of habitats.

AS 16: **Will increases in boating access and boating behavior significantly affect birds, harbor seals, or other target species on short or long timescales?**

Rationale for AS 16:

- Relatively little in the way of improved boating access is planned in Phase 1, so this phase does not afford much opportunity to study this question.
- There is one kayak launch planned in Eden Landing that could be used, in combination with other South Bay kayak launches, as part of an initial study on this question.

Sequence 3: Studies to be initiated after Phase 1 actions have been implemented and habitat has evolved or data from Sequence 1 studies have been collected.

AS 4: **Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions?**

Rationale for AS 4:

- This question requires analysis of data collected from other studies, especially AS 5, 6, and 7, but also AS 8 and 9. Thus, this question cannot be addressed until a number of years of data have been collected, during Phase 1 and after.
- This question should be analyzed at regular intervals during the Project's lifetime, beginning in Phase 1, to determine the overall effect of the Project on South Bay birds.

AS 8: **Will pond and panne habitats in restored tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?**

AS 9: **How do clapper rails and other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?**

Rationale for AS 8 and 9:

- Both questions involve determining species responses to vegetated tidal marsh conditions, which will take some time to evolve after Phase 1 tidal marsh actions are implemented.

- However, baseline data at appropriate reference sites can be collected in advance of tidal marsh evolving at the Phase 1 sites.

AS 10: **To what extent will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals?**

Rationale for AS 10:

- Response of non-avian species depends on tidal marsh evolution, which will take some time. During Phase 1, conditions will eventually change enough to potentially benefit native species survival, growth and reproduction. This study should be linked to the evolution of tidal habitat.
- However, even before marsh develops, baseline data on species use of managed ponds and the South Bay should be collected via Project monitoring and studied specifically as part of AS 13a.

AS 13b: **What are the effects of tidal habitat restoration on water quality, food web dynamics, and key components of the ecosystem such as phytoplankton, benthic invertebrates, or fish diversity and abundance in the South Bay and what factors result in these effects?**

Rationale for AS 13b:

- Response of the ecosystem and its components to restoration will depend on significant tidal marsh evolution. During Phase 1, conditions will eventually change enough to potentially affect ecosystem level components.
- However, even before marsh develops, baseline data on conditions in the South Bay ecosystem should be collected in order to assess the effects of restoration changes.

AS 20: **What are the costs and benefits associated with the Project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales?**

Rationale for AS 20:

- Monetizing Project actions standardizes the value of Project effects for clearer understanding by businesses, government agencies, and advocacy organizations (i.e., a dollar value is placed on the Project and its outcomes). The study would consist of analysis of current and projected economic conditions, estimates of Project costs (including actual construction and monitoring costs, but also potential social or health impacts), and projections of the economic benefits associated with Project activities.
- This study may be best implemented after some Project actions have occurred, allowing for public reaction. This study will provide data for Project Managers to educate the public about the benefits/needs/trade-offs associated with particular activities.

AS 21: **Will impacts associated with population growth and development adjacent to the Project sites and beyond be successfully managed over the long timescale at the regional scale**?

Rationale: for AS 21:

- Answering this question requires modeling to forecast social conditions around the Bay and the impacts of those conditions on the Project. This information will be most beneficial in later Project phases when landscape scale changes to the ponds occur. Those changes should occur in the context of predictions about impacts of future conditions, whether they be associated with climate change or the social fabric adjacent to the Project.
- However, developing this model should begin in conjunction with developing landscape scale hydrodynamic models, with the expectation of ultimately linking their predictions.

APPENDIX 3. Adaptive Management Summary Table

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Sediment Dynamics Project Objective 1 (Preserve existing estuarine habitat areas)	No significant decrease in South Bay intertidal and subtidal habitats (south of San Bruno shoal), including restored pond mudflat, intertidal mudflat, subtidal shallow and subtidal channel areas.	▪ Area of restored mudflat. ▪ Area of outboard mudflat. ▪ Area of subtidal shallows and channel. Methods: Bathymetry and LiDAR surveys will be performed periodically, initially every 3–5 years and then less frequently if data suggest slower rates of changes over time.	▪ Change in tidal mudflat and subtidal shallows expected to vary at the pond complex scales. Areas will be estimated and reported on the pond complex scale. ▪ Changes in South Bay need to be placed within system-wide (San Francisco Estuary) context to assess influence of external factors.	▪ Change in tidal mudflat & subtidal shallow: 10–20 years, assuming significant tidal habitat restoration continues beyond Phase 1. ▪ Subtidal channel change: 0–5 years.	▪ Outboard mudflat decreases greater than the range of natural variability + observational variability/error.	▪ Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance) in the South Bay? ▪ Development of a 2- and 3-D South Bay tidal habitats evolution model.	▪ Convene study session to review and interpret findings to assess if observed changes are due to restoration actions or system-wide changes in the sediment budget (*e.g.*, effects of sea level rise). ▪ Study biological effects of loss of mudflat, subtidal shallows, and/or subtidal channel habitat. ▪ Adjust restoration phasing and design to reduce net loss of tidal mudflats. Potential actions include remove bayfront levees to increase wind fetch and sustain tidal mudflat, phase breaching to match demand and supply, and/or breach only high-elevation ponds to limit sediment demand ▪ Reconsider movement up staircase
Sediment Dynamics Project Objective 1 (Rate of accretion indicates trajectory toward vegetated marsh)	Accretion rate of the restored ponds is sufficient to reach vegetation colonization elevations.	▪ Areas of inboard mudflat and pioneer marsh inside ponds ▪ Sedimentation rate inside breached ponds. Methods: Transects or SET in breached ponds, annually at first and then less frequently as rates of accretion slow. LiDAR surveys (see above).	▪ Pond scale	▪ 2–10 years depending on initial pond elevation	▪ Projections based on the rate of inboard mudflat accretion suggest vegetation colonization elevations are not likely to be achieved within the planning time frame.	▪ Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems within the 50-yr projected time frame?	▪ Convene study session to review findings to assess if observed changes are due to restoration actions and whether colonization is compromised. ▪ Study biological effects of slower tidal flat evolution. ▪ Adjust phasing and design to increase inboard mudflat accretion. Potential management actions include adding wave breaks or adding fill. ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Sediment Dynamics Project Objective 1 (Maintenance or increase of current vegetated marsh is essential to key species)	▪ No long-term net loss of vegetated tidal marsh throughout the South Bay.	Total area of tidal salt marsh Methods: Bathymetry and LiDAR surveys and/or Iconos satellite data and/or aerial photography and ground truthing	Pond Complex and South Bay	10 to 20 years	▪ Observed net loss of tidal salt marsh (area of outboard fringe marsh losses > greater area of tidal marsh in restored ponds) than the range of natural variability + observational variability/error.	▪ Will sediment accretion in restored tidal areas be adequate to create and to support net increase in emergent tidal marsh habitat within the 50-yr projected time frame? ▪ Development of a 2- and 3-D South Bay tidal habitats evolution model	▪ Convene study session to review findings to assess if observed changes are due to restoration actions. ▪ If tidal marsh area is not meeting projections, assess biological significance of long-term loss of tidal marsh. ▪ Adjust phasing and design to accelerate marsh development. Potential management actions include filling to colonization elevations, adding wave breaks and/or preserving bayfront levees ▪ Adjust phasing and design to reduce erosion of existing marsh. For example, phase tidal restoration to match sediment demand and supply.
Flood Protection Project Objective 2	▪ No increase in tidal or fluvial flood risk at any project phase and improve tidal and fluvial flood protection in the South Bay in specific areas	▪ Survey slough channel cross-sections (scour) in the vicinity of breaches; ▪ Survey marshplain accretion in the ponds; initially frequently, then less often ▪ Measure water surface elevations inside the ponds and in the sloughs in the vicinity of breaches; initially annually, then less frequently ▪ Collect high water mark elevations in the vicinity of breaches and upstream, following large flood events ▪ Inspect for levee erosion initially monthly, then annually, and after major rainfall and/or tidal events ▪ Monitor relative sea level rise (sea level rise and land subsidence) every few years ▪ Water levels and cross-sections upstream in flood-prone channels	Slough (drainage) scale	▪ Slough channel cross-sections, marshplain accretion, and water levels: rapid initial response (within approximately five years) followed by slower changes over decades. ▪ Flood high waters: approximately every ten years (depends on timing of large events) ▪ Levee erosion: same timeframe as channel cross-section and marshplain accretion responses above, or as dictated by rainfall, tidal, and other events. ▪ Relative sea level rise: approximately ten years or longer	▪ Flood modeling predicts a current or future increase in flood risk (*e.g.*, decrease in levee freeboard). ▪ Significant levee erosion observed ▪ Elevated water surface elevations projected by modeling effort and/or observed in the field ▪ Field data collection and/or observation indicates that flood risk is greater than that predicted by models (*e.g.*, water surface elevation is higher)	Will restoration activities always result in a net decrease in flood hazard?	▪ Adjust phasing and design to provide fluvial flood protection. For example, set back or lower additional levees to increase flood conveyance or dredge channels. ▪ Adjust phasing and design to protect levees. For example, adjust levee maintenance or implement levee improvements (*e.g.* widen shoulder, raise, armor, set back levee)

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Water Quality Project Objective 4	▪ Water quality parameters in ponds will meet RWQCB standards ▪ South Bay water quality will not decline from baseline levels ▪ DO levels meet Basin Plan Water Quality Objectives	▪ Water quality parameters (DO, pH, suspended sediment and turbidity, trace contaminants other than mercury, etc.) set by RWCQB in ponds and Bay (methods as per Takekawa, et al. 2005). ▪ Sediment oxygen demand ▪ Continue as is under regulatory requirements for managed ponds. ▪ Relate to RMP for conventional pollutants (Use RMP infrastructure for Far South Bay main water mass.) ▪ Relate to RMP for trace contaminants (Use RMP process for determining frequency and methods for Far South Bay main water mass. Also use RMP process for determining need for and frequency of tidal habitat special studies.)	Ponds, receiving waters, and entire South Bay	Ongoing	▪ Annual data review to determine variation from past trends ▪ Review of RMP results indicate abnormal conditions ▪ Other indication of abnormal conditions such as fish kills ▪ Increases in chlorophyll-a to levels indicating eutrophic conditions ▪ Increases in sediment oxygen demand to levels indicating risk of low DO ▪ Low dissolved oxygen in ponds or receiving waters	▪ What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal marsh restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay? ▪ Can residence time be altered to prevent low dissolved oxygen? ▪ Is it possible to re-aerate water prior to discharging to the Bay? ▪ What effect would progress all the way to 90/10 (Alternative C) have on the BOD loading to the Bay?	▪ Applied studies to find causes of water quality problems in ponds (need salinity, temperature, wind speed, solar radiation, sediment oxygen demand, and net primary production) ▪ Applied studies of Bay-wide conditions ▪ Applied studies of WQ effects on pond/Bay species (plankton, shrimp, fish, birds) ▪ Active management such as baffles, aerators, etc. ▪ Decrease number of ponds monitored as conversion away from managed ponds to full tidal occurs. Focus on managed ponds with compliance issues. ▪ Review all available data. ▪ Reduce pond residence times. ▪ Accelerate conversion from managed ponds to tidal habitat. ▪ Eliminate managed pond discharges by converting to seasonal wetlands. ▪ Decrease pond residence time ▪ Introduce re-aeration mechanisms at discharge points ▪ Reconsider movement up staircase
Mercury Project Objective 4	▪ Levels of Hg in sentinel species do not show significant increases over baseline conditions ▪ Levels of Hg in sentinel species are not higher in target restoration habitats than in existing habitats	Hg levels in sediment, water column and sentinel species (methods as per Collins, et al. 2005)	Ponds and pond complexes	1–3 years depending on specific data and overall geographic scope	▪ One or more sentinel species show higher levels of Hg in target habitats than existing habitats ▪ One or more sentinel species show higher than ambient levels of Hg in Pond A8 or Alviso Slough.	▪ Will tidal marsh restoration and associated channel scour increase methylmercury (MeHg) levels in marsh and bay-associated sentinel species? ▪ Will pond management increase MeHg levels in ponds and pond-associated sentinel species?	▪ Applied study of sources of Hg and causes of increases ▪ Applied study of sediment capping methods (if relevant) ▪ Applied study of methylation processes (*e.g.*, photo-degradation, microbial methylation) ▪ Adjust phasing and design; for example, undertake preventative dredging or prevent draining of interstitial spaces or pore water. ▪ Reconsider opening more Alviso ponds to tidal action.

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Algal composition and abundance	▪ Nuisance and invasive species of algae are not released from the Project Area to the Bay. ▪ Algal blooms do not cause low DO within managed ponds	Algal species – visual observations of macrophytes and plankton tows Chlorophyll-a Sediment oxygen demand (SOD)	Ponds (visual), Bay (plankton tows) Ponds	Annually Annually	▪ Nuisance macrophytes are observed ▪ Harmful exotic species of phytoplankton are characterized in Bay	▪ Does pond configuration affect algal composition and abundance? ▪ Do harmful exotic species of algae persist in the Bay?	▪ Alter pond configuration ▪ Introduce artificial shading ▪ Stop progression towards Alternative C
Tidal Marsh Habitat Establishment Project Objective 1A	▪ Tidal marsh vegetation/habitat mosaic (including vegetation acreage and density, species composition, acreage of mudflat, channels, marsh ponds and transition area) is on a trajectory toward a reference marsh and/or other successful marsh restoration sites in South San Francisco Bay.	▪ Tidal marsh habitat acreage (*e.g.*, vegetation, mudflat, channel, pan, transition zones, etc.; collected via remote imagery with limited ground-truthing) as a percent of the total restoration area; plant species composition, including abundance of non-natives such as non-native *Spartina* spp. (qualitative assessments for invasive species will occur annually, quadrant or transect sampling once marsh has 20% vegetation cover); habitat trajectory toward a reference marsh and other restoration sites ▪ Tidal marsh habitat quality rated as high, medium, or low based on usefulness to clapper rail and salt marsh harvest mouse, determined every 2-3 years using aerial photos and ground-truthing ▪ Habitat mapping will take place every 5 years, beginning 5 years after the restored area has reached vegetation colonization elevation. Once 40% native vegetation cover has been achieved, species composition will be collected (in years corresponding to the habitat mapping) in a variety of zones (low marsh, high marsh, upland transition) within each restored marsh. (It would be beneficial to have increased frequency of	Entire South Bay	Establishment depends on initial pond elevation, vegetation colonization anticipated to be detectable within 5 years (or less) of reaching appropriate elevations, while habitat development trajectory anticipated to be detectable within 15 years (and possibly less) of the onset of vegetation colonization	▪ Vegetation deviates significantly (30–50%) from projected trajectory after colonization elevations are achieved. ▪ Channel and marsh pond formation does not occur as predicted. ▪ Non-native *Spartina* present on the site.		▪ Review sediment dynamics ▪ Study causes of slow vegetation establishment and channel development (ex: gypsum) ▪ Active revegetation ▪ Increased non-native invasive species control ▪ If invasive species cannot be controlled, study biotic response to non-native vegetation ▪ Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus ▪ Adjust phasing and design ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
		monitoring in the early Project phases.)					
Vector Control Project Objective 5	▪ The need for mosquito control does not exceed NEPA/CEQA baseline as determined by the Vector Control agencies	▪ Presence/absence of mosquitoes in former salt ponds ▪ Number of acres of breeding mosquitoes ▪ Number of larvae/dip in potential breeding habitat ▪ Number of acres within the Project Area treated for mosquitoes ▪ Costs/level of effort (*e.g.*, hours spent in treatment, amount of material applied, helicopter cost, etc.) to control mosquitoes	Focal areas that may support mosquito sources throughout the South Bay	Ongoing	▪ Detection of breeding mosquitoes in a former salt pond ▪ Detectable increase in monitoring parameters (relative to NEPA/CEQA baseline), particularly in areas with human activity/exposure ▪ Detection of mosquitoes that are known disease vectors and/or are of particular concern (*i.e.*, *Aedes squamiger*, *A. dorsalis*) in the Project Area		▪ Adjust design to enhance drainage or tidal flushing, control vegetation in ponded areas, and/or facilitate access (for control) to marsh ponds ▪ Increase level of vector control (preferably only as an interim measure while design issues are addressed to reduce mosquito breeding habitat) ▪ Study relationships of fish abundance and community composition and mosquito larval abundance in marsh features (*e.g.*, ponds and pannes) and managed ponds ▪ Ensure management actions are consistent with Refuge mosquito management policies
Clapper Rails Project Objective 1A	▪ Meet recovery plan criteria for clapper rail habitat within the SBSP Restoration Project Area	Clapper rail tidal salt marsh habitat acreage, quality (see Tidal Marsh Habitat Establishment above)	Entire South Bay	Likely decades for high-quality tidal marsh development (10-year targets)	See triggers for *Sediment Dynamics*, *Vegetation Establishment* above	▪ How do clapper rails and/or other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?	▪ See *Vegetation Establishment* above ▪ Reconsider movement up staircase
	▪ Meet recovery plan criteria for clapper rail numbers (0.25 birds/ac over 10-year period) within the SBSP Restoration Project Area	Winter numbers, censused during high-tide airboat surveys, and breeding-season numbers, censused at representative locations	Entire South Bay	Monitoring not expected to show substantial results until 5–10 years after cordgrass establishment in 300 acres or more (10-year targets)	▪ Numbers drop below 0.20 birds/ac in any given year for Project Area as a whole ▪ Rate of increase in clapper rail numbers deviates significantly from projection		▪ See *Vegetation Establishment* above ▪ Applied studies of habitat parameters, contaminant levels, and predation pressure related to rail densities and productivity (and implement related management actions as appropriate) ▪ Reconsider movement up staircase
Salt Marsh Harvest Mice Project Objective 1A	▪ Meet recovery plan criteria for salt marsh harvest mouse habitat within the SBSP Restoration Project Area	Salt marsh harvest mouse tidal salt marsh habitat acreage, quality (see Tidal Marsh Habitat Establishment above)	Entire South Bay	Likely decades for high-quality tidal marsh development (10-year targets)	See triggers for *Sediment Dynamics*, *Vegetation Establishment* above	▪ How do salt marsh harvest mice and/or other key tidal marsh species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response?	▪ See *Vegetation Establishment* above ▪ Adjust phasing and design; for example, add or enhance upland transition habitat within and between restored marshes ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
	▪ 75% of viable habitat areas within each large marsh complex with a capture efficiency level of 5.0 or better in five consecutive years	Capture efficiency (targeting multiple areas with a CE of at least 5.0)	Entire South Bay	Monitoring not expected to begin for 5–10 years after pickleweed establishment in 300 acres or more	Rate of increase deviates significantly from projection		▪ See *Vegetation Establishment* above ▪ Adjust phasing and design; for example, add or enhance upland transition habitat within and between restored marshes ▪ Reconsider movement up staircase
Migratory Shorebirds Project Objective 1B	▪ Maintain numbers of migratory shorebirds at pre-ISP baseline numbers, if known, or as close to that baseline as can be determined.	▪ Use previously collected data (USGS, PRBO, SFBBO) on foraging shorebird densities, as well as modeled densities, to set targets for densities of foraging shorebirds for each restored/managed habitat type (*e.g.*, reconfigured ponds and restored mudflats) by season. Targets would be based on densities (by habitat type and/or geographic area) necessary to maintain pre-ISP numbers. Conduct limited surveys in a sample of habitats/locations within the SBSP Restoration Project Area to estimate foraging densities. ▪ Use existing data from Flyway Project surveys and data from initial few years of window surveys to determine the percentage of small migratory shorebirds that occur in the South Bay compared to the entire Bay. Monitor abundance in fall, winter, and spring via high-tide, baywide "window" surveys (in which multiple observers census a number of locations in a brief [*e.g.*, 3-day] period) conducted throughout San Francisco Bay. SBSP Restoration Project would provide for the coordination of these surveys.	▪ Monitoring stations in a sample of habitats/locations within the SBSP Restoration Project Area (for collection of data on shorebird densities in various habitats) and throughout the Bay Area (for collection of data on the percentage of small migratory shorebirds that occur in the South Bay compared to the entire Bay)	▪ Changes in shorebird foraging densities are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond for optimal foraging depths, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees), although any changes in densities within a given habitat type will be slower. ▪ May take years or decades for the percentage of S.F. Bay birds using the South Bay to change in response to SBSP Restoration Project.	▪ Three consecutive years in which observed densities of foraging shorebirds for selected habitat types are below targets. ▪ Three consecutive years in which the percentage of S.F. Bay small migratory shorebirds that use the South Bay is below the baseline (as determined using window survey data).	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? ▪ To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? (including studies of mudflats and managed ponds invertebrate productivity, time-energy budgets for foraging birds, relative importance of and prey use in ponds with different salinities) ▪ Will intramarsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors. Coordinate with other Pacific Flyway studies; develop the larger structure for a centralized flyway monitoring network. ▪ Conduct Bay-wide survey to determine whether Project has displaced birds to other areas ▪ If declines are likely the result of SBSP Restoration Project: - Adjust design, for example reconfigure more ponds for use by foraging shorebirds - Adjust management, for example, manage more ponds for optimal water levels and salinities for foraging shorebirds ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Breeding Avocets, Stilts, and Terns Project Objective 1B	▪ Maintain numbers and breeding success of breeding avocets, stilts, and terns using the South Bay at pre-ISP baseline numbers, if known, or as close to that baseline as can be determined.	▪ Monitor total numbers of nesting Forster's and Caspian terns in the South Bay via comprehensive breeding-season surveys (per methods currently employed by SFBBO). Baseline has been established through past/ongoing monitoring conducted by SFBBO. ▪ Sample selected areas within the South Bay during the breeding season to determine the numbers of stilt/avocet nests in those areas. ▪ Estimate reproductive success by sampling a subset of breeding locations/colonies.	▪ Local (pond-level) scale for management actions, such as island creation, at specific ponds ▪ Entire South Bay for estimates of numbers (with estimates of breeding success in a few representative areas)	▪ Immediate response (increase) expected due to Phase 1 actions ▪ Longer-term trends monitored annually	▪ Decline in numbers (in the South Bay as a whole) or reproductive success of breeding stilts, avocets, and Forster's and Caspian terns below baseline for two consecutive years	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? (including predation and predator control studies, vegetation management approaches and Hg uptake in eggs, and related toxicity studies) ▪ Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account the downward trends in abundance of Forster's terns over last few decades, which are unrelated to salt pond conversion). ▪ If declines are likely the result of SBSP Restoration Project: - Undertake applied studies of habitat parameters, contaminant levels, prey availability and type, juxtaposition of nesting and brood rearing/foraging areas, predation pressure, and disturbance to determine appropriate design/management adjustments - Conduct Bay-wide survey to determine whether SBSP Restoration Project has simply displaced birds to other Bay-area locations. - Adjust design to construct more, or more optimal, nesting islands - Adjust design to reduce Hg uptake - Adjust management. For example, manage more ponds for optimal water levels and salinities for breeding and foraging stilts and avocets, manage more ponds for optimal water depths and salinities for foraging terns and/or control predation, vegetation, human disturbance. ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Diving Ducks Project Objective 1C	▪ Maintain numbers of diving ducks using the South Bay at pre-ISP baseline numbers	Use mid-winter waterfowl survey data to monitor winter numbers of diving ducks in the South Bay. Baseline has been set by previous mid-winter surveys and Accurso's studies.	Entire South Bay	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Decline in South Bay numbers below baseline conditions for two consecutive years	▪ Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay? ▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will intramarsh pond and panne habitats in restoring tidal marshes provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors ▪ If declines are likely the result of SBSP Restoration Project: - Undertake applied studies of habitat use and effects of human disturbance to determine appropriate design/management adjustments - Adjust design to increase the restoration of shallow subtidal habitat - Adjust management. For example, manage more ponds for optimal water depths and salinities for foraging diving ducks and/or control human disturbance ▪ Reconsider movement up staircase
Salt Pond Associated Migratory Birds (Wilson's and Red-necked Phalaropes, Eared Grebes, Bonaparte's Gulls) Project Objective 1B	▪ Maintain these species' use of SBSP Restoration Project Area ▪ Minimize declines in the South Bay relative to pre-ISP baseline	Focused surveys would be conducted targeting seasonal peaks (*i.e.*, late summer/early fall for phalaropes, fall and winter for Eared Grebes and Bonaparte's gulls) and geographic concentrations (*e.g.*, high-salinity ponds and other areas known to support large proportions of South Bay numbers of these species) to determine the numbers of these species using the South Bay.	Entire South Bay (as determined by surveys in areas where these species are concentrated)	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Three consecutive years in which numbers are more than 25% below the NEPA/CEQA baseline, or any single year in which numbers are more than 50% below NEPA/CEQA baseline	▪ Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? ▪ Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner?	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account declines that have already occurred due to ISP). ▪ If declines are likely the result of SBSP Restoration Project: - Adjust management to have more ponds with optimal water levels and salinities for foraging pond-associated birds ▪ Reconsider movement up staircase

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
Western Snowy Plovers Project Objective 1A	▪ Contribute to the recovery of the western snowy plover by providing habitat to support 250 breeding birds within SBSP Restoration Project Area, and maintain a 5-year average productivity level as required by the Recovery Plan.	Snowy plover numbers and estimated nest success, determined through comprehensive, annual South Bay surveys and monitoring during the breeding season	Entire South Bay for estimates of numbers (with estimates of breeding success in a few representative areas)	Local changes in abundance are expected to be immediate upon changes in management (*e.g.*, reconfiguration and water level/prey management of ponds). Longer-term trends will be monitored annually.	▪ Rate of population change declines substantially from projected trajectory toward target ▪ South Bay population declines in any given year below 2006 baseline	Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds compared to existing ponds not managed in this manner? (including predation studies and predator control studies, vegetation management approaches, and Hg- related toxicity studies	▪ Analyze all available monitoring data for South Bay, Bay Area, and entire Pacific Flyway to determine whether declines are likely the result of SBSP Restoration Project, or the result of external factors (taking into account the downward trends in abundance of plovers over last few decades, which are unrelated to salt pond conversion). ▪ If declines are likely the result of SBSP Restoration Project: - Undertake applied studies of habitat parameters, contaminant levels, prey levels/type, juxtaposition of nesting and brood rearing/foraging areas, predation pressure, and disturbance to determine appropriate design/management adjustments - Adjust design to construct more, or more optimal, nesting habitat, create more open salt panne habitat, and/or to reduce Hg uptake - Adjust management of water levels and salinities in more ponds for optimal breeding and foraging habitat and/or control predation, vegetation, human disturbance ▪ Reconsider movement up staircase
California Least Terns	▪ Maintain numbers of post-breeding California least terns in the Project Area at multi-year average levels including natural variation in numbers; avoid negative effect of SBSP Restoration Project on Bay-area least tern breeding bird numbers (multi-year average	Counts of birds using the South Bay as a post-breeding foraging area (or breeding area, if that occurs) and breeding pairs at Bay-area nesting colonies	Post-breeding foraging sites and breeding colonies	Local changes in abundance may be immediate upon changes in management (*e.g.*, reconfiguration and management of a pond, or conversion of a salt pond bottom to intertidal mudflat upon breaching of levees). Larger-scale changes in abundance will likely be slower (on the order of years to decades).	Decline in total number of birds using the South Bay as a post-breeding foraging area or breeding pairs in the S.F. Bay Area below 2006 baseline levels, in any given year		▪ If numbers decline, first use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, the impact of South Bay California gulls on nesting colonies or changes in Bay fisheries). ▪ Conduct applied study of post-breeding habitat use and diet, especially in the South Bay. ▪ Implement management or adjust design (*e.g.*, if applied study finds

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
	levels with natural variation)						more foraging occurs in ponds than Bay, manage more ponds for suitable least tern foraging conditions). ▪ Reconsider movement up staircase.
Steelhead Project Objective 1C	▪ Enhance numbers of salmonids and juvenile in rearing and foraging habitats relative to NEPA/CEQA baseline numbers	Counts of upstream-migrating salmonids to monitor spawning populations in South Bay streams	South Bay spawning streams	5–10 years likely for effects of restoration on salmonids to be detectable	Reduction in number of upstream-migrating salmonids	Will increased tidal habitat increase native fish and harbor seal survival, growth and reproduction? (including specific study of steelhead)	▪ If numbers decline, first use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, factors associated with spawning streams). ▪ Conduct applied study of constraints to population growth (ex: Hg, water quality, food chain). ▪ Conduct applied study of condition of salmonids seaward of restoration site (sample Chinook using minnow net upstream from, at, and downstream from restoration sites before and after restoration; determine whether fish are larger and healthier after than before restoration). ▪ If numbers decline, conduct diet studies on piscivorous birds (to determine whether increased bird predation is responsible). ▪ Implement management or adjust design (*e.g.*, restore more tidal habitat adjacent to spawning streams). ▪ Reconsider movement up staircase.
Estuarine Fish Project Objective 1C	• Enhance numbers of native adult and juvenile fish in foraging and rearing habitats relative to NEPA/CEQA baseline numbers	▪ Presence/abundance of surfperch in restored marshes (as measured in permanent monitoring locations with pilings installed to facilitate monitoring) ▪ Presence/ absence of native flatfish, such as starry flounder, in restored un-vegetated shallow water areas ▪ Species richness and	Monitoring results will reflect conditions at monitoring stations scattered throughout the SBSP Restoration Project Area, in tidal habitat, ponds, and sloughs	Varies by trigger – ▪ fish are expected to move into newly restored areas almost immediately but assemblages will change as habitat matures ▪ surfperch not expected to use restored marshes until vegetation is established ▪ negative impacts may be immediate if poor water quality from a pond	▪ Detection of a fish die-off ▪ Absence of detections of surfperch using restored tidal marsh ▪ Increase in percent of individuals sampled in restored marshes that are non-native ▪ Detectable reduction in water quality (as determined by monitoring described under "Water Quality" Key	Will increased tidal habitat increase native fish abundance and will restored habitat support healthy populations? (including specific study of native estuarine fish)	▪ Use available information to attempt to determine whether declines are resulting from SBSP Restoration Project or other factors (*e.g.*, factors associated with spawning streams). ▪ Applied study of constraints to population growth (ex: Hg, water quality, food chain) ▪ If fish populations decline, conduct diet studies on piscivorous birds (to determine whether increased bird predation

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
		abundance of native fish species in a range of habitats including restored marshes and associated unvegetated shallow water areas, major and minor sloughs, and deep and shallow-water ponds ▪ Water quality parameters (see "Water Quality" Key Category)		discharge causes a die-off	Category) ▪ Deviation from expected trajectory of native fish use of restored marshes and associated unvegetated shallow water areas		is responsible). ▪ Consider possible effects of recreational angling pressure. ▪ Implement management or adjust design (*e.g.*, remove more levees to increase connectivity in restored ponds) based on study results ▪ Reconsider movement up staircase
Harbor Seals Project Objective 1C	▪ Maintain or enhance numbers of harbor seals using the South Bay	▪ Conduct periodic monitoring at known South Bay haul-out sites (*e.g.*, Mowry, Newark & Alviso Sloughs, and expand to include haul-out site in Corkscrew Slough) to determine trends in productivity and abundance, and changes in distribution. If incidental sightings at other areas are not adequate to determine if new haul-out sites are established, periodically survey other locations as well. Existing data include over 5 years of weekly survey data for Mowry and Newark sloughs, and 5 years of monthly survey data for Alviso Slough. ▪ Mercury parameters (see "Mercury" Key Category)	Focal areas (*i.e.*, known haul-out sites) throughout South Bay	Negative response to human disturbance from improved public access may be immediate; response to habitat restoration or increased mercury availability may be longer-term (a decade or more)	▪ Decline in overall South Bay numbers and pup production, if known, at haul-out sites below 2006 baseline levels for 2 consecutive years ▪ Reduction in frequency of use and pup production, if known, of Mowry Slough and adjacent haul-out/pupping areas	▪ Will increased tidal habitat increase native fish and harbor seal survival, growth and reproduction? ▪ Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales?	▪ See management actions under "Mercury" and "Public Access" Key Categories ▪ Other potential management actions may include: - Restrict public access and/or improve public education near seal haul-out sites - Create seasonal closure in areas that might be appropriate for seal protection during pupping season, including buoys restricting access to sloughs to boats and land-based trails. - Enforce protective measures such as increased patrolling etc. ▪ If seal populations decline or pupping rates decline, conduct studies on seal health (pollutant exposure), potential disturbance changes, habitat/prey alternations (fish declines or fish community changes), or reduced access to sites due to steep gradient, tidal restrictions, or insufficient deep water
Public Access Project Objective 3	▪ High quality visitor experience is maintained ▪ Facilities are not degraded by over usage	▪ Visitor use surveys (numbers, activities, demographics, overall experience and peak use (surveys yearly) ▪ Staff observations ▪ Complaints or compliments registered with land managers ▪ Cost of maintaining facilities	Within the Project Area.	Based on construction of facilities and public use (5+ years of usage)	▪ Survey results show dissatisfaction ▪ Overcrowding at staging areas ▪ Conflicts between users (recorded incidences) ▪ Maintenance costs exceed budget	▪ Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales? (Study visitor traits and use patterns, visitor satisfaction with experience, public demand for other uses, facility degradation)	▪ Adjust design. For example, limit number of visitors to a given area, provide alternate use times for certain activities and/or reduce development of some uses, increase others, based on demand. ▪ Hold public meetings/workshops to inform the public of applied studies findings to determine how best to meet public recreation

APPENDIX 3. Adaptive Management Summary Table (Continued)

CATEGORY/ PO	RESTORATION TARGET	MONITORING PARAMETER (METHOD)	SPATIAL SCALE FOR MONITORING RESULTS	EXPECTED TIME FRAME FOR DECISION-MAKING	MANAGEMENT TRIGGER	APPLIED STUDIES	POTENTIAL MANAGEMENT ACTION
							desires given specific problems ▪ Hold charrette (group design process over 1-day)
Public Access Project Objective 1A, B, C	▪ Public use does not prevent reaching restoration targets as measured by significant impacts to target species.	Numbers, species richness and behavior of target species in public access areas	Within the Project Area, except as noted in restoration targets for shorebirds, diving ducks, breeding birds, California clapper rail, Western snowy plovers, and harbor seals.	Some parameters are immediate (*i.e.*, behavior); others may take 3 years or much more	▪ For species or guilds without specific population targets: statistically significant abundance, species richness or behavioral changes compared to control sites ▪ For species with population targets: reduction in abundance or density of breeding and/or non-breeding animals due to public access	▪ Will landside public access significantly affect birds or other target species on short or long timescales? (including studies of waterfowl, clapper rail and snowy plover responses to public access, and roosting bird response to public access) ▪ Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? (including studies of waterbird response to boaters)	▪ Adjust design. For example, provide edge condition to prevent visitors from moving off-trail (*e.g.*, fencing). change design to reduce wildlife disturbance based on study findings, or, in sensitive areas, restrict public access and redirect. ▪ Increase public access if species goals are met, but continue to monitor species' response ▪ Evaluate changes in population or density of species with population targets in light of restoration targets and other impacts on the species ▪ Design future phases to avoid significant impacts to species and optimize public access in areas of little or no species impact

APPENDIX 4.
Suggested Proposal Solicitation and Directed Studies Processes

PART 1. PROPOSAL SOLICITATION

Calls for Proposals

The Science Program managers will direct the process for developing questions for study. When the list of approved applied study questions has been developed, the science managers and PMT will develop one or more competitive calls for proposals designed to solicit proposals from as wide a pool of respondents as possible. The call for proposals will be reviewed by the appropriate management and technical oversight bodies. The sponsoring agencies will also publicize the criteria to be used in proposal evaluation (see draft list below).

Pre-Proposals. In order to reduce the necessity for a large number of proponents to expend much effort in developing proposals that are eventually not funded, the Project's science managers will require that all proposals be preceded by a brief pre-proposal. Pre-proposals will be reviewed by the sponsoring agency staff, PMT, and the Science Program managers to ensure that the proposed work is responsive to the call for proposals, that the proposed work has apparent scientific merit, and that the funding request seems reasonable.

Proposals. For those selected pre-proposals, researchers will submit a proposal study plan that contains sufficient information to allow for technical and statistical evaluation by peer reviewers, including details about experimental design, field and laboratory procedures, data collection, and quantitative methods. The following format is recommended:

1. *Cover sheet* – A transmittal document that includes the call for proposals number and date; the title of the proposal; a brief statement of the purpose and objectives of the proposed study; the total funding requested by year; the name and home institution(s) of the PIs and Co-PIs; the name of the institution's Grant Administrator; the applicant's tax status; and dated signature lines for the Principal Investigator(s) and the institutional representative.
2. *Abstract* – A brief, topical abstract (200 words or less).
3. *Background and justification* – Statement of the problem(s) being addressed, hypotheses being tested, information needed, and relationship/relevance of the problem(s) being addressed to other South Bay Salt Pond Restoration Project projects or sponsoring agency projects and programs, with reference to appropriate literature citations regarding the problem(s).
4. *Study Objectives* – Description of the planned outcome of the study
5. *Study area(s)* – Description of the study location, i.e., whether it is a field and/or laboratory study. A field study proposal should include clear identification and description of the study sites, with a map.
6. *Approach* – Description of the study approach, with sampling and analytical procedures clearly described for each objective. Include details on methods/techniques, equipment and facilities, data collection, statistical analysis and quality assurance procedures, and describe the criteria to be used in hypothesis testing.

7. *Data archiving procedures* – Description of how the data will be handled, stored, and made accessible. All data collected under the auspices and funding of the South Bay Salt Pond Restoration Project will be made accessible through a Project database and website.
8. *Work Schedule* – An annual time line with expected start and stop dates, and accomplishment of major milestones.
9. *Hazard assessment/safety certification* – Identification of anticipated hazard or safety concerns affecting project personnel (e.g. aircraft, off-road vehicles, chemicals, and extreme environmental conditions).
10. *Permission to access CA Department of Fish & Game and US Fish & Wildlife Service lands* – Documentation of permission to access government property for purposes of conducting research and monitoring, or documentation that permission will be granted if funding is provided.
11. *Animal care and use certification* – Discussion of anticipated uses of animals in the research, including copies of approved forms for animal care and use. If animals are not to be used, collected, manipulated, or experimented upon, include a specific statement to the fact that no animals will be used in the research.
12. *Expected product(s)* – List of planned publications, reports, presentations, advances in technology, information transfer at workshops, seminars, or other meetings.
13. *Qualifications of Investigators, partnerships, and cooperators* – Brief resumes (two pages) of the principle investigators that include descriptions of the qualifications of principal personnel, identification of affiliations, expected contributions to the effort, including logistical support, and relevant bibliographic citations.
14. *Budget and staff allocations* – Detailed budget including salaries and benefits for each participant and costs for travel, equipment, supplies, contracted services, vehicles, and necessary overhead.
15. *Literature cited* – List of all of the publications cited in the text of the proposal.
16. *List of potential reviewers* – Names (minimum of three) and addresses of research scientists with subject area expertise who could serve as peer reviewers for the proposal.

Proposal Review Process

The South Bay Salt Pond Project will award research grants that are selected competitively on the basis of technical merit and relevance of the proposed work to South Bay Salt Pond Restoration Project goals and objectives. To do this, the Science Program managers will institute an objective process for the anonymous peer evaluation of proposals that is efficient and achieves broadest acceptance of the process within the scientific and resource management communities. Peer-review panels will consist of experts external to the Project. The PMT will select the projects to be funded based on the results of the peer review and the Project priorities.

Peer Review. Peer-review panels should include enough technical experts to thoroughly evaluate all topical areas of the proposals. The panel members should be active estuarine, freshwater or watershed research scientists/engineers who have a high degree of stature, are well connected with other scientists in their respective fields, represent different specialties within these fields, and have some familiarity with the San Francisco Bay estuarine system. Science Program managers will ensure that panel members have no conflicts of interest (e.g., current or pending support from the Program). Reviewers will score the proposals, based on their scientific merit and the relevance to the call for proposals, with numerical ratings from 1 (Poor) to 5 (Excellent) using the following criteria:

- Technical merit including (a) research scope, justification, and importance of expected results; (b) reasonableness of the hypotheses and experimental design; (c) soundness of proposed steps for data collection, analysis and synthesis
- The appropriateness of the proposed study to the South Bay Salt Pond Restoration Project goals and objectives and responsiveness to the call for proposals.
- Qualifications of the investigators and adequacy of the facilities for carrying out the proposed research
- Reasonableness of costs
- Likelihood of success

In the case of continuing projects, consideration will also be given to the level of progress achieved to date.

When all reviews have been received, the proposals will be ranked by the peer-review panel. The panel will develop an overall prioritization of the proposals and will transmit its funding recommendations to the Science Program managers and the PMT.

PMT Review. The PMT will provide its review and approval of the new proposals to be funded based on the funding available for support of the proposals under each call for proposal. In its deliberations, the PMT, guided by the Science Program managers, will give most serious consideration to those proposals having been rated 4 or 5 by the Peer Review Panel, and will not select proposals rated 1 or 2. The PMT will also evaluate renewal proposals for continuation beyond the first year.

PART 2. DIRECTED STUDIES PROGRAM

In the course of developing the focused research questions, it will probably become apparent that a specific, sustained research effort may be necessary to resolve one or more of the areas of uncertainty regarding the important resources of the bay-delta-watershed critical to the Restoration Project's goals and objectives. Examples of such needs might include the following:

- Developing an understanding of a specific ecological phenomenon over long temporal and/or large spatial scales
- Conducting major synthetic and theoretical efforts
- Providing information for the identification and solution of specific salt pond management or restoration problems
- Quantifying the linkages between potential stressors and the abundance of species populations

Addressing such needs may require interdisciplinary research coordinated among investigators, experimental studies across a range of appropriate spatial and temporal scales, and development of analytical and numerical models of critical ecosystem functions and responses to management actions.

Given the scope and complexity of some of the issues facing the Restoration Project, it may be necessary to support such sustained commitments of effort irrespective of the responses of scientists/engineers to the annual requests for proposals. In such cases, the PMT may wish to contract with specific individuals or entities, because of recognized expertise, accomplishment, and past responsiveness, to carry out a program of directed research that is not well accommodated in the year-to-year call for proposals process.

Such questions, identified by the Science Program managers and PMT, will become the subject of contractual arrangements with specific individuals or entities. In each case, the individual/entity will develop a research proposal, using the call for proposals format described above, that will be subject to review and concurrence (or rejection) by the Science Program managers and other additional subject-matter referees as necessary, with revisions being made accordingly.

In recognition of the need in these instances for sustained study effort, funding will be provided to successful proponents for specified periods up to 5 years. It is expected, therefore that the Directed Research Program proposals will incorporate a detailed multi-year strategy and budget. It will also be understood that the Principal Investigator(s) will be expected to make a long-term commitment to meeting the critical South Bay Salt Pond Restoration Project research need(s) described in the contract.

The sustained research efforts under the Directed Research Program will be subject to frequent, vigorous peer review, i.e., at the proposal stage, during the conduct of the research, and upon the conclusion of the study. Written progress reports will be required at the end of each year, or sooner if needed, with a full review of project progress and accomplishment by the Science Review Board at least every three years. Contract renewals will be contingent upon the successful demonstration of progress toward meeting project goals and Restoration Project needs and the submittal of meritorious renewal proposals.

APPENDIX 5.
Descriptions of Phase 1 Applied Studies at Ponds E12/13 and A16/SF2

Experiments designed to address selected key uncertainties regarding bird use of managed ponds will be conducted as part of the Phase 1 actions. Specifically, these experiments address two key uncertainties: the extent to which managing ponds for target depths and salinities will increase pond use by waterbirds compared to existing ponds and the extent to which reconfiguring ponds to provide numerous nesting islands will increase the densities of nesting and foraging birds compared to existing ponds. The results of these experiments will inform adaptive management approaches to management of ponds throughout the SBSP Project area for selected bird species or groups of species.

Phase 1 Applied Studies at Ponds E12/E13

Key uncertainty: Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? Ponds managed as small-scale salt pond systems may provide enhanced benefits for wide range of birds. But, the extent to which they can improve the prey base and increase foraging shorebird densities in the short and long-term is not known.

Background/Rationale
Eden Landing Ponds E12 and E13 would be reconfigured to create shallow-water foraging habitat for migratory shorebirds, with a range of salinities, and a limited number of islands for nesting bird habitat (Figure 1). The restoration action would help maintain populations of bird species breeding at the salt ponds (project objective 1B.1) through the creation of nesting island and berm habitat; maintain habitat for salt pond-specialized birds (project objective 1B.2) by creating cells with elevated salinities; and maintain population levels of foraging shorebirds (projective objective 1B.3) by managing water levels and salinities to maximize foraging potential. These reconfigured ponds would test the extent to which focused management of shallow water habitats can increase migratory shorebird densities, the importance of salinity on the density of foraging shorebirds and their prey as applied studies, and techniques for vegetation management, predator management, and water and salinity management. The specific studies described below will address the following hypotheses:

- To what the extent will focused management of shallow-water habitats increase the densities of foraging shorebirds?
- What is the importance of salinity to the density of foraging shorebirds and their prey?

Applied Study Design Concepts
Several shorebird species, particularly Wilson's and Red-necked Phalaropes, have long been known to occur in the South Bay primarily within higher-salinity ponds. These species generally forage in high-salinity ponds throughout the tidal cycle. In addition, studies by PRBO and others have demonstrated that some species that typically forage on intertidal habitats during low tide, such as Western Sandpipers and Dunlin, show an affinity for higher-salinity (vs. lower-salinity) ponds at high tide, and that many individuals of these species forage in higher-salinity ponds at high tide. However, very high densities of shorebirds have also been observed foraging in South

Bay ponds that do not have high salinities, but do have optimal foraging depths for small shorebirds. The experiment at Ponds E12 and E13 would assess whether foraging shorebirds prefer low, moderate, or high salinity levels (and the associated prey types) in cells with similar shallow water depth habitat. The results of this experiment would determine the need for ponds with elevated salinity levels for foraging by migratory shorebirds in future phases of the project within the Adaptive Management Plan. Monitoring of the use of the constructed islands by nesting birds may provide some information regarding nesting bird use at the different salinity levels in the pond; however, this would not be the focus of the Ponds E12 and E13 applied study.

Study Methodology

Shorebird monitoring. Shorebirds in all cells would be monitored every other week from mid-July through April by observers walking or driving along the perimeter of the ponds (using spotting scopes). During each survey, the number of individuals of each species roosting and foraging in each cell during a two-hour period at high tide and a two-hour period at low tide (on the same day) would be recorded.

For an additional two hours during high tide, individual birds would be observed while foraging in an attempt to determine prey species. For a two-minute period, a single foraging individual would be watched. The foraging habitat, water depth, foraging method, and number of prey items taken by prey type (if determined) and foraging method would be recorded. If the bird spends time foraging in different habitat types (*e.g.*, mud vs. water) or using different methods, the proportion of the two-minute focal period spent using different habitats or methods would be recorded. After two minutes, a different bird would be observed, and so on, so that all the major species foraging in the ponds are represented by observations. Equal time observing foraging behavior would be spent in each of the three salinity treatments. The purpose of these observations would be to collect data that can be used to determine the optimal foraging conditions for birds within these ponds, and to attempt to relate foraging behavior and success to prey type and abundance (based on foraging habitat, water depth, foraging method, and in the case of larger prey items, observation of the prey items).

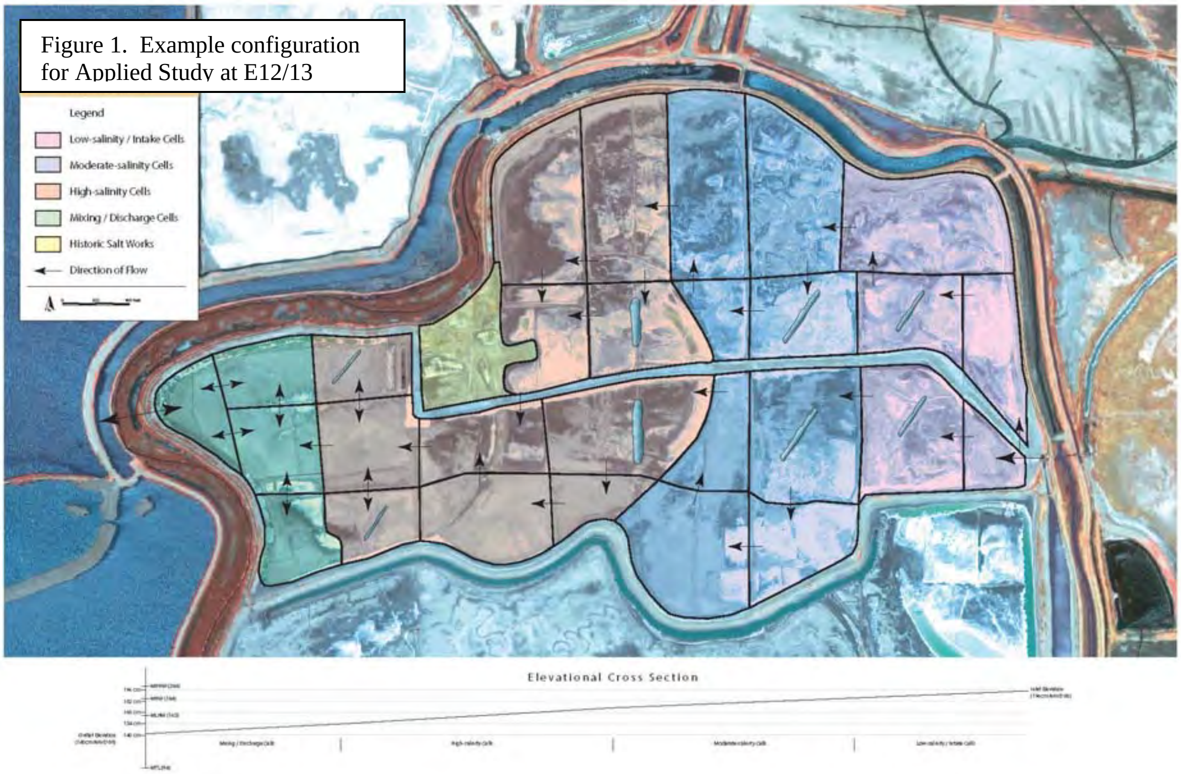
Prey monitoring. Invertebrates would be sampled at 10 locations within each salinity treatment during every other survey (*i.e.*, once/four weeks). Prey abundance would be estimated from these samples, including samples from both the water column and substrate, by prey type. Water depth, salinity, and temperature would be recorded at each sampling location.

Timeframe. The study would commence immediately following construction when water level management is underway. It is anticipated that a response to the reconfigured habitat will be discernable in the first season. However, meaningful results should be available after 5 years of monitoring.

Management Response

The extent to which salinity differences are found to affect shorebird species composition and density, foraging behavior of these birds, or the density and availability of important prey species will inform the future management of ponds within the SBSP Project area. If salinity differences significantly influence the use of managed ponds by waterbirds, future pond management in other areas may include salinity management to optimize densities of foraging birds. The results of this experiment, with respect to certain water salinities or depths corresponding to high densities of particular bird species, will also be used to optimize pond management for specific species or groups of species.

Figure 1. Example configuration for Applied Study at E12/13



Phase 1 Applied Studies at Ponds A16/SF2

Key uncertainty: Will ponds that are reconfigured to create large isolated islands for nesting and foraging significantly increase reproductive success for terns and other nesting birds and also increase the numbers and densities of foraging birds over the long term compared to existing ponds not managed in this manner? Constructing islands within managed ponds is expected to increase the densities of nesting birds in those ponds, and certain island shapes or densities may result in higher use by nesting birds than others. However, the extent to which nesting bird densities can be increased and sustained by island construction, and the shapes and densities of islands that will optimize bird use, is not known.

Background/Rationale

The A16 and SF2 managed ponds would be reconfigured to create islands for nesting birds and would be managed to provide shallow-water habitat for foraging waterbirds, particularly shorebirds (Figure 1). The Phase 1 actions at Ponds A16 and SF2 would help maintain populations of bird species breeding at the salt ponds (project objective 1B.1) through the creation of nesting islands and population levels of foraging shorebirds (projective objective 1B.3) by managing water levels to maximize foraging potential. These reconfigured ponds would test bird use of different island configurations as an applied study, and would also test management techniques for vegetation management, predator management, and water quality management. The specific studies described below will address the following hypotheses:

- Will pond reconfiguration to include numerous islands, and water-level management, increase the density of nesting and foraging shorebirds within Pond A16?
- Does island shape and density affect nesting success?
- Does vegetation type and density affect nesting success on the islands?
- Does passive human activity on trails affect nesting success on nearby islands?

Applied Study Design Concepts

Various nesting bird species may respond differently to different island shapes. For example, highly colonial species such as terns may make more use of circular islands while shorebirds such as Black-necked Stilts, American Avocets, and Snowy Plovers may benefit from long, linear islands. In addition to contrasting shapes, it is important to understand the effect of island density on habitat value. For example, high-density islands may reduce foraging area between islands and increase aggressive interactions among family groups of American Avocets and Black-necked Stilts. Vegetation also plays an important role in nesting success, as different birds species have varying vegetation tolerances or requirements. Snowy Plovers typically avoid vegetated areas for nesting, and avocets usually nest in bare or sparsely vegetated areas. While some South Bay tern colonies are located in areas with little or no vegetation, other tern colonies, as well as many Black-necked Stilt nests, are located in areas having some vegetation, which may also provide shade and cover from predators for chicks. Nesting waterfowl are likely to nest almost exclusively in vegetated areas. Although human activity in the vicinity of Ponds A16 and SF2 is expected to be limited to non-motorized recreation (*i.e.*, walking or biking around the outer levee of the pond) and pond/island maintenance, it is unknown whether this level of activity will affect island use or nesting success by birds.

The experimental studies designed for Ponds A16 and SF2 will provide an important model for island design, provide an understanding of the vegetation requirements of various pond-breeding bird species, and determine an acceptable level of human activity for reproductive success of bird species using managed ponds. This understanding will help inform and guide the design of optimal pond configurations that would be used at other locations in the South Bay.

Study Methodology

Island spacing, shape and distance to adjacent islands. Varying densities of islands will be created within Ponds A16 and SF2 to study the effects of island density on nesting bird use. There will be two island shapes: circular and linear (much longer than wide) to determine whether various nesting bird species respond differently to contrasting island shapes.

Vegetation type, density, and distribution. Vegetation is expected to establish on some of the islands after one or more years. At that point, the vegetation can either be controlled or vegetation can be manipulated by planting or selective removal, to determine the effects of vegetation type, density, and spatial distribution on nesting use and reproductive success of bird populations. The species composition, type of vegetation, and vegetation distribution will be manipulated by planting or selective control/removal to conduct studies to determine the effects and distribution of vegetation on nesting success. The decision regarding which plant species will be used in actual experiments will be determined by monitoring which vegetation types invade (and thus can be expected to survive on the islands) during the first few years following island construction.

Human activity. To determine whether human activities affect nesting birds at Ponds A16 and SF2, a portion of the trail around each pond (*e.g.*, along the entire northeastern side of Pond A16) could be closed during the breeding season every other year. The number of nests, and nest success and fledging success, would be estimated for a sample of islands to determine whether the location, number, and breeding success of birds varies depending on whether or not portions of the levee trails are open to human activity.

Timeframe. The study would commence prior to project implementation so that pre-construction conditions are documented. It is anticipated that a numerical response to island construction will be discernible in the first season after construction is complete and water level management is underway. However, it may be a few decades before ultimate densities are achieved as future phases of tidal restoration for the SBSP Project continue to reduce the amount of existing salt pond and levees available as potential nesting habitat.

Management Response

The extent to which the construction of nesting islands results in increased densities of nesting birds will inform the degree to which nesting islands are constructed in other managed ponds in the SBSP Project area. Species' responses to the shape and density of nesting islands will also help determine the types of islands that are constructed for nesting birds, and whether islands of various shapes or densities must be provided to optimize use by various species. The responses of nesting birds to vegetation type, density, and distribution will inform how the substrate on nesting islands should be managed for different species. If nesting birds respond negatively to increased human activity around the ponds, public access to trails will be modified (either spatially or temporally) to minimize disturbance. If no negative effects of human activity are noted, public access to trails will be incrementally increased and monitoring continued.

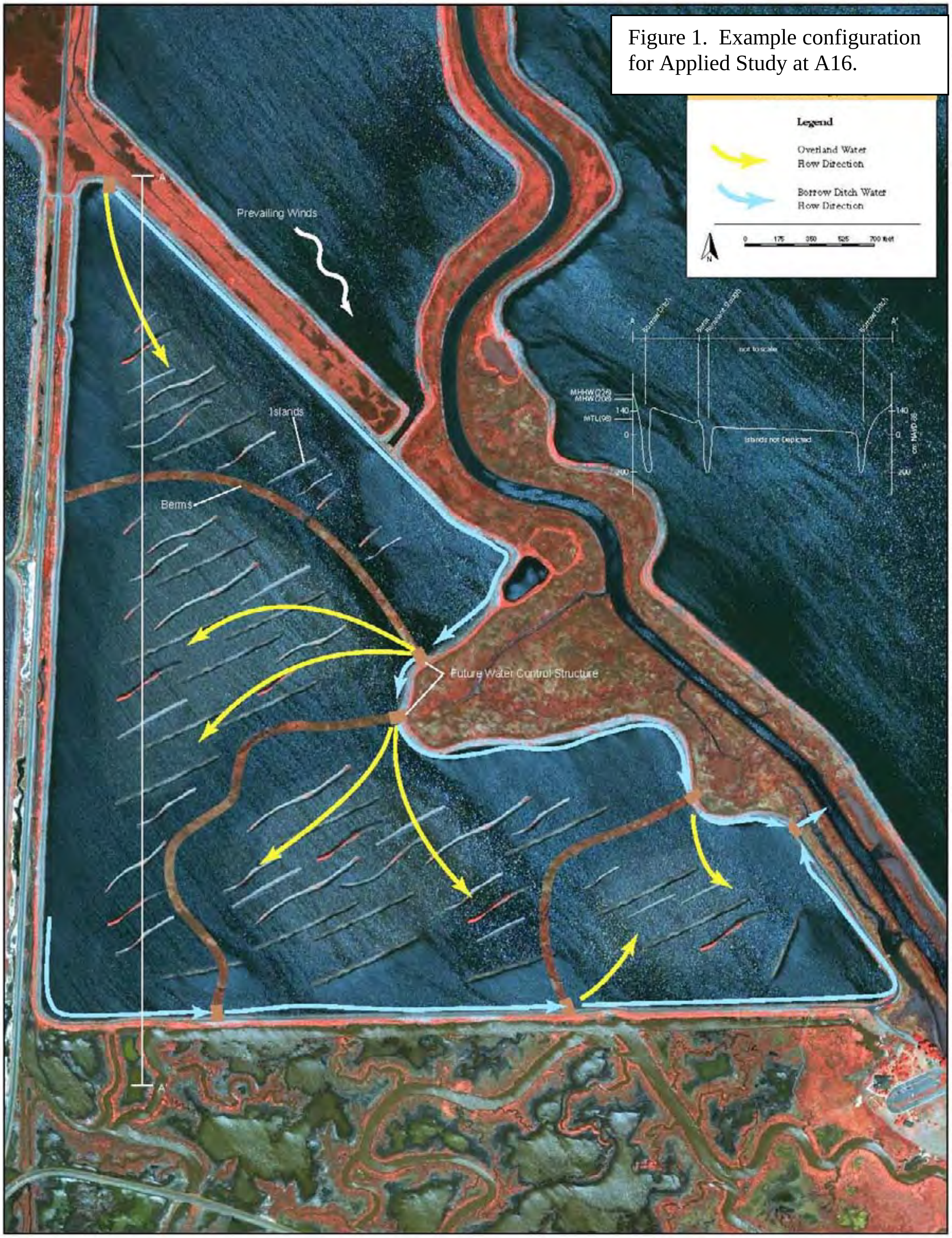


Figure 1. Example configuration for Applied Study at A16.

Addendum to the Adaptive Management Plan

2 March 2018

This Addendum to the Adaptive Management Plan (AMP) for the South Bay Salt Pond (SBSP) Restoration Project is intended to incorporate a new type of habitat restoration and enhancement feature to the previously adopted AMP. It defines and explains those features and sets for a system for how the AMP's principles and feedback mechanisms would be applied to the new features and what sorts of monitoring and adaptive management actions may be applied to them.

The SBSP Restoration Project is proposing the creation of habitat transition zones as part of Phase 2 actions. Habitat transition zones involve the beneficial reuse of material to create transitional habitats from the pond or marsh bottom to the adjacent upland habitat or levees along portions of the upland edge. These "habitat transition zones", are sometimes referred to elsewhere as "upland transition zones," "transition zone habitats," "ecotones," or "horizontal levees". Transition zones are specifically called out in documents such as the U.S. Fish and Wildlife Service's Tidal Marsh Recovery Plan and the recent Science Update to the Baylands Ecosystem Habitat Goals Project Report. A gradual transition from submerged Baylands, ponds, or open waters to uplands is largely missing in the current landscape of the South Bay, where there is often an abrupt boundary between the bay or ponds and the built environment. The SBSP Restoration Project's intention in including habitat transition zones in the Phase 2 alternatives is to restore this missing habitat feature. Doing so would:

1. Establish areas in which terrestrial marsh species can take refuge during high tides and storm events, thereby reducing their vulnerability.
2. Expand habitat for a variety of special status plant species that occupy this specific elevation zone.
3. Provide space for marshes to migrate upslope over time as sea-level rise occurs.

Before proposing these features, the SBSP Restoration Project examined the landscape to see if there are any areas adjacent to the project site where this could occur naturally. In general, the best locations for building these features would be located adjacent to open space or park land where the project can provide an even greater extent of transition into upland habitats.

However, at the edge of the Bay, these open space areas are largely former (now closed and capped) landfills which present a variety of challenges for creating the missing upland habitat. First, the existing elevation gradient between the restored marsh and the edge of the landfill is usually too steep to provide a gradual transition. Secondly, these landfills would otherwise pose a water quality risk from erosion if tidal action were introduced immediately adjacent to the protective clay liner or un-engineered rip rap slopes. In these instances, it is necessary that the project place material inside the former salt ponds to create the desired slope (15:1 to 30:1). At other locations, the actual elevations landward of the project sites are too low to create an uphill slope with the desired habitat functions. Therefore, once levees are raised or improved, such as at the All-American Canal levees, the only area remaining to build the transition zones is into the salt ponds. Finally, most of the adjacent property is not within the SBSP Restoration Project's ability to acquire, whether or not it has the desired elevation profile, because it is currently developed. In addition to being very expensive to acquire these areas, it would be infeasible to relocate all of the residences and businesses that have been built adjacent to the salt ponds. For these reasons, the project plans to use fill from upland excavation projects to create habitat transition zones inside the former salt ponds. The transition zones would provide habitat complexity and connectivity as marsh is restored. This would help improve habitat quality, particularly for endangered and threatened species, and improve resiliency of the shoreline over time as sea levels rise.

The SBSP Restoration Project notes in this Addendum that there are other new actions associated with the ongoing and more basic actions of maintaining the habitat transition zones that are more like routine maintenance of any part of the National Wildlife Refuge than they are adaptive in nature. Those activities would include the same kinds of actions performed under various regulatory permits, guidance documents, and other agreed-upon protocols. For example, commonplace Refuge practices like trash removal, fencing repairs, biological monitoring of bird populations, trail upkeep, removing invasive plant species and controlling or removing nuisance wildlife species, and other actions would proceed as normal and would therefore be implemented as needed on the habitat transition zones.

More broadly, the SBSP Restoration Project would continue to cooperate with the Santa Clara County, Alameda County, and San Mateo County Mosquito Abatement Districts to provide access by these districts to control mosquito populations. The Project would also work with the Invasive Spartina Project to remove or control populations of the non-native forms of that plant species. Similar coordination efforts to coordinate with adjacent or nearby city or county parks to control and manage use of the public access trails near transition zones by humans (and their pets, if/where allowed) would proceed as normal. None of these actions is what is typically meant by “adaptive management”.

Therefore, the table below is limited to the two more adaptive aspects of habitat transition zones: (1) the successful establishment and spread of elevationally-varying vegetation communities and habitat types, and (2) the transition zones’ ability to help maintain or improve existing levels of flood protection in the areas landward of where they are constructed. This effect is largely indirect, as habitat transition zones do not directly provide flood protection but do help protect existing levees or uplands from scour or wave run-up.

Proposed New Rows for Adaptive Management Plan Summary Table

Category / Project Objective	Restoration Target	Monitoring Parameter (Method)	Spatial Scale for Monitoring Results	Expected Time Frame for Decision-Making	Management Trigger	Applied Studies	Potential Management Action
Habitat Transition Zones Project Objective 1A. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.	The range and mosaic/composition of various vegetation communities and associated wildlife species habitat on the transition zones is at or on a trajectory resembling that of a natural (i.e., predevelopment) gradient between intertidal mudflats, low tidal marsh, high tidal marsh, and upland vegetation. This includes characteristics such as vegetation acreage and density per unit of transitional habitat, species composition, and other observable aspects of existing natural or successful marsh restoration sites in South San Francisco Bay.	- Monitoring of planted vegetation to evaluate success of establishment and spread - Acreages of each type of sub-, inter-, and -supratidal habitat (collected via remote imagery with limited ground-truthing) as a percent of the total restoration area; plant species composition, including abundance of nonnatives such as those listed elsewhere in the AMP (qualitative assessments for invasive species will occur annually, quadrant or transect sampling once habitat transition zone has 20% vegetation cover); being on habitat trajectory toward a reference marsh and other restoration sites - Habitat qualities of those different elevationally varying habitat rated as high, medium, or low based on suitability or potential usefulness to Ridgway's rail and salt marsh harvest mouse, determined every 2-3 years using aerial photos, ground-truthing, and/or other methods to evaluate these characteristics - Habitat mapping will take place every 5-8 years, beginning 5 years after the different sections of the constructed transition zone have established vegetation communities. Once 40% vegetation cover has been achieved, species composition (including native vs non-native) will be collected in a variety of zones (low marsh, high marsh, upland) on each transition zone.	Each of the proposed Phase 2 transition zones would be monitored. There are six in total. Two in Pond R4, two in Pond A8S, and one each in Pond A1 and Pond A2W.	- Establishment of different vegetation communities on the lower slopes of habitat transition zones depends on tidal flux, the depth of each pond (i.e., pond bottom elevations relative to tidal elevations). Yet natural vegetation colonization is anticipated to be detectable within 5 years (or less) of reaching appropriate elevations, while habitat development trajectory anticipated to be detectable within 15 years (and possibly less) of the onset of vegetation colonization. - In the areas where planting would take place (the higher portions of the zones), the successful establishment and spread of the planted vegetation is expected to be detectable in 5 years. - Invasive species establishment is expected to be detectable within the first year of its occurrence.	- Failure of habitat transition zones to develop native vegetation communities in elevations where those are expected to develop. - Vegetation deviates significantly (30–50%) from projected trajectory after colonization elevations are achieved. - Failure of the zones to hold or retain actively seeded or planted vegetation communities in elevations where that takes place. - Non-native Spartina, Pepperweed or Phragmites present in large numbers on site. - A level of invasive plant establishment and resistance to active control and management efforts that undermines the ecological values of the native communities and habitats intended for the transition zones to provide. - Inability to control and prevent outbreaks of vector (mosquitoes) on the slopes of the habitat transition zones using the methods and techniques discussed in the Vector Control Project Objectives.	**Applied Study Question #2017-1. Will habitat transition zones become established with naturalistic, native vegetation communities across a range of elevations and thereby provide a gradient of habitats for marsh plants and special-status species, including the California Ridgway's rail and the salt marsh harvest mouse?** Project Objective 1A states that the South Bay Salt Pond Restoration Project will create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles. Most ecotone and transitional habitat between the waters of San Francisco Bay and the adjacent uplands have been lost as a consequence of historical land use and development. The Phase 2 actions to construct habitat features to replace this lost natural gradient is an important part of meeting Project Objective 1A.	- Study causes of slow vegetation establishment - Active revegetation - Increased non-native invasive plant species control - If invasive species cannot be controlled, study biotic response to non-native vegetation - Continue to re-evaluate what is meant by "control" of invasive species and adjust monitoring and management triggers based on the latest scientific consensus

Category / Project Objective	Restoration Target	Monitoring Parameter (Method)	Spatial Scale for Monitoring Results	Expected Time Frame for Decision-Making	Management Trigger	Applied Studies	Potential Management Action
Habitat Transition Zones. Project Objective 2. Maintain or improve existing levels of flood protection in the South Bay area.	- No increase in tidal flood risk at any levee or adjacent uplands associated with a habitat transition zone.	- Collect high water mark elevations on the existing levees and adjacent uplands prior to construction and then periodically after construction, especially following large storm or flood events. - Inspect for levee erosion initially monthly, then annually, and after major rainfall and/or tidal events	Each of the proposed Phase 2 transition zones would be monitored. There are six in total. Two in Pond R4, two in Pond A8S, and one each in Pond A1 and Pond A2W.	- Slope failure or erosion/scour is expected to be detectable within 5 years of normal weather, but heavy storm years may cause it to occur earlier or sooner. -If after 10 years, no substantial failure or erosion beyond minor, localized failures, it would be unlikely to occur, as the vegetation communities and natural sediment dynamics should have become established.	- Significant erosion observed - Elevated (higher) water surface elevations projected by modeling effort and/or observed in the field - Field data collection and/or observation indicates that flood risk is greater than that predicted by models	**Are habitat transition zones effective in slowing the amount of erosion or scour due to tides, storm surges, wind waves, or other erosional forces and thereby reducing the risk of levee failure or other aspects of flood risk to surrounding communities and infrastructure?** Habitat transition zones also address Project Objective 2 (Maintain or improve existing levels of flood protection in the South Bay area) because they slow wave run up, buffer storm surges, and provide a broader range of roughly horizontal surfaces on which sediment can accrete and vegetation can form. They thereby provide a foundation for naturalistic future sea-level rise adaptation by providing substrate on which tidally varying habitats can migrate upslope.	- Reconstruct failing portions of the habitat transition zones with material of higher quality. - Construct transition zones with a higher level of soil compaction.

APPENDIX L

USFWS PROGRAMMATIC BIOLOGICAL OPINION

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United States Department of the Interior

US FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way W-2605
Sacramento, California 95825

IN REPLY REFER TO:
81420-08-F-0621

AUG 12 2008

Ms. Jane Hicks
Chief, Regulatory Division
(Attn: Paula Gill)
U.S. Army Corps of Engineers
1455 Market Street, 16th Floor
San Francisco, California 94103-139

Subject: Formal Endangered Species Consultation on the Proposed South Bay Salt Pond Restoration Project Long-term Plan and the Project-level Phase 1 Actions, Alameda, Santa Clara, and San Mateo Counties, California (Corps File Numbers 07-27703S and 08-00103S)

Dear Ms. Hicks:

This is in response to the U.S. Army Corps of Engineers' (Corps) letters, dated December 13, 2007 and April 15, 2008, requesting formal U.S. Fish and Wildlife Service (Service) section 7 consultation to allow for the proposed implementation of the project-level Phase 1 actions (Phase 1 actions) and the operation and maintenance of the South Bay salt pond levees, as part of the South Bay Salt Pond Restoration Project Long-term Plan (SBSP Project), Alameda, Santa Clara, and San Mateo Counties, California. We received your letters in this office on December 14, 2007 and April 16, 2008, respectively. This document includes the Service's programmatic biological opinion (PBO) for the SBSP Project and the project-level biological opinion for the Phase 1 actions (Phase 1 BO). At issue are the effects of the proposed action on the endangered California clapper rail (*Rallus longirostris obsoletus*) (clapper rail), endangered salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*) (harvest mouse), threatened Pacific coast population of the western snowy plover (*Charadrius alexandrinus nivosus*) (snowy plover), endangered California least tern (*Sternula antillarum browni*) (least tern), and endangered California brown pelican (*Pelecanus occidentalis californicus*) (brown pelican). This biological opinion is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The proposed action is not likely to destroy or adversely modify critical habitat for snowy plovers since no critical habitat is located within the proposed action area. No critical habitat has been proposed or designated for clapper rails, harvest mice, or least terns, therefore, none will be destroyed or adversely modified. We have determined that the proposed action is not likely to adversely affect the endangered vernal pool tadpole shrimp (*Lepidurus Packardi)* and designated critical habitat, endangered California tiger salamander (central population) (*Ambystoma californiense)* and designated critical habitat, and endangered Contra Costa goldfields (*Lasthenia conjugens*) and designated critical habitat. The proposed action would not occur in vernal pool habitats that support these species, and the proposed action could implement measures to avoid and minimize any construction-related disturbance. We understand that you have made a "no effect" determination for other listed species that are known to occur in the region, but are absent from the action area (Service 2008). Listed anadromous and marine species that fall under the jurisdiction of National Marine Fisheries Service (NMFS) will be evaluated in their biological opinion on the proposed action.

This biological opinion is based on information provided in: (1) the July 2008 *Programmatic Biological Assessment for the South Bay Salt Pond Restoration Project* (Programmatic BA) (Service 2008a); (2) the July 2008 *Phase 1 Biological Assessments for the South Bay Salt Pond Restoration Project* (Phase 1 BAs) (Service 2008b-i); (3) the *South Bay Salt Pond Restoration Project/Final Environmental Impact Statement/Environmental Impact Report* (Final EIS/EIR) (Service and California Department of Fish and Game (CDFG) 2007); (4) miscellaneous correspondence and electronic mail concerning the proposed action between representatives of the Service, CDFG, biological consultants for the proposed action, and interested parties; (5) relevant published and unpublished studies, and communications on the distribution and abundance of the clapper rail, harvest mouse, least tern, snowy plover, and brown pelican; and (6) additional information available to the Service.

Consultation Process

The lead Federal agency for implementing the proposed action is the Service (San Francisco Bay National Wildlife Refuge (SFBNWR)). This section 7 consultation has been triggered by four Federal actions: 1) the U.S. Army Corps of Engineers (Corps) propose to issue a 404 Permit under the Clean Water Act to the Service (SFBNWR) for construction of the Phase 1 actions; 2) the Corps propose to extend an existing 404 Permit for the Service (SFBNWR) to conduct operations and maintenance (O&M) on all South San Francisco Bay (South Bay) salt ponds located within the proposed action area; 3) the Service (SFBNWR) (with CDFG) propose to implement the proposed action; and 4) the Service (SFBNWR) propose to issue a Special Use Permit to Pacific Gas and Electric (PG&E) to conduct O&M on all South Bay salt ponds located within the proposed action area. Therefore, this biological opinion satisfies formal intra-Service section 7 consultation as well as formal section 7 consultation with the Corps. The State of California's Resources Agency is an applicant for the purposes of this consultation, and represents CDFG. Both the Service and NMFS will evaluate effects on listed fish and wildlife and issue biological opinions for those species under each agencies respective administration.

The proposed action features a two-tiered approach to ensure compliance with the Act as well as the California Endangered Species Act (CESA). This biological opinion is both a programmatic biological opinion covering the 50-year SBSP Project as well as a project-level biological opinion covering the specific components and implementation of the Phase 1 actions.

Programmatic Compliance

The Service used the Programmatic BA's biological information to conduct a program-level evaluation of the 50-year SBSP Project. This biological opinion on the programmatic SBSP Project will not exempt the prohibition against take of listed species. Rather, as discussed below, take authorization for entities implementing the project-level Phase 1 actions will follow a compliance process that will tier from the programmatic consultation.

Project Level Compliance

Because the Programmatic BA did not provide the specificity of detail needed to authorize take of listed species under the Act, entities implementing Phase 1 actions will develop tiered biological assessments that will be submitted independently over time. A specific action will be adequately defined when sufficient detail exists about the nature, scope, location, timing, and impacts of the action; and any additional site-specific biological data is available. Future project-level actions (Phase 2 and beyond) will be evaluated in tiered consultations and will be consistent with the proposed action's objectives and will be based on the data, information, and analysis, and conservation measures in the Final EIS/EIR and this biological opinion.

Because information in the Phase 1 BAs has already been adequately defined, this biological opinion includes the analysis of the Phase 1 actions. Individual biological assessments were developed for the Phase 1 actions to provide the level of detail necessary to evaluate affects on each listed species and to quantify the amount and extent of incidental take associated with site-specific actions. The Phase 1 BAs identified listed species likely to be present within each action area and specified measures necessary to avoid and minimize adverse effects on listed species, consistent with the conservation measures described in this biological opinion. The Phase 1 actions include:

1. Ravenswood Pond SF2 Restoration Action
2. Alviso Pond A6 Restoration Action
3. Alviso Ponds A5, A7 and A8 Restoration Action
4. Alviso Ponds A16 and A17 Restoration Action
5. Eden Landing Ponds E8A, E8X, and E9 Restoration Action
6. Eden Landing Ponds E12 and E13 Restoration Action
7. Operations and Maintenance Activities for the Service and CDFG within the SBSP Project Area
8. Operations and Maintenance Activities for PG&E within the South Bay Salt Pond SBSP Project Area

Introduction

The SBSP Project was developed collaboratively by Federal, State, and local agencies working with scientists and the public to develop a long-term, comprehensive plan to restore and enhance wetlands in the South Bay while providing for flood management and wildlife-oriented public access and recreation within formerly-owned Cargill Corporation Inc. (Cargill) salt ponds. The SBSP Project is intended to be implemented in several phases over a 50-year timeframe. The first phase of restoration, known as Phase 1, is proposed to be implemented between 2008 and 2010 and the remaining phases will be described and occur later in time. The Service (SFBNWR) and CDFG currently own and manage the land in the SBSP Project area. The Service (SFBNWR) owns and manages the Ravenswood and Alviso pond complexes and CDFG owns and manages the Eden Landing pond complex.

Background

In October 2000, Cargill proposed to consolidate its operations and sell lands and salt production rights on 61 percent of its South Bay operation area. A Framework Agreement was developed to establish a process for public acquisition of these South Bay salt ponds as well as 1,400 acres of crystallizer ponds along the Napa River. In May 2002, the Framework Agreement was signed by the Service (SFBNWR), California Resources Agency, Wildlife Conservation Board, CDFG, California State Coastal Conservancy, Cargill, and Senator Dianne Feinstein. The Framework Agreement identified the process for the public to acquire the South Bay salt ponds and 1,400 acres of crystallizer ponds along the Napa River in the North San Francisco Bay (North Bay). In December 2002, final negotiations were completed regarding the Conveyance Agreement and Phase-out Agreement, which described specific details regarding the property to be acquired and the responsibilities of Cargill for the phase-out of salt production operations. In February 2003, Cargill sold the ponds to the Service (SFBNWR) and CDFG, with the Service (SFBNWR) acquiring 9,600 acres located at the western end of Dumbarton Bridge (the Ravenswood pond complex) and along the South Bay from Mountain View to Fremont (the Alviso pond complex). CDFG acquired the remaining 5,500 acres just south of the eastern end of the San Mateo Bridge (the Eden Landing pond complex). Although the land is currently owned by the Service (SFBNWR) and CDFG, Cargill continues to manage the levees, ponds, and water control structures proposed for future South Bay salt pond activities under the Service's 1995 biological opinion (Service File Number 1-1-95-F-0047) for Cargill's salt pond operations and management.

In June 2003, the Service (SFBNWR) and CDFG prepared an Initial Stewardship Plan (ISP) that would describe the O&M of the ponds until a long-term restoration plan was developed. The ISP provided guidance on ceasing commercial salt operations, introducing tidal hydrology to ponds where feasible, maintaining existing high quality open water and wetland wildlife habitat, maintaining ponds in a restorable condition to facilitate future long-term restoration, minimizing management costs, and meeting regulatory requirements to maintain water quality standards in the South Bay. In December 2003, the Service (SFBNWR) and CDFG prepared a Draft EIS/EIR in accordance with the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) to address the potential impacts of implementing the ISP. In March 2004 the Final EIS/EIR for the ISP was released. In March 2004, the Service issued a biological opinion for the ISP (Service File Number 1-1-03-F-0359). The biological opinion did not explicitly include operations and management activities for the ponds in the project description, however, the biological opinion acknowledged that some ponds would need to be managed under the ISP for 20+ years once transfer criteria is met. The SBSP Project will assume operations, management, and maintenance activities of all the newly acquired Cargill ponds (including those under the ISP) as part of the proposed action, as well as the operations, management, and maintenance of new ponds created through the proposed action.

In March 2007, the Service (SFBNWR) and CDFG released a Draft EIS/EIR to evaluate the potential environmental impacts of the proposed action. Long-term restoration alternatives were developed to evaluate a range of scenarios within the three pond complexes over a 50-year timeframe. The ultimate configuration of tidal habitat and managed ponds that achieves the proposed action's objectives will likely fall between 50:50 and 90:10 (tidal habitat:managed pond) ratios. An Adaptive Management Plan (AMP) was developed to guide the planning and implementation for the proposed action and it is described in the Final EIS/EIR (Service and CDFG 2007). It is anticipated that the AMP will maximize the benefits of restoration activities for the life of the SBSP Project. The Final EIS/EIR also evaluated Phase 1 actions (proposed to be implemented between 2008 and 2010) in more detail than the long-term restoration alternatives. The proposed Phase 1 actions are common to both long-term alternatives and will include restoration and creation of a range of habitat types and provide opportunities to assess the AMP. Therefore, the Final EIS/EIR is both a programmatic EIS/EIR covering the 50-year SBSP Project as well as a project-level EIS/EIR evaluating the components and implementation of Phase 1 actions.

Project Location

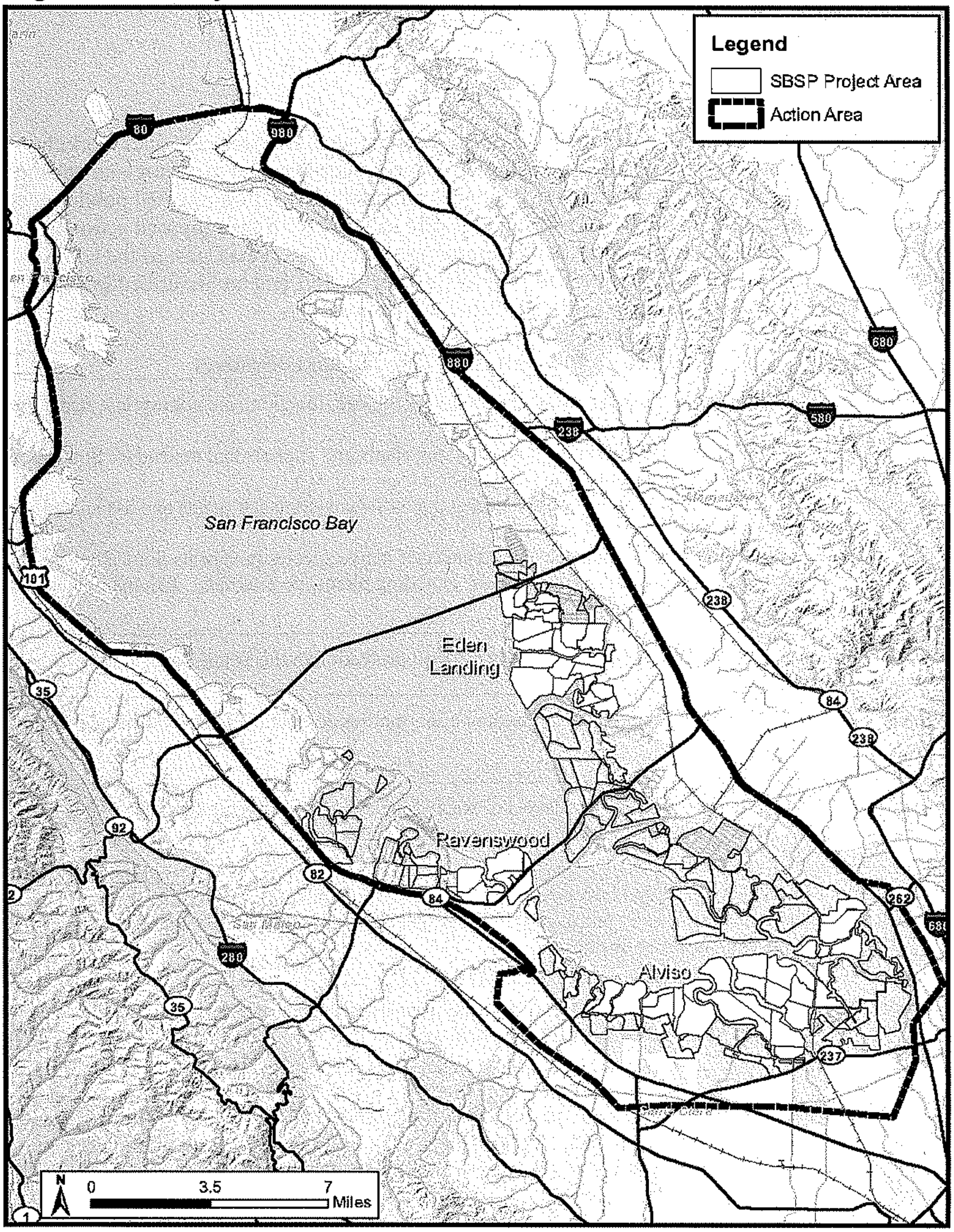
The SBSP Project is located in the South Bay in northern California and consists of approximately 15,100 acres of salt ponds and adjacent habitats within three pond complexes (Ravenswood, Alviso, and Eden Landing pond complexes) (Figure 1). The Ravenswood pond complex consists of seven ponds totaling 1,455 acres within San Mateo County. To the north of the Ravenswood complex is Redwood Creek and to the south is a portion of State Route 84 and the Union Pacific Railroad. To the east is the San Francisco Bay and the western boundary adjoins Bayfront Park in the City of Menlo Park. The Alviso pond complex consists of 25 ponds totaling 7,485 acres within Santa Clara and Alameda Counties. To the north of the Alviso pond complex is Mowry Slough and Mowry Ponds and the south is bordered by commercial and industrial land uses as well as NASA Ames Research Center and Sunnyvale Baylands Park. On the east lies Coyote Creek in San Jose and Cushing Parkway in Fremont and the pond complex is bordered on the west by the Palo Alto Baylands Nature Preserve and Charleston Slough. The Eden Landing pond complex consists of 23 ponds totaling 4,600 acres within Alameda County. The Eden Landing pond complex is located within the Eden Landing Ecological Reserve (ELER). The approach to the San Mateo Bridge forms the northern boundary of the pond complex and Alameda Creek Flood Control Channel and the Coyote Hills form the southern boundary. The ponds are east of the San Francisco Bay and west of Hayward and Union City.

Consultation History

March 1995: The Service issued a biological opinion (Service File Number 1-1-95-F-0047) to the Corps on issuance of a regional permit to Cargill to perform activities associated with solar salt production in the South Bay. This includes O&M activities on levees, ponds, and water control structures.

March 2004:	The Service issued a biological opinion to the Corps for the South Bay Salt Pond ISP (Service File Number 1-1-03-F-0359) for interim maintenance of salt ponds in the South Bay. The Service (SFBNWR) and CDFG applied for a section 404 permit from the Corps to implement the ISP until the proposed action could be implemented.
2004 – 2007:	The Service (SFBNWR) continued coordination with other Federal, State, and local agencies as well as stakeholders regarding the development of the proposed action's components for NEPA and CEQA review.
2006 –2008:	The Service (SFBNWR) continued coordination with other Federal and State agencies regarding the development of the proposed action's programmatic and project-level biological assessments.
December 2007:	The Service (SFBNWR) and CDFG released the Final EIS/EIR for the proposed action.
December 2007:	The Service received a request to initiate formal consultation on implementation of the SBSP Project (including all Phase 1 actions) from the Corps.
Jan.-July 2008:	The Service coordinated with NMFS and biological consultants for the proposed action to finalize the restoration design and plan for Phase 1 actions: Ravenswood Pond SF2; Eden Landing Ponds E8A, E8X, and E9 and E12-E13; Alviso Ponds A6, A8, and A16; CDFG and Service O&M; and PG&E O&M.
July 2008:	The Service received the Programmatic BA (Service 2008a) and the Phase 1 BAs (Service 2008b-i)

Figure 1. SBSP Project Location and Action Area



PROGRAMMATIC BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The proposed action is a collaborative effort among federal, state, and local agencies working with scientists and the public to develop a long-term, comprehensive plan to restore and enhance wetlands in South Bay while providing for flood management and wildlife-oriented public access and recreation within the 15,100 acres of former Cargill salt ponds. If the proposed action is approved, it would be the largest wetlands restoration project on the West Coast of the United States. The six proposed action objectives are identified in Table 1 and are described in detail in the Final EIS/EIR and are summarized in the following sections.

Table 1. South Bay Salt Pond Restoration Objectives

Objective 1	Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to: ▪ Promote restoration of native special-status plants and animals that depend on South Bay habitat for all or part of their life cycles. ▪ Maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees. ▪ Support increased abundance and diversity of native species in various South Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish mammals, birds, reptiles, and amphibians.
Objective 2	Maintain or improve existing levels of flood protection in the South Bay.
Objective 3	Provide public access and recreational opportunities compatible with wildlife and habitat goals.
Objective 4	Protect or improve existing levels of water and sediment quality in the South Bay, and take into account ecological risks caused by the restoration.
Objective 5	Implement design and management measures to maintain, or improve current levels of vector management, control predation on special-status species, and manage the spread of non-native invasive species.
Objective 6	Protect the services provided by existing infrastructure (e.g., power lines, clapper railroads, and wastewater treatment plants).

The Final EIS/EIR for the proposed action evaluated three long-term alternatives with respect to tidal habitat restoration, managed ponds, flood management, and recreation and public access. The alternatives included Alternative A (No Action), Alternative B (Managed Pond Emphasis-50:50 tidal habitat:managed ponds by area), and Alternative C (Tidal Emphasis-90:10 tidal habitat:managed ponds by area). Each Alternative is identified in Table 2. The ultimate configuration of tidal habitat and managed ponds that achieves the proposed action's objectives will likely fall between of 50:50 and 90:10 (tidal habitat:managed pond) ratios. The final mosaic combination will be guided by the AMP and implemented in adaptive steps over a 50-year period, resulting in 6,800 to 11,880 acres of tidal habitat being restored.

Table 2. Proposed Action Alternatives A, B, and C

Components	Alternative A	Alternative B	Alternative C
Tidal Habitat Restoration	Limited tidal restoration may occur from uncontrolled breaching of levees.	• 6,800 acres (50% of the proposed action area).	• 11,880 acres (90% of the proposed action area)
Managed Ponds	Current pond management would be scaled back. Many ponds would convert to seasonal habitat, filling and drying through rainfall and evaporation. Some ponds would convert to tidal habitat through uncontrolled breaching.	• 6,800 acres (50% of the proposed action area) • 20% of the managed pond area would be reconfigured for birds; the rest would have no grading or minimal grading (some island creation)	• 1,700 acres (10% of the proposed action area) • All ponds would be reconfigured to enhance foraging, roosting and nesting opportunities
Flood Management	Limited maintenance of pond levees would occur. Flooding may worsen as a result of uncontrolled breaching of levees.	• Integrated system of both coastal and fluvial flood elements: • Shoreline levees for coastal flood protection • Raise existing levee elevations where fluvial and coastal flooding occurs	• Similar to Alternative B, with differences in the actual location of levee installation/ removal
Recreation and Public Access Features	No new recreational facilities would be provided. Existing recreation opportunities may decrease as a result of uncontrolled breaching of levees.	• New recreational trails • New viewing areas • New staging areas • New field office	• Similar to Alternative B, with differences in locations of some facilities, and requirements for removal of trails

A detailed description of the long-term alternatives is located in the Final EIS/EIR for the proposed action. Implementation of the proposed action will be funded by a variety of sources, including, but not limited to grants, bonds, and appropriations, and other projects requiring mitigation within the proposed action area.

Pond Complexes

Within the South Bay, the proposed action area is divided into three main areas: Eden Landing, Alviso, and Ravenswood pond complexes (Table 3). A detailed discussion of habitats and species located within the South Bay and specifically within the proposed action pond complexes are described with the Final EIS/EIR. The Alviso pond complex contains approximately 7,400 acres of former salt ponds, 420 acres of salt marsh, 900 acres of brackish marsh, and other associated South Bay habitats. The Ravenswood pond complex contains 1,440 acres of salt ponds, with a mix of other habitats surrounding the ponds, including salt marsh (over 100 acres). The Eden Landing pond complex contains approximately 4,400 acres of salt ponds and over 700 acres of salt marsh. Of the over 18,000 acres mapped in the three pond complexes, over 13,000 acres consist of salt ponds. South Bay habitat comprises mudflat (less than 10 percent vegetated) and open water. Hardscape such as levees, ruderal upland vegetation or landscaping, unvegetated areas, and areas developed for commercial use or infrastructure, are categorized as "Other".

Table 3. Habitat Area within the Pond Complexes

HABITAT CATEGORY	COMPLEX	ACREAGE
Salt Pond*	Alviso	7,364
(Total acreage = 13,227)	Ravenswood	1,440
	Eden Landing	4,423
Marsh Habitat	Alviso	1,607
(Total acreage = 2,584)	Ravenswood	153
	Eden Landing	824
Bay Habitat	Alviso	838
(Total acreage = 1,231)	Ravenswood	283
	Eden Landing	110
Other	Alviso	617
(Total acreage = 1,228)	Ravenswood	176
	Eden Landing	435

*Note: These areas represent the actual amount of salt pond habitat contained within the existing levees of the proposed action area, and should not be confused with the 15,100 acre figure which represents the entire area purchased from Cargill and includes levees and some adjacent habitats.

The baseline conditions, as described in the Final EIR/EIS, are the conditions that are predicted to be present once the ISP is fully operational. Therefore, the ponds that are the subject of the proposed SBSP Project are no longer salt production ponds after ISP implementation. However, because the vast majority of research that has been conducted on these ponds was performed when they were functioning as salt ponds, the term "salt pond" is used to refer to these ponds. The ponds within the proposed action area are, collectively, highly productive systems, supporting very high invertebrate biomass due to the abundance of a few key species and providing roosting, nesting, and foraging habitat for large numbers of waterbirds. However, with the exception of the birds that move in and out of the ponds, and some fish and aquatic invertebrates that are drawn into intake ponds, the salt ponds are primarily a closed system, with virtually no export of detritus, nutrients, or energy to the tidal marsh, sloughs, mudflats, or open waters of the South Bay. Specific habitat descriptions for each of the pond complexes are described in the Final EIR/EIS. Characteristics of individual ponds selected for Phase 1 actions will be described within the project-level evaluations in the second part of this biological opinion. The following is a discussion of each of the six SBSP Project objectives:

- Ecosystem Restoration
- Flood Management
- Public Access and Recreation
- Protect Water and Sediment Quality
- Control Vectors and Nuisance Species
- Maintain Existing Infrastructure and Operations and Maintenance

Ecosystem Restoration

The Ecosystem Restoration Objective includes the creation, restoration, and/or enhancement of habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals and maintain current migratory bird species that utilize existing salt ponds and levees. Ecosystem restoration will also support increased abundance and diversity of native species in South Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles, and amphibians. The proposed action includes a mix of restored tidal and managed pond habitats. The tidal habitat will include salt and brackish marsh, mudflats, subtidal flats and channels, marsh ecotones and upland transitional zones, salt pannes and ponds, and sloughs. For managed pond habitats, multiple options for pond reconfiguration and water regime management will be used to enhance and create ponds with a variety of depths (including vegetated ponds, salt flats, very shallow ponded areas, and deep-water areas) and salinities (e.g., ponds with salinity close to bay water as well as higher salinity brine ponds), and associated levees and islands.

General Construction Activities Associated with Ecosystem Restoration

It is anticipated that each individual restoration action will be completed in a single season (2 to 5 months), however, the timing and duration of construction will be governed by both weather conditions and the need to avoid construction in sensitive areas during certain times of the year to avoid and minimize impacts to listed species. Types of land-based construction equipment may include excavators, front-end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, and water trucks. If water levels in the restoration sites are at sufficient depths for floating equipment, types of water-based equipment may include diesel-powered barges with long reach excavators or cranes outfitted with clamshell buckets and boats. Ancillary types of equipment that may be used include diesel generators, water pumps, and pile drivers. It is anticipated that dewatering and sheet piling will necessary during the construction of water control structures. Dredge-locks or coffer dams may be constructed using earth levees or sheet piling to allow access for water-based equipment within a site. When possible, amphibious excavators, vibratory pile drivers, and other less-impacting equipment will be used. Occasional delivery of supplies and materials, such as piping, water control gates, lumber, and fuel, will be necessary. Staging areas will be temporarily established as described in the conservation measures for activities such as fueling and equipment storage. Any fill materials proposed to be used for construction of restoration sites will be stockpiled on-site and may be derived from a variety of approved sources. The stockpiling areas, though not the sources, are included within the action area for the proposed action. Ultimately, construction activities associated with ecosystem restoration and the type of equipment used will be determined by the final design of each restoration action and the conditions at the restoration site. Construction activities and methods will be detailed in the descriptions of each project-level restoration action and will include conservation measures specific to each action. The evaluations for each restoration action will tier from this PBO.

Tidal Habitat Restoration Activities

Construction activities related to tidal habitat restoration anticipated to occur include, but are not limited to, the following bullets described below. Not all of these activities may be used as part of a single habitat restoration action at a given pond or group of ponds. All construction activities related to tidal restoration will be described in detail within each of the Phase 1 action project descriptions and all future tiered action descriptions.

- Breaching sections of outboard levees
- Lowering sections of outboard levees
- Breaching internal levees
- Excavating pilot channels to sloughs through the fringe marsh outboard of outboard levee breaches
- Constructing ditch blocks in the perimeter and internal borrow ditches with material excavated from the levee breaches and lowered levees, or from other clean sediment
- Importing dredged or fill material
- Side-casting of dredge spoils into adjacent marsh
- Retrofitting infrastructure (e.g., tower footings, boardwalks, sewer lines, etc) within the project area prior to restoration
- Constructing slough channels and marsh pannes in pond bottoms, or along the tops of lowered internal levees
- Removing or abandoning existing water control structures
- Reconfiguring culvert connections
- Breaking up gypsum layer mechanically

Managed Pond Construction Activities

Construction activities related to reconfiguring managed ponds anticipated to occur include, but are not limited to, the following below. Not all of these activities may be used as part of a single action at a given pond or group of ponds. All construction activities related to managed pond reconfiguration will be described in detail within each of the Phase 1 action project descriptions and all future tiered action descriptions.

- Installing, replacing, or modifying intake/outlet water control structures with tide gates
- Installing fish screens on outboard intake/outlet water control structures as appropriate
- Constructing low berms to divide a pond into multiple cells
- Installing water control structures, such as flashboard weirs, in internal berms to regulate flow among cells
- Constructing intake and outlet canals to convey water among individual cells
- Using dredge/fill material to construct internal islands for nesting, roosting, and foraging
- Grading pond bottoms to achieve desired grades and elevations
- Improving, raising, and extending levees between managed ponds and existing or restored marshes as necessary to prevent tidal inundation of managed ponds
- Installing or operating pumps as necessary
- Excavating pilot channels to the bay through the fringe marsh outboard of new water control structures
- Improving levees around ponds to improve maintenance access and/or contain water

South Bay Salt Pond Mitigation Program

Mitigation, through habitat restoration, is used in certain instances to offset project impacts to wetland and estuarine habitats or for listed species. There are various conditions which must be met before it can be determined that mitigation is appropriate to minimize the effects of project impacts. Most importantly, a project's impacts should not compromise a species' recovery goals or jeopardize its continued existence. Under the Mitigation Program, impacts to wetland or estuarine habitat, or to listed species or their habitats that meet the appropriate conditions may be mitigated through restoration within the proposed action area. Any project that wishes to mitigate within the proposed action area is subject to the following criteria:

- Projects are subject to the review and approval of the Service, NMFS, and CDFG.
- Projects must be located south of the San Francisco Bay Bridge and within the proposed action area.
- The impacts for which mitigation is performed within the proposed action area must be located below mean high tide line.
- Projects must not conflict with any policies of the relevant regulatory agencies (i.e., Service, NMFS, Corps, CDFG, RWQCB) relating to mitigation.
- The mitigation must benefit the wetland and estuarine habitats or listed species impacted by the proposed project needing mitigation.

<u>Mitigation on Service Land</u>

In 1999, the Service adopted a policy that it would not allow the use of National Wildlife Refuge System lands for mitigation banks under the Clean Water Act. However, in 2004, the Service (SFBNWR) was granted an exception to this policy under the National Wildlife Refuge System and Compensatory Mitigation under the Section 10/404 Program for Refuges in the San Francisco Bay Area. Therefore, additional requirements exist for mitigation on the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) for impacts under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and

Harbors Act.

- Mitigation must be approved by the Service's California Nevada Operations Office.
- Projects for which the mitigation is accepted must comply with the Section 404 (b)(1) Guidelines of the Clean Water Act.
- Mitigation must be consistent with the purposes of the Service and the mission of the National Wildlife Refuge System.
- Mitigation would result in a significant increase in natural resource benefits when compared to other appropriate, off-site mitigation options
- Mitigation plan is written to ensure there is no obligation to allow compensatory mitigation on any National Wildlife Refuge System Lands in the future.
- Projects for which the mitigation is accepted are in compliance with all applicable Federal environmental statutes including the Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, Magnuson-Stevens Act, NEPA, Fish and Wildlife Coordination Act, and permits as would be required and provided by Federal, State and local governments.
- Mitigation must be consistent with and would assist in meeting the goals of, the Bay Ecosystem habitat Goals Report, prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project and applicable recovery plans for endangered species.
- Projects for which the mitigation is accepted are only public work development projects. This would limit the use of refuge lands to projects needed for the public good and would not apply to projects that may require compensatory mitigation from private entrepreneurs or developers.

<u>Mitigation on CDFG Land</u>
CDFG will also consider the use of CDFG lands for mitigation, when appropriate and consistent with CDFG policy and management objectives, on a case by case basis with the concurrence of permitting and resource agencies. Upon approval, projects wishing to mitigate on CDFG land would be responsible for getting approval from the regulatory agencies as part of their permitting process.

- CDFG Mitigation Requirements on existing CDFG lands:
- Mitigation applicants need to provide funding to offset the cost of acquisition which CDFG uses for other acquisition or restoration.
- Funding for planning and implementation of the mitigation actions
- Endowment for long-term stewardship which is to generate support for long-term O&M of the CDFG lands used for mitigation.
- Funding for regulatory requirements for monitoring if required

Flood Management

The Flood Management Objective includes maintaining or improving existing levels of flood protection in South Bay. Therefore, flood hazards to adjacent communities or infrastructure should not occur due to implementation of the proposed action. The proposed action will ensure that future flood protection with the proposed action area is comparable to, or better than, current conditions.

General Construction Activities Associated with Flood Management

Each proposed restoration alternative describes provisions to manage flood hazards from both fluvial (stream) and coastal flood sources, which are described in detail in the EIS/EIR for the proposed action. A common strategy among restoration alternatives is to improve the inboard levee system (along the landward side of the ponds) to reduce the hazards of coastal flooding. Other salt pond levees include: 1) existing outboard levees (*i.e.*, bayfront and slough/creek levees adjacent to tidal waters) that were built to enclose evaporation ponds on former tidal marshes and mudflats and to protect the salt ponds from Bay inundation; 2) smaller inboard levees (*i.e.*, pond levees constructed inland along the historic Bay margin) that offer the last line of defense against flooding of low-lying, inland areas; and 3) internal levees that separate the individual salt ponds from each other. These salt pond levees were not designed, constructed, and maintained following a well-defined standard and would likely require significant improvements to provide an adequate flood protection. Construction of the inboard levee system (along the landward side of the ponds) to reduce the hazards of coastal flooding is the predominant proposed action activity associated with flood protection. For each phase of the proposed action, flood management strategies will be developed and they will be evaluated under tiered section 7 consultations under this PBO. Activities associated with flood protection may include:

- Modifying (raising or retrofitting) existing levees
- Placing fill to raise high ground areas and adding erosion protection where necessary.
- Constructing new flood protection levees
- Breaching, or setting back the existing salt pond levees, widening the channel and providing additional cross-sectional area for flow to improve floodwater conveyance
- Using regular tidal scour to enlarge the channel cross-section and increase conveyance
- Breaching slough levees to route more tidal flow through the sloughs/channels, to increase channel deepening and widening downstream of the breaches
- Removing or allowing levees on one or both sides of the channel to scour where channel scour is expected
- Relocating maintained levees to accommodate the expected channel enlargement or armoring them to ensure that they remain intact
- Providing temporary floodwater storage within the managed ponds to reduce flooding impacts
- Converting ponds to muted tidal or seasonal wetland with flood-flow diversion to increase storage of fluvial floodwaters, resulting in decreased water levels and reduced flood hazards in tributary channels

Although the proposed action is committed to ensuring that future flood protection with each individual project is equal to, or better than existing conditions, it is desirable that a comprehensive flood management strategy be developed around the entire proposed action area that would provide a consistent level of flood hazard management with flood protection measures (levees, high ground) meeting both Federal Emergency Management Agency (FEMA) and Corps criteria.

Public Access and Recreation

The Public Access and Recreation Objective will provide public access and recreational opportunities compatible with wildlife and habitat goals. Public access and recreation, flood management, and habitat features will be developed in concert with each other to maximize the ability to manage these resources over time. Trails and other access features that are developed on existing or proposed levees would be integrated with the levee structure, without interrupting the flood control function.

Features Associated with Public Access and Recreation

The proposed public access and recreation components would include an interrelated system of trails and viewing platforms, interpretive stations, waterfowl hunting, access to and interpretation of cultural resource features, opportunities for education and interpretation, small watercraft launching points, and associated access points and parking areas. Tidal access and recreation areas would be designed to withstand periodic inundation, if appropriate, and may be in locations that would have more limited access or use, depending on tidal location and habitat requirements. Public access and recreation features would be designed to respect habitat requirements and therefore, may be seasonal or limited in the number of visitors that can be accommodated. These features are described in general below and the Final EIS/EIR describes the locations and types of features in greater detail.

- **Trails** - The trails component of the public access and recreation plan is hierarchical, with certain segments helping to complete the Bay Trail regional system, and local trail connectors that may be part of an existing local system. Where possible, new loop trails are proposed near areas where the restoration will result in the removal of existing loop trails. Trail segments will vary in size, width, surfacing and the types of users they can accommodate and when visitors will have access. Trail segments may amount to approximately 23.5 miles of new and/or improved trails. Trails may be designed to accommodate vehicular use in some locations to provide access to a staging area or launching point, or for disabled access. Trails would also provide waterfowl hunting and fishing access to areas that accommodate these activities. Trails will also provide opportunities for walking, jogging, bicycling, wildlife viewing, and nature photography. In general, trail access is considered to be less compatible with tidal habitat restoration than with managed pond restoration because, in the absence of data on public access effects on listed species, the Service must take a conservative approach to protecting listed species. Thus, tidal habitat species are currently considered sensitive to public access.

- **Access Points and Staging Areas** - Various access points and staging areas will be designated to provide access to the other features such as trails, kayak, fishing and waterfowl hunting access. Access would be designed to be as barrier-free as possible to provide access for visitors of varying abilities and would comply with the Americans with

Disabilities Act (ADA).

- **Boating** - Water-based activities such as non-motorized boating (canoes and kayaks) would be incorporated into the public access plan for hunters, anglers, and people interested in wildlife viewing.

- **Historic Features** - Historical and cultural features will be accessible as part of the larger trail network and where interpretive signage and guided or self-guided walks is appropriate. The history of landscape change in the South Bay provides a wealth of possible themes to develop as part of the public access plan. The history of the many salt works operating in the South Bay or the use of the South Bay for duck hunting are examples of themes that may be developed for interpretive and educational value. Historical as well as future landscape change would be considered in the final design of public access features.

- **Interpretive Stations** - Interpretive stations are proposed at strategic locations along the trail network within the proposed action area. These are envisioned to be of varying sizes and scope and may be interactive features that can operate independently or can be enhanced with the assistance of docents.

- **Viewing Platforms** - Viewing platforms would be located at vista points where important information about the landscape can be viewed. These may also incorporate interpretive panels or signage to link the viewer with the site location.

- **Waterfowl Hunting and Fishing** - Hunting and fishing within the proposed action area will occur for the Service (SFBNWR) and ELER, and does not include hunt programs authorized for other parcels under previous biological opinions. If these programs change in the future, the changes will be proposed to the Service, and the effects of such changes on listed species will be analyzed as specific activities tiering off this PBO. Effects to listed species cannot be greater than those already considered in the Service's biological opinion. It is likely that the Service's (SFBNWR) entire hunting program will be modified in the development of their Comprehensive Conservation Plan (CCP).

General Construction Activities Associated with Public Access and Recreation

Construction of the recreation and public access components may consist of the following activities:

- Trail construction activities may consist of grading and, for all-weather trails, gravel application. Equipment required for trail construction may include small, Bobcat-sized equipment, backhoes or front-end loaders, graders, bulldozers, asphalt placement equipment, and dump trucks. Depending on the length of trail, construction activity could take one to seven days.
- Constructing trails, including some trails designed to accommodate vehicular use, trails to provide access to a staging area or launching point, and trails for disabled access.
- Constructing interpretive stations of varying size and scope, which will include interactive

features that can operate independently or can be enhanced with the assistance of docents.

- Constructing viewing platforms at vista points where important information about the landscape can be described. Viewing platforms will be made of wood, metal, or plastic material and assembled in-place using a backhoe or excavator and hand tools. Interpretive stations will be built on-site, or will be prefabricated structures. Assembly and installation will require a backhoe or excavator and hand tools.
- Constructing non-motorized boat launching points and associated staging and parking areas for water-based activities.
- Constructing a boat launch facility for the launching of kayaks and small boats will require the building of a ramp for trailer access. Equipment required will include a backhoe or excavator, compaction equipment and a dump truck for imported fill materials.

Protect Water and Sediment Quality

The fourth objective is to protect or improve existing levels of water and sediment quality in the South Bay, and take into account ecological risks caused by the restoration. The habitats to be created by the proposed action will include a mix of managed pond and restored tidal habitats. The proposed action is designed to restore and improve water and sediment quality in the South Bay beyond the duration of the proposed action via the beneficial water quality functions of the restored tidal wetlands. The specific construction activities to achieve these beneficial water quality functions through tidal restoration have been listed under the Ecosystem Restoration Objective. More specific water and sediment quality concerns that accompany proposed action activities involve mercury mobilization, low dissolved oxygen in managed pond and releases from these ponds, and increased turbidity during construction.

Mercury-Related Activities

Sediments in some parts of the proposed action area, particularly in and along Alviso Slough, contain high levels of mercury contamination. Re-mobilization of mercury-contaminated sediments into the water column, either directly (e.g., during excavation of pilot channels) or indirectly (through increased sediment scour after a pond is opened to tidal action), can lead to exceedance of water quality objectives for mercury and result in adverse effects on South Bay biota. For mercury, the proposed action will attempt to avoid causing or contributing to mercury levels exceeding 0.2 parts per million (ppm) in large fish and 0.03 ppm in small fish, both in the project area and in the South Bay; these thresholds are driven by the total maximum daily load (TMDL) plan for mercury in the San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006). The Bay mercury TMDL also requires that activities avoid release of sediments into the bay that have a median mercury concentration greater than 0.2 ppm, and that existing water quality objectives (0.025 – 0.050 μg/L) for mercury be attained.

To help ensure that these objectives are met, testing of sediments within ponds to be opened to tidal action, and within sloughs and marshes that may scour following breaching of a pond, for mercury concentrations will be conducted, primarily along Alviso Slough.

A mercury monitoring study is currently underway to ensure that mercury impacts on biota are minimized during restoration. This study focuses on the Alviso area where mercury levels are known to be high, but also includes sampling sites elsewhere in the South Bay. This study is measuring mercury levels in the sediment, water column, and various sentinel species; measuring the bioavailability of inorganic mercury in sediments; measuring mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. This study will increase the understanding of mercury cycling within the proposed action area and will inform future management decisions to further minimize mercury exposure.

Monitoring of mercury cycling during Phase 1 restoration and management activities will also provide information on management or restoration activities that are desirable, or that are to be avoided, in areas of high mercury concentrations. Decisions regarding restoration or management activities involving breaching and scour in a particular area will be made only after the sediments to be mobilized by such activities are tested for mercury levels, and in the context of the results of ongoing and future studies regarding the effects of mercury. Once it is determined the nature and scope of these studies, they will be evaluated and tiered under this PBO.

Other activities will be implemented as adaptive management actions if monitoring of mercury levels indicates unacceptable levels in sediments, the water column, or tissues. These activities may include:

- Adding an upper layer of clean sediment within managed ponds to decrease mercury concentrations in re-suspended sediments
- Placing berms or islands within ponds to decrease fetch length and decrease wind-driven resuspension of sediments
- Removal of mercury-contaminated sediments from areas of particularly high concentrations, or areas where mercury-laden sediments are being scoured and resuspended.

Activities Related to Low Dissolved Oxygen

Changes in water flow/residence time and increased algal productivity could reduce dissolved oxygen (DO) levels in managed ponds and discharges from these ponds to sloughs and to the South Bay. DO is depleted in pond and marsh environments by respiration and chemical and microbial aerobic processes. DO is replenished in the system through photosynthesis and oxygen transfer from the atmosphere, termed reaeration. Microbial degradation of organic matter in pond and marsh sediments can be a significant oxygen demand in the system. This sediment oxygen demand is dependent on the amount of organic matter available to decay. Death of algae and aquatic organisms contributes to the organic matter supply. Respiration may be a significant oxygen demand if algae and organism populations are large. Algae are net oxygen consumers at night, when wind-driven re-aeration is also low. This creates periods of low DO. DO is then replenished during the day when the algae photosynthesize instead of respiring and wind-driven re-aeration increases. Waters flowing slowly through a pond will not be as well mixed as faster moving waters. Stagnant conditions lead to anoxic waters as oxygen demands exceed re-aeration. Significant impacts as a result of low DO will include depressed species diversity, fish kills and death of other aquatic organisms, and odor problems.

For water discharges from the proposed action area, the goal is to avoid discharges that result in DO less than 5 mg/L in the South Bay, which is established by the regional water quality regulations. Within managed ponds in the proposed action area, where lower DO levels are expected to occur more commonly, the goal will be to avoid DO levels less than 2 mg/L. Several activities will be undertaken to prevent DO levels in managed ponds and releases from these ponds from becoming too low or increase DO levels when monitoring indicates that they are too low. These activities include:

- Decreasing the hydraulic residence time to counter algal growth and increase re-aeration
- Altering levee configurations to increase wind-driven re-aeration and/or improve pond circulation
- Decreasing water depth to counter sediment oxygen demand
- Installing baffles to re-direct flow from low-DO areas or discharge water from high-DO areas
- Installing passive or active re-aeration systems

Control Vectors and Nuisance Species

The proposed action will implement design and management measures to maintain or improve current levels of vector management, control predation on special-status species, and manage the spread of non-native invasive plant species. Vector control is incorporated into the proposed action primarily through the design and restoration of well-drained tidal marshes, as described previously for the Ecosystem Restoration Objective. Any residual mosquito control needs will be addressed by mosquito abatement districts under separate authorization; such mosquito control is not covered under this PBO. The activities for predator management and management of non-native invasive plant species are listed under the sub-headings below.

Control of Predation on Special-Status/Sensitive Species

Predation by a number of both native and non-native predator species impacts populations of special-status and sensitive species in the South Bay. The level of impact to a species by a particular predator varies by site, depending largely upon the local predator population level, habitat conditions, and surrounding landscape features. Some of the most common predators include: 1) non-native mammals such as red foxes (*Vulpes vulpes*), Norway rats (*Rattus norvegicus*), roof rats (*Rattus rattus*), and feral and domestic cats (*Felis catus*); 2) native mammals such as gray foxes (*Urocyon cinereoargenteus*), striped skunks (*Mephitis mephitis*) and raccoons (*Procyon lotor*); and 3) native birds such as California gulls (*Larus californicus*), northern harriers (*Circus cyaneus*), common ravens (*Corvus corax*), and American crows (*Corvus brachyrhynchos*). Other less common predator species may have either localized or larger scale impacts to certain special-status or sensitive species.

Predator management by California Wildlife Services, USDA-APHIS for protection of special-status and sensitive species already occurs in a large portion of the proposed action area, including an ongoing mammalian predator management program on the Service (SFBNWR) and

ELER (Foerster and Takekawa 1991), and focused removal of avian predators to protect snowy plovers on ELER (CDFG 2000). Predator management activities on the SFBNWR are limited to control of mammalian species, as authorized by the San Francisco Bay National Wildlife Refuge Predator Management Plan and Environmental Assessment (Foerster and Takekawa 1991). Predator management will continue on an as-needed basis to protect listed species, such as snowy plovers, clapper rails, harvest mice, and least tern colonies from predators. When the Service (SFBNWR) develops the revised CCP, the predator management program will be expanded to include both avian and mammalian predator species. The Service (SFBNWR) is scheduled to conduct the CCP process beginning in 2008. Until then, predator monitoring and management will continue under their current authorities and the proposed action will continue coordination with Wildlife Services to focus predator control in priority listed species habitats to reduce high levels of predation. Although these activities will continue during and post-implementation of the proposed action, they will not be covered under this PBO.

Manage the Spread of Non-native Invasive Species

A number of non-native plant species occur within the proposed action area, some of which have been identified as invasive or potentially invasive. Vegetation management activities will focus on detection and removal of invasive plant species that threaten native habitats and/or alter special-status species or migratory bird habitat. Current management focus is on several species of cordgrass (*Spartina spp.*) and perennial pepperweed (*Lepidium latifolium*). Although the growth of invasive *Spartina* is limited to salt and brackish marsh habitats, pepperweed grows in a wider variety of wetland types and in certain habitats.

The proposed action is operating under the assumption that invasive *Spartina*, including non-native smooth cordgrass (*S. alterniflora*) and its hybrids, will be controlled by the Invasive *Spartina* Project. All invasive *Spartina* control work, including monitoring and spraying as needed, will be performed under the existing Invasive *Spartina* Project Biological Opinion (Service File Number 81420-2008-F-1546) and future amendments to this authorization, until the Invasive *Spartina* Project is completed.

Control of perennial pepperweed is currently occurring only on a small-scale, experimental basis along levees. No large-scale control program yet exists to facilitate effective long-term control. Breaching of levees and subsequent increases in tidal prism could reduce the amount of brackish marsh habitat available for colonization by pepperweed. Monitoring new establishment of pepperweed will involve activities that will be covered under the Phase 1 BO in the second part of this biological opinion. These activities may include walking on levees and in marshes, driving motor vehicles on levees and roads, and boating in the South Bay and in sloughs and channels. If, over time, other non-native invasive species are detected within the proposed action area, the threat to the ecosystem will be assessed and management activities will be implemented according to the adaptive management process.

Protect Existing Infrastructure and Operation and Maintenance

The proposed action will restore a substantial portion of the 15,100-acre restoration area to tidal marsh, and will therefore contribute to changes in water levels, tidal flows, and sedimentation patterns in the South Bay, the tidal sloughs, and the ponds over the 50-year life of the proposed action. The protection of existing infrastructure is being achieved through project design, which will minimize changes that will potentially affect the operation and management of existing utilities (e.g., electrical transmission lines and sub-stations, gas pipelines, storm drains, pump stations, and wastewater treatment plant outfalls) located within the proposed action area. Activities related to infrastructure protection such as accessing infrastructure via foot, boat, helicopter or vehicles (both light vehicles and heavy equipment) for visual inspections or surveys of levees, towers, outfalls, etc are being covered under the Phase 1 BO in the second part of this biological opinion. Such inspections will be brief at any given location, and are expected to occur no more than once per year.

The proposed action would involve O&M activities associated with Ecosystem Restoration, Flood Management, and Recreation and Public Access. O&M activities would occur periodically over the 50-year planning horizon and include activities for all South Bay salt ponds, including O&M of Phase 1 actions and future actions. O&M would include activities such as the replacement and/or repairs of water control structures, and maintenance of existing and new levees. O&M would be covered by the existing Corps Permit #19009S98 which was issued by the Corps in November 1995 to Cargill for certain structures. The portions of the permit covering lands which are part of the proposed action were transferred to Service (SFBNWR) and CDFG in May 2003. All O&M activities for ponds in the South Bay salt pond complex are addressed in two separate descriptions: 1) O&M activities to be performed by the Service (SFBNWR) and CDFG; and 2) O&M activities to be performed by PG&E on their infrastructure (by way of a Special Use permit issued by the Service (SFBNWR)). Changes in operations and maintenance of PG&E infrastructure resulting from the proposed action, as well as the activities required to protect PG&E infrastructure (raising tower footings, raising boardwalks, building boat blocks) prior to restoration actions. These activities are covered under the Phase 1 BO in the second part of this biological opinion.

Other Projects and Programs

Moffett Federal Airfield (Moffett) is a restricted use Federal airfield owned by the National Aeronautics and Space Administration (NASA) to meet the needs of NASA, other agencies, and other NASA Ames Research Center authorized users. The California Air National Guard's 129th Rescue Wing (129 RQW) is based at Moffett and operates C-130 aircraft and HH-60 helicopters, in addition to aircraft operations by NASA and other authorized users of the airfield.

The north end of the runways at Moffett is located within 10,000 feet (a critical phase of flight area) to the proposed action area (Alviso Ponds A2E, AB2, and A3W). Data complied over many years by NASA and others show wildlife-aircraft collisions occur with greater frequency at low altitudes, along shorelines, and areas favorable for wildlife habitat. These types of collisions have resulted in fatalities and the loss of an aircraft shortly after take-off when it struck a flock of birds. Therefore, the Service has been coordinating with the California Air National Guard regarding the control of wildlife hazardous to 129 RQW flight activities over and around the proposed action area. As Alviso Ponds A2E, AB2, and A3W are restored (Phase 2 - after 2010), listed species may be attracted to habitat within 10,000 feet of the north end of the runways. This may pose hazards to aircraft operating to and from Moffett. Therefore, the Service will continue to coordinate with the California Air National Guard to ensure that their needs for wildlife control are met while complying with the Act. The Service anticipates that the California Air National Guard's wildlife control plan may require section 7 consultation if their wildlife control plan may affect listed species. If so, this consultation would be a project-level consultation which would tier under this PBO.

Conservation Measures

The following conservation measures will be implemented as part of the proposed action to further reduce or avoid adverse effects on the clapper rail, harvest mouse, snowy plover and critical habitat, least tern, and the brown pelican during the 50-year life of the project. These conservation measures are expected to be implemented in a manner and to an extent sufficient to sustain Act, and CESA compliance. Additionally, all project-level actions proposed to be implemented under the programmatic action will implement these conservation measures as appropriate and feasible for each project-level action (Phase 1 actions and future actions). However, the precise conservation measures that will apply to avoid or minimize a specific action's adverse effects will depend on the location and timing of the action, as well as the current status, distribution, and needs of the affected species and habitats. Implementation of these conservation measures as necessary is a key component in determining effects to listed species and a key component in the determination made for listed species in this biological opinion.

As the proposed action develops new information about implementation, the Service (SFBNWR) and CDFG may revise the conservation measures as necessary, consistent with the Act and CESA. However, the Service will not approve revisions to the conservation measures that would cause or allow an increase in incidental take of a listed species or critical habitat designated under the Act that was not considered in this biological opinion. Any revisions to conservation measures that are consistent with the PBO can be incorporated without re-initiating section 7 consultation.

1. To minimize or avoid the loss of individual clapper rails, activities within or adjacent to clapper rail habitat will not occur within two hours before or after extreme high tides (6.5' or above, as measured at the Golden Gate Bridge), when the marsh plain is inundated, because protective cover for clapper rails is limited and activities could prevent them from reaching available cover.

2. To minimize or avoid the loss of individual clapper rails, activities within or adjacent to tidal marsh areas will be avoided during the clapper rail breeding season from February 1 through August 31 each year unless surveys are conducted to determine clapper rail locations and clapper rail territories can be avoided, or the marsh is determined to be unsuitable clapper rail breeding habitat by a qualified biologist. If breeding clapper rails are determined to be present, activities will not occur within 700 feet of an identified calling center. If the intervening distance across a major slough channel or across a substantial barrier between the clapper rail calling center and any activity area is greater than 200 feet, then it may proceed at that location within the breeding season. *Exception*: Only inspection, maintenance, research, or monitoring activities may be performed

during the clapper rail breeding season in areas within or adjacent to clapper rail breeding habitat with approval of the Service and CDFG under the supervision of a qualified biologist.

3. To minimize or avoid the loss of individual harvest mice from any excavation, fill, or construction activities in suitable habitat within tidal marsh areas, vegetation removal will be limited to the minimum amount necessary to permit the activity to occur. Sufficient pickleweed habitat, as determined by a Service-approved biologist, will remain adjacent to the activity area to provide refugia for displaced harvest mice. Silt fences will be erected adjacent to construction areas to define and isolate potential harvest mouse habitat.

4. To minimize or avoid the loss of individual snowy plovers, no activities will be performed within at least 600 feet of an active snowy plover nest during the snowy plover breeding season, 1 March through 14 September (or as determined through surveys). Vehicles driving on levees and pedestrians walking on boardwalks or levees should remain at least 300 feet away from snowy plover nests and broods. In addition, personnel that must stop at a specific site for brief inspections, maintenance, or monitoring activities should remain 600 feet away from snowy plover nests and broods. *Exception*: Only inspection, maintenance, research, or monitoring activities may be performed during the snowy plover breeding season in areas within or adjacent to snowy plover breeding habitat with approval of the Service and CDFG under the supervision of a qualified biologist. If snowy plover chicks are present and are foraging along any levee that will be accessed by vehicles (e.g., for construction, inspection, or access), vehicle use will be under the supervision of a qualified biologist (to ensure that no chicks are present within the path of the vehicle).

5. Water-level manipulation (e.g., for management) within ponds that contain suitable snowy plover habitat will not be performed unless surveys are conducted to determine whether they are present during the breeding season (1 March through 14 September). If snowy plovers are present, any addition of water to the pond will be monitored closely to ensure that no nests are flooded.

6. No activities will be performed within 300 feet of an active least tern nest during the least tern breeding season, 15 April to 15 August (or as determined through surveys). *Exception*: Only inspection, maintenance, research, or monitoring activities may be performed during the least tern breeding season in areas within or adjacent to least tern breeding habitat with approval of the Service and CDFG under the supervision of a qualified biologist.

7. Water-level manipulation (e.g., for management) within ponds known to contain nesting least terns will be monitored closely to ensure that no nests are flooded during the least tern breeding season (15 April to 15 August) unless surveys demonstrate that nesting least terns are absent.

8. For each project-level activity, the supervising construction personnel will participate in a

Service-approved worker environmental awareness program. Under this program, construction personnel shall be informed about the presence of listed species and habitats associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to construction activities, a qualified biologist approved by the Service shall instruct all construction personnel about: (1) the description and status of the species; (2) the importance of their associated habitats; and (3) a list of measures being taken to reduce impacts to these species during project construction and implementation. The awareness program will apply to construction occurring within or adjacent to tidal marsh or slough habitat and within or adjacent to managed pond habitat. A fact sheet conveying this information shall be prepared for distribution to the construction crew and anyone else who enters the project site. A Service representative shall be appointed who will be the contact source for any employee or contractor who might encounter a listed species. The representative(s) shall be identified during the environmental awareness program. The representative's name and telephone number shall be provided to the Service and CDFG prior to the initiation of any activities.

9. To avoid or minimize potential adverse effects from public access and recreation features constructed near tidal marsh, trails adjacent to some nesting areas for sensitive bird species will be closed during the breeding season. Public trails within 300 feet of suitable snowy plover or least tern nesting habitat will be closed during the breeding season. In addition, if trails are to be open during the breeding season of these species, viewing platforms, kiosks, benches, boat ramps, interpretive displays, restrooms, and other focal areas for public use will be located a minimum of 600 feet from suitable nesting habitat. The locations of trail segments to be closed, and the periods of closure, will depend on whether sensitive bird species, such as snowy plovers or least terns, are nesting in certain areas in a given year, and whether nesting areas are located in close proximity to the trails. Decisions on whether to close a particular trail segment will be made early in the breeding season (and possibly later in the season as conditions change) following surveys for nesting birds within a given pond adjacent to a trail.

10. Interpretive signage prohibiting access to areas that are closed to the public, and indicating the importance of protection of sensitive biological resources, will be placed in key locations, such as along trails near sensitive habitats, at boat launches, and near the mouths of sloughs that are closed to boating access. Interpretive signage at boat launches will describe areas that are closed to boating access and describe measures to be implemented to avoid impacts to harbor seals, clapper rails, and other sensitive wildlife.

11. In order to minimize potential effects on salt marsh habitat and associated species (clapper rail and harvest mouse), hunters will not be allowed to construct new permanent blinds in marsh areas. Wildlife managers may close certain ponds to hunting if deemed necessary to protect important habitat for snowy plovers.

12. If brown pelican observations increase substantially on any ELER ponds during the hunting season, the potential for disturbance may be reevaluated and the hunting program may be modified to avoid any impacts.

13. Dogs are restricted to designated trails, and designated hunting areas during the waterfowl season. Dogs must be on a leash at all times other than dogs used for hunting in designated hunting areas. In designated hunting areas, dogs may be off leash only for hunting during waterfowl season and must be under voice control at all times.

14. To reduce potential impacts from infestation by non-native *Spartina*, pepperweed, and other invasive, non-native plant species, all equipment (including personal gear) will be cleaned of soil, seeds, and plant material prior to arriving on site to prevent introduction of undesirable plant species. Equipment and personal gear will be subject to inspection. All infestations occurring within the wetlands would be controlled and removed to the extent feasible without substantially hindering or harming the establishment of native vegetation in the restored wetlands.

15. A hazardous spill plan will be developed prior to construction of each action. The plan will describe what actions will be taken in the event of a spill. The plan will also incorporate preventative measures to be implemented, such as vehicle and equipment staging, cleaning, maintenance, and refueling; and contaminant (including fuel) management and storage. In the event of a contaminant spill, work at the site will immediately cease until the contractor has contained, and mitigated the spill. The contractor will immediately prevent further contamination and notify appropriate authorities, and mitigate damage as appropriate. Containers for storage, transportation, and disposal of contaminated absorbent materials will be provided on the project site.

16. Project sites will be maintained trash-free and food refuse will be contained in secure bins and removed daily.

17. Any large wood, native vegetation, and weed-free topsoil displaced by construction will be stockpiled for use during site restoration.

18. Vehicles driving on levees to access the South Bay, tidal sloughs, or channels for construction or monitoring activities will travel at speeds no greater than 10 mph to minimize noise and dust disturbance.

19. A stormwater management plan will be developed to ensure that during rain events, construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion control materials (i.e., baffles, fiber rolls, or hay bales; temporary containment berms) and erosion control measures such as straw application or hydroseeding with native grasses on disturbed slopes; and floating sediment booms and/or curtains to minimize any impacts that may occur due to increased mobilization of sediments.

20. All clean fill material proposed for upland and wetland placement will meet the qualifications set forth in the Regional Water Quality Control Board's (RWQCB) waste discharge requirements (Tentative Order), approved with respect to chemical and biological suitability for uplands and wetlands by the Dredged Material Management Office (DMMO). If the above-mentioned thresholds are not attained and the material is

approved for use by the RWQCB, consultation will be reinitiated to analyze the potential effects of the contaminated material to listed species.

21. The restored tidal marsh wetlands would be monitored for possible infestation by non-native cordgrass and other invasive, non-native plant species. If any invasive, non-native plant species are found, a qualified botanist would recommend specific measures to control the spread of non-native plant species. All infestations within the restored tidal marsh wetlands would be controlled and removed in coordination with the current eradication program for *Spartina* being implemented within San Francisco Bay without substantially hindering prepared or harming the establishment of native vegetation in the restored wetlands.

22. The Service (SFBNWR), in coordination with NMFS and CDFG, will continue to develop a Monitoring and Adaptive Management Plan to determine the rate of tidal wetland restoration and quantity and quality of the wetlands established. A draft plan in nearly complete and would be finalized by the end of Phase 1. The monitoring program would be designed to determine whether tidal marsh is developing at the estimated rate of development. Monitoring of the development of the restored areas is intended to enable the Service, NMFS, and CDFG, to assess the success of habitat development and make decisions regarding corrective measures if necessary.

23. The Service (SFBNWR) and CDFG will provide access to their facilities, cooperate with designated managers of the predator control program and each provide 1/3 of the cost of the predator control program to control predators on restoration areas, mitigation areas, and at key locations throughout the Project Area. In the event that predators are controlled to a point that only a maintenance program is indicated, the dollar contribution portion of this conservation measure would be eliminated

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." Restoration actions and on-going operations and maintenance activities include a number of actions that may occur throughout the South Bay. As a result, the action area for the SBSP Project encompasses:

- Three pond complexes (Eden Landing, Alviso, and Ravenswood) and the neighboring sloughs (Mt. Eden Creek, North Creek, Old Alameda Creek, Alameda Creek Flood Control Channel, Mud Slough, Coyote Creek, Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough, Charleston Slough, and Ravenswood Slough).
- Recreation areas within those complexes, portions of the Bay Trail, Alameda Creek Regional Trail, Don Edwards Environmental Education Center, and the Alviso Marina County Park, as well as the associated staging areas, parking lots and access points near the three pond complexes
- San Francisco Bay south of the Bay Bridge, where indirect effects of the proposed action on bathymetry and salinity may occur

- Portions of San Francisco Bay and associated wetlands and channels south of the Bay Bridge, up to the mean high tide line, where projects that may use the proposed action for mitigation can be located
- Portions of San Francisco Bay that may be traversed by water-based equipment that may be used for dredging or other actions that require water access
- Any other areas in the vicinity of on-going maintenance and operations that may be directly or indirectly affected by noise, dust, or other factors resulting from associated operations

Applied studies will be conducted in concert with the AMP. The applied studies implemented as part of the proposed action will either be performed within the Action Area defined above, or will be performed in such a way that there will be no effect to listed or candidate species, or critical habitat.

STATUS OF THE SPECIES AND ENVIRONMENTAL BASELINE

California Clapper Rail

The clapper rail was federally listed as endangered in 1970 (35 FR 16047). Critical Habitat has not been proposed or designated. This subspecies is one of three subspecies in California listed as endangered under the Endangered Species Act (Act). The other subspecies include the light-footed clapper rail (*R. l. levipes*), which is found in tidal marshes in southern California and northwestern Baja California, and the Yuma clapper rail (*R. l. yumanensis*), which is restricted to the Colorado River basin. A detailed account of the taxonomy, ecology, and biology of the clapper rail is presented in the *Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan* (Service 1984) (Recovery Plan) and the references cited therein. The clapper rail is a fully protected species under California law (See California Fish and Game Code Section 3511).

The clapper rail is endemic to tidally influenced salt and brackish marshes of California. Historically, the clapper rail occurred in tidal marshes along California's coast from Morro Bay, San Luis Obispo County, to Humboldt Bay, Humboldt County. Currently, clapper rails are known to occur in tidal marshes in the San Francisco Estuary (Estuary) (San Francisco, San Pablo, Grizzly, Suisun and Honker bays).

The clapper rail is distinguishable from other clapper rails by its large body size of 13 to 19 in. from bill to tail, and weighs approximately 8.8 to12.3 oz. It has an orange bill, a rufous breast, black and white barred flanks, and white under tail coverts (Albertson and Evens 2000). Clapper rails are sexually dimorphic; the males are slightly larger than females (Garcia 1995). Juveniles have a pale bill and dark plumage. Clapper rails are capable of producing several vocalizations, most common of which are a series of keks or claps (Massey and Zembal 1987).

Clapper rails are typically found in the intertidal zone and sloughs of salt and brackish marshes dominated by pickleweed (*Salicornia virginica*), Pacific cordgrass (*Spartina foliosa*), gumplant (*Grindelia stricta* var. *angustifolia*), saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), and adjacent upland refugia. They may also occupy habitats with other vegetative components, which include, but are not limited to, bulrush (*Scirpus americanus* and *S. maritimus*), cattails

(*Typha* spp.), and Baltic rush (*Juncus balticus*).

Evens and Page (1983) concluded from research in a northern San Francisco Bay marsh that the clapper rail breeding season, including pair bonding and nest construction, may begin as early as February. Field observations in South Bay marshes suggest that pair formation also occurs in February in some areas (J. Takekawa, pers. comm.). The end of the breeding season is typically defined as the end of August, which corresponds with the time when eggs laid during renesting attempts have hatched and young are mobile. Harvey (1988) and Foerster *et al.* (1990) reported mean clutch sizes of 7.27 and 7.47 eggs for clapper rails, respectively. The clapper rail builds a bowl shaped platform nest of marsh vegetation and detritus (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990). The clapper rail typically feeds on benthic invertebrates, but its diet is wide ranging, and includes seeds, and occasionally small mammals such as the harvest mouse.

An estimated 40,191 acres of tidal marshes remained in 1988 of the 189,931 acres of tidal marsh that historically occurred in the Estuary; this represents a 79 percent reduction from historical conditions (Goals Project 1999). The suitability of many remaining marshes for clapper rails is limited, and in some cases precluded, by their small size, fragmentation, and lack of tidal channel systems and other micro-habitat features. These limitations render much of the remaining tidal marsh acreage unsuitable or of low value for the species.

A number of factors influencing remaining tidal marshes limit their habitat values for clapper rails. Much of the east San Francisco Bay shoreline from San Leandro to Dumbarton Bridge is rapidly eroding, and many marshes along this shoreline could lose their clapper rail populations in the future, if they have not already. In addition, an estimated 600 acres of former salt marsh along Coyote Creek, Alviso Slough, and Guadalupe Slough, have been converted to fresh- and brackish-water vegetation due to large-volume freshwater discharge from wastewater facilities in the South Bay and are now of lower quality for clapper rails. This conversion has at least temporarily stabilized as a result of the drought since the early 1990s.

In addition, the introduction of non-native, invasive plant species such as *Spartina* and its hybrids into tidal wetlands within the Estuary is potentially impacting clapper rails by drastically changing the structure and function of tidal marshes in the estuary. Invasive *Spartina* chokes tidal creeks, changing the hydrology of the marsh and reducing the amount of foraging habitat within tidal channels, as well as replacing much of the native diverse tidal marsh vegetation. Other invasive plant species such as perennial pepperweed and glasswort (*Salsola soda*) also have the potential to alter the marsh landscape, making it less suitable as clapper rail habitat.

Throughout the Estuary, the remaining clapper rail population is impacted by a suite of mammalian and avian predators. At least 12 native and 3 non-native predator species are known to prey on various life stages of the clapper rail (Albertson 1995). Artificially high local populations of native predators, especially raccoons, skunks, and ravens occur due to the presence of landfills and other sources of human food waste adjacent to marshes. Feral cats also represent another predation threat on adult and young clapper rails near residential areas and landfills (Albertson 1995). Non-native Norway rats have long been known to be effective predators of clapper rail nests (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990). According to Harvey (1980) and Foerster *et al.* (1990), predators, especially rats, accounted for clapper rail nest losses of 24 to 29 percent in certain South Bay marshes. Placement of shoreline riprap, levees, buildings, and landfills favor rat populations, which results in greater predation pressure on clapper rails in certain marshes. Encroaching development displaces lower order predators from their natural habitat and adversely affects higher order predators, such as coyotes, which will normally limit population levels of lower order native and non-native predators, especially red foxes (Albertson 1995).

Hunting intensity and efficiency by many avian predators is increased by the presence of electric power transmission lines, which cross tidal marshes and provide otherwise-limited hunting perches (J. Takekawa, pers. comm.). In addition, both red-tailed hawks and common ravens nest on transmission towers. Common raven populations have recently increased dramatically within the Estuary and evidence of clapper rail egg predation by this species has been detected (J. Albertson, pers. comm.).

These predation impacts are exacerbated by a lack of high marsh and natural high tide cover in most remaining marshes. DeGroot (1927) noted that clapper rails were extremely vulnerable to predation by raptors during high tide events when they were forced to seek refuge in exposed locations. Similarly, Johnston (1956, 1957) and Fisler (1965) observed heightened predator activity in marshes coinciding with extreme high tides. Evens and Page (1986) also documented the susceptibility of black clapper rails (*Laterallus jamaicensis coturniculus*) to predation during extreme high tides. More recently, clapper rail predation was noted in west Marin during extreme high tides in 2005 (G. Downard, pers. comm.). There is an abundance of falcons, raptors, egrets, and herons during high tides that opportunistically take advantage of prey during this vulnerable period.

The proliferation of non-native red foxes into tidal marshes of South Bay since 1986 has had a profound effect on clapper rail populations. As a result of the rapid decline and almost complete elimination of clapper rail populations in certain marshes, the San Francisco Bay National Wildlife Refuge implemented a predator management plan in 1991 (Foerster and Takekawa 1991) with an ultimate goal of increasing clapper rail population levels and nesting success through management of red fox predation. This program was successful in increasing the South Bay clapper rail populations from an all-time low.

Mercury accumulation in eggs is perhaps the most significant contaminant problem affecting clapper rails in the Estuary, with the South Bay containing the highest mercury levels. Mercury is extremely toxic to embryos and has a long biological half-life. Schwarzbach et al. (2006) found high mercury levels and low hatching success (due both to predation and, presumably, mercury) in clapper rail eggs throughout the Estuary.

The clapper rail was listed as endangered primarily as a result of habitat loss. The factors described above have contributed to the more recent population reduction, which has occurred since the mid-1980s. Although many factors are at work, predation by native and non-native predators, in conjunction with historic habitat loss and fragmentation are the current known primary threats. With historic populations at Humboldt Bay, Elkhorn Slough, and Morro Bay now extirpated, the Estuary represents the last stronghold and breeding population of this subspecies.

Dispersal or movements by clapper rails in California occurs between and outside of marshes (Orr 1939; Zembal *et al.* 1985; San Francisco Bay Bird Observatory [SFBBO] 1986; Page and Evens 1987; Albertson 1995). Eddleman (1989) identified movements by Yuma clapper rails outside of their territories as juvenile dispersal; dispersal by an unmated individual bird; and shifts in home ranges after the breeding, in the winter, and during high water periods; and attributed these movements to a search for more suitable habitat where territories, mates, food, or safe refuge were better available. Juvenile dispersal apparently constitutes the main type of long-distance movements by light-footed clapper rails, while adult birds tend to stay within territories once they are established (Zembal and Massey 1988, Zembal *et al.* 1989, Ledig 1990; Zembal 1990, Zembal 1994, Zembal *et al.* 1996, Zembal *et al.* 1997, Zembal *et al.* 1998). Similarly, clapper rails tend to stay within established territories or home ranges year-round (SFBBO 1986; Albertson 1995). Zembal and Massey (1988) noted that 3 of 6 radio-tagged light-footed clapper rails that moved extensively were preyed upon within a relatively short period of time. By comparison, seven other birds that remained sedentary within established territories were not preyed upon during the telemetry period.

Clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. Certain types of disturbances have occurred within or adjacent to some marsh areas for a long time and certain clapper rails appear to have habituated or become tolerant of these disturbances, while others appear to habituate over time or are unable to habituate to these disturbances at all. For example, certain clapper rails in the Palo Alto Baylands Nature Preserve appear to be somewhat tolerant of the relatively common pedestrian traffic on the public boardwalk that dissects the marsh. Clapper rail nests have been documented within 10 ft of trails in Elsie Romer and Cogswell marshes in Alameda County, and within 65 ft of a busy street near White Slough (Solano County).

In contrast, Albertson (1995) documented a clapper rail abandoning its territory in Laumeister Marsh in the South Bay, shortly after a repair crew worked on a nearby transmission tower. The bird did not establish a stable territory within the duration of the breeding season, but eventually moved closer to its original home range several months after the disturbance. As a result of this territorial abandonment, the opportunity for successful reproduction during the breeding season was eliminated (J. Takekawa, pers. comm.). Clapper rails in Laumeister Marsh have little contact with people, and are apparently quite sensitive to human-related disturbance.

Evens and Page (1983) documented 4 clapper rail breeding territories along the Greenbrae boardwalk in the Corte Madera Ecological Preserve. In 1993, no clapper rail breeding territories were discovered along the boardwalk even though clapper rail habitat conditions remained unchanged (J. Garcia, pers. comm.). This territorial abandonment is attributed to an increase in domestic and feral dogs and cats along the boardwalk resulting from new residents moving into nearby residential areas since 1983 (J. Garcia, pers. comm.).

Clapper rail reactions to disturbance may vary with season, however both breeding and non-breeding seasons are critical times. Clapper rail mortality is greatest during the winter, primarily due to predation during extreme winter high tides (Eddleman 1989, Albertson 1995). Human-related disturbance may increase the clapper rails' vulnerability to predators. During high tides, clapper rails and other wildlife hide within any available cover in the transition zone and high marsh. As people approach, the birds may flush and attract predators. The presence of people and their pets in or near the high marsh plain or upland areas during marsh inundation may even prevent clapper rails from leaving the lower marsh plain to seek cover, which also leaves them vulnerable to predation (Evens and Page 1983, Evens and Page 1986). Public trails that run along a narrow marsh transition zone may be particularly hazardous to marsh species that depend on this habitat for refuge during high tides.

On numerous occasions at the Corte Madera Ecological Preserve, clapper rails have been observed seeking refuge from unrestrained dogs entering tidal marshes from adjacent levees with public access (J. Garcia, pers. comm.). These disturbances have occurred despite the presence of signs notifying users that they are entering sensitive wildlife species areas and that pets must be under restraint while in the preserve area. Similarly, along the Redwood Shores Peninsula in San Mateo County, fences and signs installed to prevent access into areas with listed species habitat have been repeatedly vandalized and people continue to enter the prohibited areas beyond the fences and signs (Popper and Bennett 2005).

A population viability analysis under development for clapper rails identified changes in adult survivorship as the factor with the largest influence on population growth rates (M. Johnson, pers. comm.). Another model also indicates that adult survivorship of clapper rails is the primary demographic variable for maintaining a stable population or causing the population to either increase or decline (Foin *et al.* 1997). These models indicate that survival of adult birds has the strongest effect on the perpetuation or extinction of the overall population.

Although Gill (1978) may have overestimated the total clapper rail population in the mid-1970s at 4,200 to 5,900 birds, surveys conducted by CDFG and the Service estimated that the clapper rail population was approximately 1,500 birds in the mid-1980s (Harvey 1988). A conservative estimate of the population in North San Francisco, San Pablo, and Suisun Bays, was 195 to 282 pairs based on a synoptic survey conducted in 1992-93 (Collins *et al.* 1994). In 2004, Avocet Research Associates conducted surveys within San Pablo Bay and estimated about 200 pairs of clapper rails in that area. These surveys did not include some marshes in north Central San Francisco Bay and Suisun Bay that were surveyed in 1992-93. Between the surveys conducted in 1992-93 and 2004, several population centers in San Pablo Bay have declined precipitously. The population in the White Slough tidal marshes on the west side of the Napa River declined from an estimated 16 to 23 pairs as recent as 2000, to an estimated 2 to 5 pairs in 2002, and 3 to 5 pairs in 2004, while the population in the Sonoma Creek marshes declined from 13 pairs in 1992 to no pairs in 2001 and 2004 (Avocet Research Associates 2004).

In 1988, the total clapper rail population was estimated to be 700 individuals, with 400 to 500 clapper rails in South Bay (Foerster 1989). The total clapper rail population reached an estimated all-time historical low of about 500 birds in 1991, with about 300 clapper rails in the South Bay (Service unpubl. data). In response to predator management, the South Bay clapper rail population rebounded from this lowest population estimate to an estimated 650 to 700 individuals in 1997-98 (Service unpubl. data). Subsequently, the South Bay population declined again the following year to about 500 individuals and remained at that level through early 2002 (Service unpubl. data). However, the South Bay population declined further in 2002-2003 and was estimated to be 400 to 500 individuals (Service unpubl. data), which represented the lowest estimated population level in this area since the late 1980's and early 1990's. The South Bay population apparently increased slightly in 2004 with the population estimated at 500 individuals (Service unpubl. data).

Both winter and breeding season surveys suggest that there is substantial annual variability in local distribution and abundance of clapper rails in the South Bay. For example, at one of the sites where clapper rails were found in brackish marshes in Guadalupe Slough (discussed above), no clapper rails were found during protocol-level surveys the year before (H. T. Harvey & Associates 1990a; H. T. Harvey & Associates 1990b; H. T. Harvey & Associates 1991).

Breeding-season surveys of South Bay marshes for clapper rails through the early 1990's, summarized by Foin et al. (1997), indicated that the most substantial populations of clapper rails in the South Bay were, predictably, in the largest sections of tidal salt marsh: at Mowry Marsh and Dumbarton Marsh (in the East Bay between the Dumbarton Bridge and Mowry Slough), at the Faber/Laumeister Tracts and other marshes in the Palo Alto/East Palo Alto area, and at Greco Island in Redwood City. Mean counts from these areas include 68 birds at Mowry Marsh, 57 at Faber-Laumeister, and 44 at Dumbarton (Foin et al. 1997). Nest searches by Refuge personnel detected 40 nests in the Faber/Laumeister Tracts, 33 on Greco Island, and 13 in North Mowry Marsh in 1992 (Keldsen 1997). Clapper rails occurred in many other marshes as well, including Ideal Marsh (adjacent to Cargill pond N5), Calaveras Marsh (adjacent to Cargill Ponds M2 and M3), and Triangle Marsh in Alviso. Other surveys have also documented clapper rails in southern Whale's Tail Marsh, adjacent to the Eden Landing salt ponds (J. Krause, pers. comm.). Clapper rails have been found to occasionally use salt pond dredge locks as high-tide refugia (Wetlands Research Associates 1994b). Although site-specific surveys have not been conducted in all suitable habitat for clapper rails in the South Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as well.

Although clapper rails are typically found in tidal salt marshes, they have also been documented in brackish marshes in the South Bay. Breeding-season surveys conducted in marshes bordering Coyote Creek in 1989 documented breeding clapper rails in a wide variety of plant associations. Surveys conducted during the 1990 breeding season (H. T. Harvey & Associates 1990b) and winter season (H. T. Harvey & Associates (1990a) found a number of clapper rails occupying salt/brackish transitional marshes and several brackish, alkali bulrush-dominated (*Scirpus robustus*) marshes, including Warm Springs Marsh (immediately east of Pond A19) and the marshes along upper Coyote Slough even farther east. In addition, clapper rails were found in nearly pure stands of alkali bulrush along Guadalupe Slough in 1990 and 1991 (H. T. Harvey & Associates 1990a; H. T. Harvey & Associates 1990b; H. T. Harvey & Associates 1991). Although it has been suggested that habitat quality may be lower in brackish marshes than in salt marshes (Shuford 1993), further studies comparing reproductive success in different marsh types are necessary to determine the value of brackish marshes to clapper rails.

On rare occasions, clapper rails have been recorded even further upstream, in brackish/freshwater transition marshes, particularly during the non-breeding season. In the Alviso/Sunnyvale area, such individuals have been recorded along upper Alviso Slough near the Gold Street bridge (on 14 February 1997; S. Terrill, pers. obs.), in nontidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of Highway 237 in Sunnyvale (on 16 August 1998; S. Rottenborn, pers. obs.), and along Artesian Slough near the Environmental Education Center in January 1999 and January to February 2001 (Santa Clara County Bird Data unpubl.).

Salt Marsh Harvest Mouse

The harvest mouse was federally listed as endangered in 1970 (35 FR 16047). Critical Habitat has not been proposed or designated. A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the Recovery Plan (Service 1984) and the references cited therein. The harvest mouse is a fully protected species under California law (See California Fish and Game Code Section 4700).

The harvest mouse is a rodent endemic to the salt and brackish marshes of the Estuary and adjacent tidally influenced areas. The harvest mouse closely resembles the western harvest mouse (*R. megalotis*). The harvest mouse typically weighs about 0.35 oz, has a head and body length ranging from 2.7 to 2.9 in, a tail length ranging from 2.6 to 3.2 in, and a hind foot length of about 0.7 in (Fisler 1965). As stated in the recovery plan, the harvest mouse, when compared to the western harvest mouse, has darker ears, belly and back, and a slightly thicker, less pointed and unicolored tail. The harvest mouse is further distinguished taxonomically into the northern and southern subspecies, *R. raviventris halicoetes* and *R. raviventris raviventris*, respectively. Of the two subspecies, *R. r. halicoetes* more closely resembles *R. megalotis*, and can be difficult to differentiate in the field; body color and color of ventral hairs as well as the thickness and shape of the tail have been used to distinguish the two.

As described by Fisler (1965), male harvest mice are reproductively active from April through September, but may appear active throughout the year. Females are reproductively active from March to November, and have a mean litter size of approximately four offspring.

The harvest mouse has evolved to a life in tidal marshes. Specifically, they have evolved to depend mainly on dense pickleweed as their primary cover and food source and may utilize a broader source of food and cover that includes saltgrass and other vegetation typically found in the salt and brackish marshes of this region. In natural systems, harvest mice can be found in the middle tidal marsh and upland transition zones. Upland refugia is an essential habitat component during high tide events. Harvest mice are highly dependent on cover, and open areas as small as 33 ft wide may act as barriers to movement (Shellhammer 1978, as cited in Service 1984). The harvest mouse does not burrow. It has been noted that the northern subspecies may build nests of loose grasses.

The historic range of the species included tidal marshes within the San Francisco and San Pablo Bays, east to the Collinsville-Antioch areas. Agriculture and urbanization has claimed much of the former historic tidal marshes, resulting in a 79 percent reduction in the amount of tidal marshes in these areas (Goals Project 1999). At present, the distribution of the northern subspecies occurs along Suisun and San Pablo Bays north of Point Pinole in Contra Costa County, and Point Pedro in Marin County. The southern subspecies is found in marshes in Corte Madera, Richmond, and South Bay mostly south of the San Mateo Bridge (Highway 92).

Historically, the marshes in San Francisco Bay were a complex mosaic of vegetation zones, generally consisting of low marsh adjacent to mudflats dominated by cordgrass, high marsh plains dominated by pickleweed, and broad transitions of peripheral halophytes (salt-tolerant plants that cannot tolerate as much inundation by the tides) into upland habitats, with narrower transitional zones on natural levees along larger channels within the marshes. Most of the tidal marshes around the Bay and especially in the South Bay were eliminated, and those remaining have lost the upper portion of their pickleweed zones as well as the higher zone of peripheral halophytes (Shellhammer 1982; Shellhammer and Duke 2004). For example, detailed mapping by H.T. Harvey & Associates for the proposed action reveals that pickleweed dominated habitat and peripheral halophyte habitat comprise only 92 and 13 acres respectively, within the 1,600-acre Ravenswood Complex, 638 and 58 acres, respectively, within the 5,500-acre Eden Landing Complex, and 275 and 113 acres, respectively, within the 8,000-acre Alviso Complex; much of the peripheral halophyte acreage in the Alviso Complex, however, is adjacent to little used brackish vegetation. Most of the tidal salt marshes in the South Bay are small, isolated strip-like marshes along backshores against levees or other hardened structures that promote predation, inhibit further high marsh development, and are threatened by sea level rise (Shellhammer 1989). Similarly, most of the marshes do not have higher order tidal channels within them and hence lack a pattern of natural levees supporting shrubs such as gum plant, and other peripheral halophytes, within them that might act as escape cover for mice within the marshes. Shellhammer and Duke (2004) note that most of the marshes of the South Bay are de facto corridors, likely not wide enough to support viable populations but wide enough to function as dispersal corridors.

Recent mapping is also documenting the fragmentation of the habitat. For example, sections of bare, rip-rapped bayfront levees more than 3,500 feet long separate appropriate pickleweed dominated habitat in the Ravenswood Complex. A similar gap of approximately 3,600 feet occurs in the Eden Landing area, between the Alameda Creek Flood Control Channel and the pickleweed-dominated habitat at the "Whale's Tail" marsh near Old Alameda Creek. Cover-dependent harvest mice are unlikely to move long distances over bare areas, and thus, isolation of suitable habitat may lead to genetic isolation of populations. While they are known to swim well, especially in comparison with western harvest mice, they have not been documented to move more than 13.1 to 16.4 feet across water or more than 16.4 feet over bare ground (Bias 1994; Geissel et al. 1988). The maximum movement through brackish or fresh water vegetation is reported in H.T. Harvey & Associates (Shellhammer 1982), in which two harvest mice moved several hundred feet along a levee side-slope at the upper edge of a brackish marsh. Based on this information, Shellhammer and Duke (2004) have hypothesized that barren areas of land more than 16.4 feet wide, reaches of water more than 42 feet wide, and brackish or freshwater marsh more than 820 feet wide act as barriers to movement of the southern subspecies of the harvest mouse, and hence barriers to gene flow. Areas of bare ground, water, or fresh/brackish marsh less than or equal to these distances may act as filters, reducing the movement of this species (and hence the rate of gene flow) between populations or between portions of a semi-fragmented population. The isolation of populations has contributed to the decline of the species (Shellhammer and Duke 2004) and could lead to local extinctions due to demographic processes or genetic "death." Based on their assessment of potential barriers in the South Bay, Shellhammer and Duke (2004) estimated that there were potentially 25 separate populations of harvest mice in the South Bay as of 2002 (not including mice that might be present in very small patches of pickleweed).

Habitat degradation has also occurred as a result of the conversion of existing tidal salt marsh to brackish or even freshwater marsh over the past four decades. Within the Alviso Complex, the combination of treated effluent discharge, sedimentation that has reduced the tidal prism, and freshwater flows from rivers and streams (especially in high-rainfall years) has created conditions too fresh for pickleweed to compete and survive (H. T. Harvey & Associates 1994; 1997b; 1998; 1999; 2000; 2001; 2002; 2003; Shellhammer 1982; Shellhammer et al. 1988; Shellhammer et al. 1982). Traditionally the brackish species alkali bulrush was considered to have little habitat value in either tidal or diked situations in the South Bay because surveys in the 1960s and 1970s found no harvest mice. However, the habitat value of brackish marsh needs reexamination after recent results in the South Bay and Suisun Marsh. Trapping in harvest mouse preserves in the range of the northern subspecies in the Suisun Bay by Barthman-Thompson of CDFG in 2005 showed that harvest mice do use other species of bulrush and cattail in the area. In the summer of 2006, several harvest mice were captured in stands of pure alkali bulrush in the brackish Warm Springs Marsh of the South Bay. Preliminary results from a number of harvest mouse trapping projects (most of which were done in the Suisun Bay) suggest that monocultures of peppergrass (*Lepidium virginicum*), which dominate large areas of brackish marsh in the South Bay, are not used by harvest mice.

As a result of habitat loss, degradation, and fragmentation, harvest mouse populations are low. A database for all salt marsh studies carried out in the South Bay, including the entire project area, was compiled by H. Shellhammer at H.T. Harvey and Associates (Shellhammer and Duke 2004). Trapping records from permits issued by the Service and CDFG were reviewed and compiled. The database, which includes 198 trapping projects (estimated 95 percent of all such projects and studies) representing 134,204 trap nights (TN) completed through 2003, shows that 37 percent of all trapping projects (73 of 198, or 49,481 TN of a total of 134,204 TN) captured no harvest mice. The average capture efficiency (C.E., or total effort in TN divided by the number of mice captured) of all trapping projects was 0.013. In terms of unit effort, it took an average of 79 TN to capture one harvest mouse. Approximately 64 percent of the projects in which at least one harvest mouse was captured (153 of 198) had a capture efficiency equal to or less than 0.019, or it took 77 TN to capture a single harvest mouse. There were few projects in which numerous harvest mice were captured (*i.e.*, in 8 projects was there a C.E. of 0.06 or more).

Despite the species' low populations, the harvest mouse is known to rapidly colonize restored areas. This species quickly moves into areas of appropriate habitat from nearby inhabited areas as has been shown in numerous trapping projects' reports. A representative sample of those studies in the South Bay area include H. T. Harvey and Associates (1984a; 1985a; 1985b; 1985c; 1987; 1996; 1997a).

Harvest mice may be affected by mercury and polychlorinated biphenyls (PCBs) in the intertidal zone. Clark *et al.* (1992) found that harvest mice were captured only at sites where concentrations of mercury or PCBs were below specific levels in house mice (*Mus musculus*). Their results seem to suggest a southern source of mercury contamination, with mercury an order of magnitude higher in livers of house mice at Calaveras Point than at any other point measured in the San Francisco Bay.

Western Snowy Plover

The snowy plover is a small pale shorebird that nests on beaches and salt pans in western North America. The Service listed the coastal population of the snowy plover as a threatened species in 1993 (58 FR 12864) because of a decline in the breeding population, loss of breeding habitat, and increased depredation by non-native predators. The Service designated Critical Habitat for the snowy plover in 2005 (70 FR 56969). A final recovery plan was released in 2007 (Service 2007). This recovery plan contains additional information on the biology and ecology of this species.

Snowy plovers nest on barren to sparsely vegetated beaches, salt flats, dredge spoils, levees, river bars, and salt evaporation ponds (Page *et al.* 1995). Many snowy plovers overwinter in these same areas. In the South Bay, snowy plovers nest on low, barren to sparsely vegetated dry salt ponds as well as on levees and islands, and at pond edges (Page *et al.* 2000); they preferentially use light-colored substrates such as salt flats (Feeney and Maffei 1991; Marriott 2003). Nesting areas are located near water, where prey (usually brine flies and other insects) are abundant. In some areas, snowy plovers nest within dry salt ponds; in other areas where ponds typically hold water through the summer (*e.g.*, the Newark salt ponds), nests are located primarily on levees and pond edges. Often, nests are located near disruptive objects such as rocks or surface irregularities, and may be constructed in depressions created by footprints and vehicles (Marriott 2003; Page *et al.* 1995). Nests consist of a depression scratched into the substrate sometimes lined with shell fragments, salt crystals, plant debris, fish bones, exoskeletons, and pebbles or similar local materials (Page *et al.* 2000; Page *et al.* 1995).

The breeding season of the snowy plover in California, from nest initiation to fledging of chicks, is considered to be 1 March to 31 September. Unlike sandy beach habitat, salt pan habitat used for nesting in the San Francisco Bay takes some time to dry after rains. For this reason, nesting habitat within salt ponds may not be available in March or early April, typically the beginning of the breeding season. During years of late rains, nesting habitat may not become available until well into the breeding season (e.g. late April or May; Hannon and Clayton 1995). The snowy plover is opportunistic, capable of moving around among potential breeding areas and breeding where conditions are suitable. The abundance and distribution of snowy plovers in the South Bay shifts annually, and is also dynamic within a given nesting season. Early in each breeding season, many ponds may not be suitable for nesting due to late rains creating muddy substrates, and nesting may be concentrated at a few ponds with suitable conditions. Later in the season, as more ponds dry out and become available for nesting, snowy plovers may be more dispersed among many nesting locations, and nest in lower densities. In 1990 nest density at four Oliver/Eden Landing ponds averaged 1 nest/6.3 acres, with a range of 1 nest per 3.1 to 14.2 acres (Feeney and Maffei 1991). In 2006, nest density on four ponds in the South Bay averaged 1 nest/74 acres with a range of 1 nest per 13 to 417 acres (San Francisco Bay Bird Observatory (SFBBO), unpub. data). In 2006, these numbers reflect large areas of ponds not used by snowy plovers probably due to water on the surface of the pond, and to a low number of plovers scattered over a large area.

Snowy plovers consume flies, beetles, crabs, polychaete worms, amphipods, sand hoppers, moths, grasshoppers, small crustaceans, mollusks, and plant seeds (Page *et al.* 1995). They forage by pursuing their prey on foot, picking from the surface or probing in sand and loose soils, and will charge dense aggregations of flies, snapping their bill at those flushed (Purdue 1976, Page *et al.* 1995). Within the San Francisco Bay Area, snowy plovers forage on brine flies and brine shrimp (Feeney and Maffei 1991, Page *et al. 2000*). Exposed mudflats, the open water on salt ponds, historic channels, and excavated "borrow ditches" provide foraging areas in the South Bay. Brine flies are usually found in greatest densities at the shallow margins of salt ponds or puddles.

Degradation and use of habitat for human activities has been largely responsible for the decline in the snowy plover breeding population (Page *et al.* 1995). Other important threats to the snowy plover are mammalian and avian predators, and human disturbance (Page *et al.* 1995). Human disturbance (including disturbance from domestic dogs) can lead to nest abandonment or direct trampling of eggs or chicks. In addition, because young chicks are dependent on adults for protection, human disturbance resulting in the separation of chicks from adults can lead to the death of the chicks. Precocial chicks feed themselves but require the protection of an adult for brooding and evasion of predators (Page *et al.* 1995). Additional pressures include oiling, entanglement in fishing line, striking objects, and shooting; in the South Bay, the use and maintenance of levee roads for access to salt ponds, tidal flats and marsh also causes disturbances to nesting snowy plovers.

Non-native predators, such as red fox, have had major negative effects on snowy plover populations in California; for example, in the South Bay, two snowy plover nests were known to have been depredated by red foxes in 1993 and 1994 in the Coyote Hills and Dumbarton areas (Harding *et al.* 1998), and such events have probably occurred much more frequently than is known. Efforts to curtail nest depredation by mammalian predators through a predator management program have greatly enhanced nesting success by snowy plovers on the Central Coast of California (Neuman *et al.* 2004). In the South Bay, no strong increase in nest success was noted between 1991 and 1996, after a predator management plan was implemented, except at a few nests where exclosures were used (Harding *et al.* 1998). Overall nest success in the South Bay has been fairly high in some recent years, with 80 percent nest success in 2001 (n = 78 nests) and 58 percent in 2006 (n = 81 nests, Robinson *et al.* 2006). However, predation levels have dramatically increased over the past four years, from 5 percent in 2004 (n = 59 nests) to 41 percent in 2007 (n = 84 nests) largely due to avian predation (Strong *et al.* 2004, SFBBO, unpub. data). Fledging success is unknown, and may be far less due to avian predators.

Avian predators, particularly corvids (crows and ravens), are increasingly becoming an issue for snowy plover reproductive success (Wilson 2004). American crows (*Corvus brachyrhynchos*) and common ravens are adept at finding snowy plover nests and preying on eggs. Corvid numbers are increasing throughout California, at least partially in response to increased availability of food from anthropogenic sources, such as garbage dumps (Boarman and Heinrich 1999, Verbeek and Caffrey 2002). Other avian predators, including loggerhead shrikes (*Lanius ludovicianus*), American kestrels (*Falco sparverius*), and northern harriers (*Circus cyaneus*) have been documented taking snowy plover chicks, and in some areas, have dramatically reduced fledging success (K. Neuman, pers. comm.).

Some snowy plovers remain in their coastal breeding areas year-round while other individuals are migratory. In San Francisco Bay, higher numbers in winter indicate that snowy plovers from the Great Basin population probably move into the area for the winter. At the same time, some individuals that nest in the San Francisco Bay Area probably migrate south as far as Mexico (Service 2007). There is overlap between the San Francisco Bay population and the adjacent coastal nesting population. Birds banded at Monterey Bay and Oregon have been seen in the San Francisco Bay (Feeney and Maffei 1991). It is not known whether this species nested inside San Francisco Bay before conversion of salt marsh to salt evaporation ponds. However, these ponds have provided suitable nesting and foraging habitat since the beginning of the 20th century (Grinnell *et al.* 1918). Within San Francisco Bay, snowy plovers were noted to be a common nester in this area by 1918 (Page and Stenzel 1981).

Window surveys along the Pacific Coast indicate that the numbers of breeding snowy plovers have ranged from a low of 976 in 2000 to a high of 1,904 in 2004; in 2006 1,723 plovers were counted along the Pacific Coast (Service 2007). In 1977, nesting snowy plovers in the San Francisco Bay accounted for 22 percent of all snowy plovers counted along the coast; in 2006 only 6 percent of the snowy plovers along the entire Pacific Coast were counted in the San Francisco Bay. Nearly all of the San Francisco Bay nesting occurs south of State Route 92 (San Mateo Bridge) in the South Bay (Page and Stenzel 1981, Page *et al.* 1991, Service 2007).

Within the proposed action area, the highest numbers of nesting snowy plovers occur at Eden Landing where snowy plovers have recently been focused in Ponds E6A and E6B in 2003 and 2004 (Strong and Dakin 2004; Strong *et al.* 2004) and in B8A, B12 and B14 in 2007 (SFBBO unpub. data). Numbers of nests in the Eden Landing ponds have ranged from 10 nests in 1999 (Casady 1999) to 84 nests in 2007 (SFBBO unpub. data), although nest finding effort has not been consistent throughout this time period.

Low numbers of breeding snowy plovers also occur in the Ravenswood Complex, in the Warm Springs Complex, and in the Alviso Complex. The Ravenswood ponds were used irregularly for nesting (e.g., 13 nests found during the 2003 breeding season, most of them in RSF2; (Strong and Dakin 2004); 7 nests in 2007, most in R1 (SFBBO unpub. data)). High counts here during the 2004 nesting season included 53 birds at R2, 23 at SF2, and 18 at R1 (Strong *et al.* 2004). At Warm Springs, Pond A22 was used, with more than 10 adults found during the 2003 nesting season, and a high count of 32 snowy plovers at A22 in 2004 (Strong *et al.* 2004). Low densities of snowy plovers have been recorded during the breeding season, sometimes with nests or chicks, at some other Alviso salt ponds, primarily at A6 and A8 (Ryan and Parkin 1998; Strong 2004). Pond A6 has since been occupied by a colony of approximately 20,000 California Gulls. Snowy plovers also nested in the late 1990s in Alviso Pond A3N and in a small impoundment immediately east of Pond A12 in 2006 (B. Bousman, pers. comm.).

Outside the proposed action area, snowy plovers also breed in Cargill ponds near the east end of the Dumbarton Bridge (*e.g.*, N2, N3), and north of the San Mateo Bridge in managed ponds in Hayward. The Oliver Salt Ponds, relatively small ponds adjacent to Eden Landing on either side of the east end of the San Mateo Bridge, have been used regularly for nesting, although not in recent years. In 1989, Feeney and Maffei (1991) found 29 nests here, and 152 individual snowy plovers during the nesting season. To the south, in 1995, Hannon and Clayton (1995) found 90 nests in the Newark Ponds near the Dumbarton Bridge. The Patterson ponds, between Ponds N4A and N1A, have also been used regularly by nesting snowy plovers, at least up until 2001, when eight nests were found here (Marriott and Schelin 2001); no nests have been found here since then probably due to vegetation encroachment on the ponds. Page *et al.* (1979) and Rigney and Rigney (1981) also provide census information for Cargill ponds between Eden Landing and Warm Springs, but current data on the number of snowy plovers breeding in these ponds are not available. Due to limited habitat in these areas it is doubtful that large numbers of plovers use these areas. Marriott and Schelin (2001) surveyed the Newark ponds and found no nests, and they noted that levee over-topping by Cargill in 2000 had diminished the suitability of levees in these ponds for snowy plover nesting.

Western Snowy Plover Critical Habitat

Critical habitat for the Pacific coast population of the western snowy plover was designated on September 29, 2005, (70 FR 56969). In determining which areas to designate as critical habitat, the Service considers those physical and biological features (primary constituent elements) that are essential to the conservation of the species, and that may require special management considerations and protection (50 CFR §424.12). Such physical and biological features include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing (or development) of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

This final rule establishes approximately 12,145 acres within 32 Critical Habitat units in Washington, Oregon, and California based on three primary constituent elements: (1) Sparsely vegetated areas above daily high tides (such as sandy beaches, dune systems immediately inland of an active beach face, salt flats, seasonally exposed gravel bars, dredge spoil sites, artificial salt ponds and adjoining levees) that are relatively undisturbed by the presence of humans, pets, vehicles or human-attracted predators (essential for reproduction, food, shelter from predators, protection from disturbance, and space for growth and normal behavior); (2) Sparsely vegetated sandy beach, mud flats, gravel bars or artificial salt ponds subject to daily tidal inundation but not currently under water, that support small invertebrates such as crabs, worms, flies, beetles, sand hoppers, clams, and ostracods (essential for food); and (3) Surf or tide-cast organic debris such as seaweed or driftwood located on open substrates such as those mentioned above (essential to support small invertebrates for food, and to provide shelter from predators and weather for reproduction).

The Service has excluded six units bordering the South Bay totaling 1,847 acres. Snowy plover habitat in this region consists primarily of artificial salt ponds and associated levees, much of which is under the management of the Service and CDFG as part of the proposed action. The protections provided under section 7 of the Act largely overlap with protections resulting from critical habitat designation. By excluding the six units from critical habitat designation, the Service avoids restricting the flexibility for the development of the salt pond management plan which might otherwise establish habitat managed for plovers in other locations. The six excluded San Francisco Bay units were chosen based on recent high usage of those areas by plovers, although the plovers have demonstrated a willingness to travel relatively large distances within the Bay area to nest wherever habitat is most appropriate. Because plover habitat in the area can easily be created or removed in different areas by drying or flooding particular ponds, the management planners currently have the flexibility to move plover habitat to wherever it would be most advantageous in light of the conservation needs of the population and of other threatened and endangered species present in the Bay area. By designating critical habitat according to the current locations of essential habitat features, the Service would tend to lock the current management scheme into place for the designated units, thereby reducing management flexibility for other listed species and targeted ecosystems that are included as part of the proposed action. Because the proposed action planning process is a collaborative effort involving cooperation and input from numerous stakeholders such as landowners, public land managers, and the general public, it allows the best information and local knowledge to be brought to the table, and may encourage a sense of commitment to the snowy plover's continuing well-being. Therefore, critical habitat is not designated in the proposed action area, and would not provide as great a benefit to the species as the positive management measures in this plan.

California Least Tern

The least tern was federally protected as endangered on 13 October 1970 (35 FR 16047). A detailed account of the taxonomy, ecology, and biology of the least tern is presented in the approved Recovery Plan for this species (Service 1980). Supplemental or updated information is provided in the Service's 16 July 1993, Biological Opinion on the Federal Aviation Administration's authorization for proposed facilities improvements at San Diego International Airport, California, which is hereby incorporated by reference.

Least terns search for prey by hovering over shallow to deep waters in bays, lagoons, estuaries, river and creek mouths, marshes, lakes and offshore and diving to the surface. Least terns feed primarily on small surface-swimming, nonspiny fish (2.0–9.0 cm long with body <1.5 cm deep), but also shrimp and other invertebrates; more than 50 fish species documented as prey throughout their range (Thompson *et.al.* 1997).

Population declines of the least tern are possibly due to the use of organochlorine pesticides, loss of nesting habitat, and disturbance on the nesting grounds by humans. Least terns require large open areas of sand or gravel with little vegetation for nesting and will use filled or graded lands as well as airports if no other habitat is available. Nesting areas must be located near open water to maintain adults and young throughout the nesting season. Conservation efforts for the least tern include protection of nesting sites, predator management, and vegetation control (Feeney 2000).

Currently, the breeding colony at Alameda Point is one of the most important breeding colonies in the state. In 2005, this colony had 424 breeding pairs (Marschalek 2006). This total is up considerably from prior decades: 128 pairs were found in 1993, and only 70 pairs nested in 1982 (Collins 1994). Least terns typically arrive at Alameda Point in mid to late April, but have arrived as early as 6 April, and depart in mid to late August each year. Hatchlings are typically fed from June through mid-August. Since 1977, the majority of nesting activities have occurred in the 4-acre, fenced "traditional" colony site on the western end of Alameda Point, but prior to 1987, least tern nesting also occurred in other areas at Alameda Point outside the traditional site area. Furthermore, least terns have moved their young to various locations within the buffer zone surrounding the main colony site during several breeding seasons (and on one occasion as far as about 4,000 feet northwest of the main colony site), apparently to avoid predator pressure at the main colony site. While at the Alameda Point during the breeding season, least terns forage for fish in the open water offshore of the western end of Alameda Point, which contains extensive, generally productive foraging habitat areas. Foraging intensity has varied between different offshore areas, but has occurred in the Oakland Harbor, Seaplane Lagoon at Alameda Point, and areas southeast, south, and west of the traditional least tern colony site. During the breeding season, least terns are central-place foragers, that is, they return regularly to the nest from their foraging trips. Most foraging activity occurs within 2 miles of the nesting site (Atwood and Minsky 1983). Having foraging places near their nests is beneficial to least terns because it reduces the energy cost of flying to the feeding site and reduces the time needed to bring a load of fish back to the nest.

According to Caffrey (1995), the least tern breeding site at the Alameda Point has played a significant role in recent increases in the number of least terns throughout California. The Alameda Point site is consistently one of the most successful sites in California. Between 1987 and 1994, the Alameda Point site supported 5 to 6 percent of the statewide breeding population out of 35 to 40 sites each year, but produced an average of 10.6 percent of the total number of fledglings produced statewide in each of those years. By consistently producing large numbers of fledglings each year, the colony has added large numbers of potential new breeding birds to the statewide population. Therefore, this site is considered to be one of the most important "source" populations in California serving to balance out losses at many "sink" locations throughout the State.

Least terns also nested in 2000 and 2001 at Albany (near Alameda), with up to 12 pairs in 2000. At Pittsburg, on Suisun Bay, 13 pairs nested in 2001 and 8 pairs nested in 2003. Historically, small numbers of birds have nested at the Oakland International Airport (last reported in 1995), Bay Farm Island (last reported 1975), Bair Island (last reported 1984), Port Chicago (last reported in 1988), the Bay Bridge Sand Spit (one-time attempt in 1985), and Tern Island (one-time attempt in 1990, USGS Preliminary data, unpub.).

In addition, salt ponds in the South Bay have been used for sporadic and limited nesting attempts. These include attempts on levees at Ponds E10/E11 at Eden Landing (last reported 1985), Ponds N5/N7 (last reported 1983) and N1A in the Newark salt ponds, and Pond R3 in the Ravenswood Complex (Hurt 2004; Wetlands Research Associates 1994a). In the South Bay, recent breeding has occurred at Hayward Regional Shoreline, where 59 pairs nested in 2008 (45 of the 59 nests produced chicks). Of the 109 eggs laid at the site, 81 chicks have been produced. A total of 68 chicks have been observed on the site (age classes: twelve chicks at 1 to 5 days old, twenty-seven chicks at 5 to 10 days old, and twenty-three chicks at 10 to 17 days) and six fledglings. Currently, 55 to 100 least terns have been observed flying around the colony with the highest numbers observed during high tide events. Wildlife Services Specialists and staff are closely monitoring predators and will continue managing gulls, and prevent California gulls from negatively affecting the reproductive success of the tern colony. A total of two dead chicks have been found, three depredated eggs and two chicks presumed taken by aerial predators (American crow and California gull).

Least terns also nested at Pond E8A within the SBSP restoration project in the Eden Landing Complex, where several pairs nested in 2007; this site was largely abandoned for unknown reasons. These Eden Landing birds were observed foraging both in a borrow ditch within Pond E8A and in Old Alameda Creek (C. Robinson, pers. comm.).

The Alameda Point site currently represents nearly the entire San Francisco Bay Area population, and is the northernmost of least tern breeding colonies by about 178 miles. Because of its northern location, the Alameda Point site is relatively unaffected during El Niño years when many southern California sites experience pronounced breeding failure resulting from limited food availability. In the most recent previous El Niño year, 1992, the Alameda Point site supported 6 percent of the statewide number of breeding pairs, but produced 16 percent of the total statewide number of fledglings. The 1998 season was another El Niño year, one of the most severe recorded, and least tern breeding at NAS Alameda was less successful. Only 90 young fledged, more than a 70 percent reduction from 1997. Observations of delayed breeding, reduced fish catch, and the highest non-predator mortality of young ever observed (about 50 percent, L. Collins, pers. comm.) suggest food limitation and associated problems as a cause.

The major cause of breeding failure at many least tern colony sites in California has been documented as predation on eggs, chicks, fledglings, and adults (Caffrey 1995). A wide variety of predators has been documented to prey upon least terns, including most gull species and 22 other avian species, 14 mammalian species, and some species of snakes, crabs, ants, and spiders. In addition to direct loss or mortality of eggs and individuals, avian and mammalian predators can cause least tern adults to abandon breeding sites prior to completion of nesting activities. While many least tern breeding colony sites have been plagued by high predation pressure, the Alameda Point generally has been less affected by predation threats than many other sites throughout California (Caffrey 1995).

Currently, least terns use the proposed action area primarily as a post-breeding staging area from about late June through late August, prior to their southward migration. Here, both adult and juvenile least terns roost on salt pond levees (both outboard levees and interior levees between ponds) posts, and boardwalks, and forage both in the salt ponds and over the open waters of the San Francisco Bay. At the Alameda Point, least terns forage primarily on silversides (*e.g.*, topsmelt [*Atherinops affinis*]), northern anchovies (*Engraulis mordax nanus*), Pacific herring (*Clupea pallasi*), and surfperches (*Hyperprosopon* spp.) (Elliott *et al.* 2004). Although data are unavailable regarding diet during the post-fledging period in the South Bay, diet is likely similar.

In recent years, the main post-breeding staging area for least terns in the South Bay has been in the complex of salt ponds immediately north of Moffett Field (Ponds AB1, A2E, and AB2). For example, 276 least terns were seen in these 3 ponds on 27 July 2004 (S. Rottenborn, pers. obs.). This site is used predictably for roosting and foraging by both adult and juvenile least terns in July and August every year, with typical counts of 20 to 100 birds. Least terns have also been recorded at a number of other ponds in the project area, including A1, A2E, A3N, A3W, A4, A5, A7, A9, A10, A11, A14, (Hurt 2004, Marschalek 2006, J. Krause pers. comm., USGS

Preliminary data, unpub.). Ravenswood ponds, particularly R1, are used occasionally for foraging and roosting, with counts of 96 terns in July 2002 (Hurt 2004), 42 in July 2003, and 110 in July 2004 (USGS Preliminary Data, unpub.). Eden Landing Ponds are also used irregularly for foraging including E2, E4, E5, E8A, E9, E10, and E11. Approximately 305 least terns were observed at pond E8A in August 2006, and several dozen were seen foraging in shallow San Francisco Bay waters immediately adjacent to E2 in July 2004, (USGS Preliminary Data, unpub.). Least terns also forage heavily in adjacent open San Francisco Bay waters. For example, 50 of 58 least terns observed foraging in the proposed action area on 14 July 2004 were doing so over the San Francisco Bay, with only 8 individuals actively foraging in salt ponds (S. Rottenborn, pers. obs.). However, the relative importance of salt ponds versus San Francisco Bay waters for foraging by least terns in the South Bay is largely unknown.

California Brown Pelican

The brown pelican was listed as endangered on 13 October 1970 (35 FR 16047). A detailed account of the taxonomy, ecology, and biology of the brown pelican is presented in the approved Recovery Plan for this species (Service 1983). Supplemental or updated information is provided in the Service's 17 September 1996, Biological Opinion on the U.S. Bureau of Land Management's authorization for the construction of the proposed Bal'diyaka Interpretative Center in Coos Bay, Oregon, which is hereby incorporated by reference.

Brown pelicans were threatened with extinction in the 1970's due to the use of the pesticide dichloro-diphenyl-trichloroethane (DDT). This chemical gets into the food chain and affects the bird's calcium metabolism, resulting in thin-shelled eggs that break during incubation. DDT use was banned in the United States in 1972, and the brown pelican is recovering from the chemical contamination. However, DDT is still manufactured for export and its effects in the environment linger. Food availability is now the major cause of concern. The Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), and the northern anchovy are important food for the brown pelican, especially during the breeding season. By the early 1900s commercial over-harvesting of these fish had resulted in less food availability during this critical time. In 1985, the brown pelican was delisted in the Southeastern United States as recovered, but west coast populations did not recover as quickly, and have remained fairly stable since 1985 (Shields 2002).

The brown pelican nests colonially on islands from Mexico to Florida; in California pelicans breed on the California Channel Islands, and at the Salton Sea. Nesting season begins in early spring, approximately January to May (Anderson and Gress 1983; Shields 2002). Much of the post-breeding dispersal occurs northward (as far north as Canada), and by June, many post-breeding birds are present in central California. Local abundance in central California usually peaks from August to October (Briggs *et al.* 1987; Jaques 1994). Although a small number of non-breeding birds may be found locally year-round, most brown pelicans return to their southern breeding grounds by January. Brown pelicans feed on northern anchovies and other small fishes, which they capture by plunge-diving. Brown pelicans require secure night-roosts, free of terrestrial predators (Ainley 2000, Jaques 1994).

Brown pelicans are typically less abundant inside San Francisco Bay than along the immediate cost, although counts of more than 1,000 individuals have been recorded as far south in the San Francisco Bay as the Alameda Point area. Several hundred brown pelicans typically occur in the San Francisco Bay during summer and fall, but numbers are variable. In years when high numbers do not breed, such as El Niño years, thousands of brown pelicans occur throughout the year in the San Francisco Bay area (Ainley 2000). The largest roost in the San Francisco Bay area is located on Breakwater Island at the proposed Alameda Point, which peaks in numbers from June to August. On June 2004, 3,307 brown pelicans were counted at this roost (Hurt 2006).

Post-breeding dispersants typically begin to arrive in the South Bay in June and July, with most individuals departing by late fall. However, a few may also be found in the South Bay in winter and spring as well (Santa Clara County Bird data unpub.). Although information on daily activity patterns, habitat use, and key foraging areas of brown pelicans in the South Bay is limited, this species uses salt ponds both for foraging (which takes place in the less saline ponds supporting fish) and for roosting (on levees between ponds).

EFFECTS OF THE PROPOSED ACTION

Effects of the action are defined in 50 CFR §402.02 as "the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with the action, that will be added to the environmental baseline." Direct effects occur at the project site and may extend upstream or downstream based on the potential for impairing important habitat elements. Indirect effects are defined as "those that are caused by the proposed action and are later in time, but still are reasonably certain to occur." They include the effects on listed species of future activities that are induced by the proposed action and that occur after the action is completed. Interrelated actions are "those that are part of a larger action and depend on the larger action for their justification." Interdependent actions are "those that have no independent utility apart from the action under consideration." Cumulative effects, which are discussed separately after this section, are the effects of future State, local, or private activities, not involving Federal activities that are reasonably certain to occur in the action area.

The most significant effects of the proposed action on the harvest mouse, clapper rail, snowy plover, least tern, and brown pelican are potential beneficial effects on the extent and quality of habitat being restored for these species. As a result, it is important that the evolution of habitats in the South Bay over the 50-year duration be described. Habitat evolution will first be described generally (i.e., in terms of the extent of different types of habitats over the duration of the project). Then, proposed action effects, including habitat evolution/alteration as a result of restoration activities as well as potential adverse effects will be described individually for each of the listed species that are the subject of this PBO.

Habitat Evolution

Overview of Habitat Evolution

The habitats to be created by the proposed action include a mix of managed pond habitats and restored tidal habitats. Tidal habitat to be created by this project includes tidal salt and brackish marsh, tidal mudflat, subtidal flats and channels, marsh ecotones and upland transitional zones, salt pans and ponds. Multiple options for pond reconfiguration and water regime management will be used to enhance and create ponds with a variety of depths (including salt flats, very shallow ponded areas, and deep-water areas) and salinities (e.g., ponds with salinity close to bay water as well as higher salinity brine ponds), and associated levees and islands.

When tidal action is restored to a subsided pond site through a deliberate or accidental levee breach, physical processes are set in motion that dictate the rate and manner in which the site will evolve. These sedimentary processes have been described in conceptual models of youthful salt marsh development (Allen 1990; Orr et al. 2003) and are different from the processes, dominated by sea-level rise, which created the extensive transgressive ancient marshes of the South Bay.

In a restoring marsh, flood tides carry in suspended estuarine sediments that deposit in the wave-protected slack waters of the flooded site. Ebb tidal currents are insufficient to resuspend deposited muds, except in the locations of nascent tidal channels. As sediment accumulates, large areas of intertidal mudflats form. As they rise in elevation, the period of tidal-water inundation decreases and rate of sedimentation declines.

Once tidal mudflats reach a high enough elevation relative to the tidal frame, pioneer plant colonization can occur. Initial establishment usually occurs by seed or from plant fragments. Colonization becomes progressively more rapid through lateral vegetative expansion from the pioneer plants and continued deposition of seeds and plant fragments. Sites that have relatively high initial elevations will therefore reach colonization elevation more quickly than more deeply subsided sites.

In the San Francisco Bay, Pacific cordgrass (*Spartina foliosa*) is typically the first vegetation to colonize an accreting mudflat and dominates the low marsh. In the fresher parts of the San Francisco Bay bulrushes (*Scirpus maritimus* and *S. californicus*) will be the pioneer vegetation and will colonize lower in the tidal frame. Once mudflat colonization occurs, a vegetated marsh plain forms through lateral expansion of roots and rhizomes from established plants on the mudflat, and from plants along the site perimeter. The presence of vegetation contributes to the slow build-up of the marsh plain through sediment trapping and organic accumulation (Eisma and Dijkema 1997). Once vegetation is established, organic material will accumulate within the marsh both above ground as surface litter and below ground, through the decay of roots, rhizomes, and tubers, in the form of peat. As the vegetated marsh plain rises within the tidal frame, estuarine sediment accretion slows exponentially until a marsh plain forms at an elevation around mean higher high water (MHHW) (Atwater et al. 1979). As tidal inundation decreases, soil salinities increase and pickleweed (*Salicornia virginica*) out competes cordgrass to form the characteristic salt marsh plains of the San Francisco Bay.

The rate at which the mudflat and marsh plain builds up is dependent on the amount of sediment, or suspended sediment concentration (SSC), carried into the site by the flood tide, the rate of relative sea-level rise, the tidal range, and the amount of wind-wave action that erodes deposited sediments. The higher the average SSC in the flood tide entering the site, the quicker the restored site will evolve. Long-term average annual SSCs at any point in the South Bay vary depending on position relative to the hydrodynamics of the estuary, in particular its proximity to extensive intertidal mudflats where sediment can be resuspended by wave action (Schoellhamer 1996). Average SSCs are ultimately determined by the long-term sediment budget of the estuary, which dictates how much sediment is available to the Estuary, and the estuarine hydrodynamics that determine how it moves and where it is concentrated.

The proposed action will be implemented in a series of phases over many years, on the order of several decades. It is anticipated that each pond will be managed in a manner similar to the ISP until its implementation phase. The initial phases, including Phase 1, will include a range of habitat types – tidal habitat, enhanced managed ponds, and reconfigured managed ponds – and early experiments for adaptive management.

The phasing of tidal- and managed-pond restoration will begin with areas that are the most feasible and/or have the highest certainty of achieving the project objectives. The ultimate progression of future restoration phases, including the total number of phases for implementation, will need to consider many factors, such as maintaining consistency with anticipated future phases, and mitigating for impacts as early as possible (preferably before they occur), for example creating a tidal marsh corridor before existing marsh is lost through tidal scour. Future phases are also likely to be associated with additional interim feasibility studies associated with the Shoreline Study, as well as restoration and adaptive management actions associated with the restoration plan. The proposed action and Shoreline Study planning efforts are, and will continue to be, closely coordinated.

Because the proposed action is phased, a mosaic of habitats will be developing over the length of the project at varying intervals. For example, mudflats will accrete sediment until the marsh begins to vegetate at which time mudflat area may decrease, but newly restored areas will again be accreting sediments. The phased nature of the project will result in shifts between habitat types during the interim times scales over the length of the project. It is important to estimate habitat development and understand these interim shifts along the restoration trajectory to determine whether the project is meeting the habitat goals for target species. These interim shifts in habitat evolution are included as estimates over decadal time scales in Table 4.

Methods of Predicting Habitat Evolution

Sedimentation forecasts by Philip Williams and Associates, Ltd. (PWA) for each Alternative every ten years were modeled in 2004. However, problems with the datum used by the USGS in conveying existing bathymetry invalidated that analysis. The analysis was performed again with the correct datums, but only for Year 0 and Year 50 (PWA 2006). Below, the original decadal analysis was used as a relative indicator of projected marsh evolution in conjunction with the final Year 50 hydrodynamic modeling as well as the Geomorphic Assessment (PWA 2006) to develop estimates of habitat development throughout the South Bay over decadal time scales (Table 4).

Table 4. Habitat Evolution over Decadal Time Scales.

Habitat Type	Year 0 (acres)	Year 10 (acres)	Year 20 (acres)	Year 30 (acres)	Year 40 (acres)	Year 50 (acres)	Year 80 (acres)
Deep Subtidal	3800	3800	3800	3900	3900	3900	-
Shallow Subtidal	13,000	13,500	14,000	14,500	14,900	15,200	-
Intertidal Mudflat (outboard)	12300	11560	10770	9980	9190	8400	-
Intertidal Mudflat (within ponds)	960	2500	2500	2200	2200	1200	0
Managed Ponds	11,790	9300	6800	4600 – 6800	2400 – 6800	1200 – 6800	1200 – 6800
Restored Tidal Marsh Habitats							
Vegetated High Marsh	0	0	624	2431	4,306	4306-5625	4306-7475
Vegetated Low Marsh	0	720	1971	2159	452-1246	452-1471	452-1150
Channels	0	115	415	715	715-912	715-1056	715-1380
Ponds and Pannes	0	125	450	775	775-988	775-1144	775-1495

Based on these two sets of modeling results, the following assumptions were used to determine the habitat evolution acreages on a decadal scale:

Breached Pond Acreage and Phasing Assumptions

- Although the proposed action's acquisition boundary comprises 15,100 acres, only approximately 13,200 acres of salt pond habitat are available for restoration. Based on detailed habitat mapping in 2004, portions of the official project area comprise existing marshes, channels, adjacent upland habitats, and infrastructure such as levees. The 13,200-acre number represents the total area within each of the ponds that is available for restoration
- Approximately 478 acres of the project area has already been restored to tidal action as part of the ISP
- Year 0 - the initiation of tidal restoration under Phase 1 includes Ponds E8A, E8X, E9, and A6 (960 acres). The Island Ponds (478 acres) were not included in this analysis because they were breached as part of the ISP. Likewise, changes to other tidal restoration sites (e.g., Cooley Landing) in the South Bay were not included in Table 4, which summarizes habitat evolution in the South Bay
- After the Phase 1 activities, the remaining acreage required to reach the 50:50 (tidal:managed pond) scenario by Year 20 was divided equally into a hypothetical Phase 2 at

Year 10 and Phase 3 at Year 20 (actual timing of these phases may vary)

- Year 10 – approximately 2,500 acres of pond will be breached
- Year 20 – The remaining 2,500 acres of pond required to achieve the 50:50 scenario will be breached
- If, after Year 20, the proposed action determines (as a result of monitoring via the AMP) that no additional tidal restoration will occur, then the habitats restored through Year 20 will simply continue to develop. This represents the low end of the range shown in Table 4. However, if the project determines that it is able to proceed along the tidal restoration staircase, the upper end of the range of the restored habitats will follow the below assumptions
- If the results of monitoring under the AMP continue to allow for progression along the staircase, the 90:10 alternative will be achieved at Year 50, with additional breaching assumed (for the sake of these habitat evolution projections) as follows:
    - Year 30 – 2,200 additional acres will be breached
    - Year 40 – 2,200 additional acres will be breached
    - Year 50 – 1,200 additional acres will be breached, achieving the 90:10 scenario and the upper range of possible habitats depicted in Table 4.
- The ponds being restored after Year 20 comprise the more subsided ponds, and therefore habitat development to tidal marsh will take longer in later phases

General Tidal Habitat Development Assumptions

- Between breaching and vegetation colonization, restored areas will be dominated by intertidal mudflats.
- It was assumed that the ponds restored in early phases are the less subsided ponds and therefore will take approximately 10 years (after breaching) to develop into low marsh and 20 years to develop into mature/high marsh.
- It was assumed that the ponds restored in later phases are the more subsided ponds and therefore will take approximately 10-20 years (after breaching) to develop into low marsh and 20-30 years to develop into mature/high marsh.
- Low marsh habitat was assumed to be approximately 10 percent of a mature marsh.
- Channel development was assumed to occur during the first 10 years and will equal approximately 12 percent of the total breached area (based on PWA's estimates).
- Marsh pond and panne habitat was assumed to occur during the first 10 years and will equal approximately 13 percent of the total breached area (based on PWA's estimates).
- At Year 50, some tidal restoration will still occur to achieve 90:10, which means that a portion of tidal marsh habitats will be newly breached and therefore still developing at that time.
- A Year 80 column has been included in Table 4 to illustrate the range of habitats inside the restored ponds once all restoration actions, including new breaches that occur at Year 50, have had time to develop.

Assumptions for Other Habitat Types

Deep Subtidal

- Deep subtidal habitat (i.e., habitat greater than 6 m below MLLW) is expected to remain relatively stable through Year 50, with a slight increase (less than 100 acres) of new habitat.

Shallow Subtidal

- Shallow subtidal habitat (i.e., habitat 0-6 meters below MLLW) is expected to increase through Year 50, with increases in habitat tapering off near the end of the 50-year proposed action duration.

Intertidal Mudflat

- The intertidal mudflat development outside of the restored ponds was modeled for Year 0 and Year 50 assuming all ponds were breached in Year 0. We used these model results as bookends and assumed a linear decrease for the interim years.
- At Year 0, intertidal mudflat within the ponds breached during Phase 1 will be equal to the breached pond acreage. An estimated 2,500 additional acres will be breached in Year 10, with 2,500 more acres in Year 20, at which time the 50:50 scenario will be reached.
- To calculate the high-end restoration trajectory, it is assumed that 2,200 acres will be breached in Year 30, and again in Year 40. The remaining 1,200 acres will be breached at Year 50.

While intertidal mudflat area outside of the ponds is expected to decrease between Year 0 and Year 50, there will be intervals within that time frame where overall intertidal mudflat area increases as new mudflat areas develop within the restored ponds. The cumulative result is a net increase in mudflat habitat from Year 0 until approximately Year 20, then a net overall decrease after Year 20 as restored tidal areas become vegetated and outboard intertidal mudflat is lost to sea level rise and vegetation colonization.

Habitat Evolution Results. The approximate acreages of key habitat types in the South Bay, by decade, are listed in Table 4. A summary of the relative extent of marsh channels expected to develop within restored marshes at Year 50, by channel order/size, appears in Table 5.

Table 5. Approximate Extent of Channels by Order in Restored Marshes at Year 50.

Channel Size	Average Width	Relative Proportion of Channels in Restored Tidal Area
1st Order	0.5 m	3.5%
2nd Order	1.5 m	5.9%
3rd Order	10 m	23.1%
4th Order	15 – 20 m	32.6%
5th Order	15 – 20 m	34.9%

California Clapper Rail and Salt Marsh Harvest Mouse

Habitat Restoration

The harvest mouse and clapper rail are both dependent on salt marsh habitats in the San Francisco Bay. These species have somewhat different habitat associations. The clapper rail is restricted to tidal salt and, to some extent, brackish marshes, where it occurs most commonly in lower-marsh habitats dominated by taller vegetation such as cordgrass, and with numerous tidal channels. The harvest mouse is found in both diked and tidal salt marsh, where it occurs more commonly in somewhat higher areas of the marsh plain that are dominated by pickleweed; this species has been recorded in brackish marsh in the South Bay (H.T. Harvey & Associates 2006). For the sake of discussion of the general effects of habitat evolution under the proposed action on these species, they are considered together since (a) both occur most commonly in tidal salt marsh, (b) attempting to predict the extent of high marsh vs. low marsh at any given time in the future will be difficult given uncertainties in sediment accretion rates, and (c) no creation of diked salt marsh (which will potentially provide habitat for the harvest mouse but not the clapper rail) is proposed under this proposed action.

Following is a prediction of how habitat for the harvest mouse and clapper rail is expected to increase over the 50-year duration of the proposed action.

Years 0-10. In the first year of project implementation, Phase 1 activities will restore full tidal action to approximately 960 acres of salt pond, as described in detail in the Phase 1 actions description below. Initially, these former ponds will be below elevations that will allow colonization by vegetation, and the former pond bottoms will provide intertidal mudflat habitat. By Year 10, enough sediment is expected to have accumulated in these former ponds that low tidal marsh vegetation will have become established throughout approximately 720 acres of the former pond area. This low tidal marsh is anticipated to be predominately vegetated with Pacific cordgrass. In addition to the vegetated low marsh, there will also be approximately 115 acres of tidal channels and approximately 125 acres of salt ponds and pannes in these restored salt marshes. All of the marshes restored in these first 10 years (Phase 1) will be salt marshes.

Use of the restored marshes by clapper rails is expected to occur as soon as enough vegetation is present to provide cover for foraging clapper rails. Even though this vegetation may not be dense and/or broad enough to provide nesting habitat for several more years, clapper rails are expected to forage on intertidal mudflats near vegetative cover. By Year 10, the cordgrass-dominated vegetation will provide cover, and possibly nesting habitat (if it is dense enough by Year 10), and the margins of the tidal channels will provide foraging habitat, at least at low tide. The harvest mouse reaches its highest densities in mature high marsh habitats with tall, thick pickleweed, and generally does not utilize low marsh habitat because it is too frequently inundated to provide permanent habitat for the harvest mouse. The cordgrass vegetation may also not provide sufficient food or cover from predators for harvest mice. The restored marsh after 10 years is not expected to provide important habitat yet for the harvest mouse because it will not yet have high marsh habitat.

Years 10-20. By Year 20, approximately 624 acres of the low marsh habitat present at year 10 will have matured to high marsh habitat, which is expected to be dominated by pickleweed. Approximately 2,500 acres of additional salt pond habitat will be opened to tidal action in year 10, and most of this will have matured to vegetated low marsh habitat by Year 20 to form a total of approximately 1,970 acres of vegetated low marsh. The amount of restored tidal channel habitat at year 20 will be approximately 415 acres, and the amount of marsh pond/panne habitat within the restored marshes will be approximately 450 acres.

The 624 acres of restored pickleweed-dominated high marsh is anticipated to constitute suitable habitat for the harvest mouse. The high fecundity of harvest mice will ensure that it will rapidly colonize the restored pickleweed marshes, so long as this species could disperse to the restored high marsh habitat and the habitat were indeed suitable. The clapper rail could utilize portions of this high quality pickleweed marsh habitat along tidal channels, and will continue to utilize restored low marsh habitat and restored tidal channels. By Year 20, the amount of restored high marsh habitat will have much more than compensated for any fringe marsh habitat lost to scour from restoration actions.

Years 20-30. By Year 30, most of the low marsh habitat present at Year 20 will have matured into pickleweed-dominated high marsh. The high marsh habitat present at year 20 will have further matured, and will likely have thick, tall, dense pickleweed, and associated late successional salt marsh plants like gumplant. This is the type of mature pickleweed marsh that is optimal habitat for the harvest mouse. A total of approximately 2,430 acres of restored high marsh in habitat at various stages of maturity will be present at this time, constituting a major increase habitat for both of these endangered species that should substantially contribute to their survival and recovery. The clapper rail could also utilize the approximately 2,160 acres of restored low marsh habitat and 715 acres of tidal channel and slough habitat available in year 30.

Whether or not more salt pond is opened to tidal action to further restore tidal marsh in Year 30 depends upon results of monitoring following the initial restoration phases. Approximately 6,600 acres of salt pond will be opened to tidal influence by Year 20. Monitoring of key habitat, species, and communities under the AMP will determine whether the conversion of salt pond habitat to tidal habitat has had unintended, adverse effects on key habitats, species, and communities. If no adverse effects have been noted, or if adaptive management actions can stall or reverse any negative trends resulting from restoration, then conversion of salt pond to tidal marsh will continue in the South Bay, potentially until 90 percent of the original salt ponds have been opened to tidal action, or until monitoring under the AMP indicates that restoration should cease to prevent impacts. If the adaptive management program indicates that further marsh restoration is to occur in Year 30, up to 2,200 acres of salt pond will be opened up to tidal action that year.

Years 30-40. By Year 40, most of the vegetated low marsh present at Year 30 will have become high marsh supporting pickleweed, for a total of approximately 4,300 acres of restored high marsh habitat in the South Bay. The high marsh present at Year 30 will have further matured, with more of it supporting dense, tall pickleweed. This high marsh habitat is expected to provide high-quality habitat for the harvest mouse.

If no further conversion of salt ponds occurred in Year 30 due to project impacts on pond-associated species (or other impacts), the area of restored low marsh habitat will be approximately 452 acres, and the areas of tidal channels and salt ponds and pannes will be the same as in Year 30. If restoration efforts proceeded in Year 30, up to approximately 1,250 acres of restored low marsh habitat will be present in the South Bay, and up to 912 acres of tidal channel and 988 acres of marsh ponds and pannes will be present. Clapper rails will utilize these restored low marsh and tidal channel habitats in addition to portions of the restored high marsh habitats. If the adaptive management program indicates that further restoration efforts are to begin in Year 40, up to 2,200 additional acres of salt pond will be opened to tidal action in that year.

It should be noted that a fraction of the marshes restored in the Alviso Complex will be brackish rather than salt marshes. None of the marshes in Phase 1 are likely brackish, but some of the marshes restored in Years 30-50 likely will be. Because brackish marsh habitat is considered to be of lower quality for harvest mice and clapper rails, this restored marsh will have relatively lower value for these species. However, these brackish marshes will be a small fraction of the total restored marsh habitat. Furthermore, the total amount of brackish marsh in the entire South Bay at Year 50 is predicted to decline from 14 percent to 12.8 percent as a result of the increased tidal flow that will accompany the marsh restoration, so overall the fraction of salt marsh habitat available to these species will increase as a result of the project. Finally, both the harvest mouse and clapper rail have been recorded using brackish marshes in the South Bay, and thus these marshes will provide some benefit to these species.

Years 40-50. If no further tidal marsh restoration occurs beyond Year 20 (i.e., beyond the 50/50 managed pond/tidal habitats scenario), then the amount of restored high marsh in Year 50 will be the same as in Year 40, approximately 4,300 acres. This high tidal marsh habitat will have had 30 years to mature by Year 50 of the project, and so nearly all of it will likely have developed fully mature pickleweed and other late successional salt marsh plants associated with the highest quality harvest mouse habitat. Likewise, if no further marsh restoration activities took place after Year 20, the amount of low marsh habitat, tidal channel habitat, and marsh pond/panne habitat will be the same in Year 50 as in Year 30. Clapper rails will be able to utilize the restored low marshes, portions of the mature high marshes, and the tidal slough habitats.

However, if restoration efforts on as much as 90 percent of the proposed action area have proceeded up to Year 50 according, then in Year 50 there will be approximately 5,630 acres of restored high marsh, 1,470 acres of restored low marsh, 1,060 acres of restored tidal channels, and 1,140 acres of marsh ponds/pannes. Furthermore, an additional 1,200 acres of salt pond habitat will be open up to tidal action in Year 50. Any restored tidal marsh opened up in Years 30, 40, and 50 will be continuing to mature and further improve in quality for the harvest mouse. Once the tidal marsh restored under the Alternative C fully matures, which will occur by approximately year 80, there will be a total of 7,480 acres of restored high marsh, 1,150 acres of restored low marsh, 1,380 acres of restored tidal channels, and 1,500 acres of restored marsh ponds and pannes, for a total of approximately 11,500 acres of restored tidal marsh habitat. This vast amount of restored habitat for the harvest mouse and clapper rail will be expected to substantially increase South Bay populations of the species, and contribute greatly to their survival and recovery.

Habitat Loss

Over the entire 50-year life of the proposed action, approximately 220 to 250 acres (90 to 100 hectares) of fringe marsh habitat will be lost, mostly due to tidal scouring. Habitat for the clapper rail will develop quickly, and restored habitats is anticipated to outpace (and eventually far exceed) any localized loss of habitat due to scouring, excavation of pilot channels, or other activities. Mature pickleweed habitat for the harvest mouse takes longer to develop, and it is possible that it will take a decade or more for localized losses in certain areas to be offset by increases in harvest mouse habitat at that location due to tidal marsh restoration. However, lowered levees and interior levee walls within ponds opened to tidal action will be colonized rapidly by pickleweed, helping to offset the temporary loss of harvest mouse habitat in specific areas until the restored marshes achieve elevations suitable for pickleweed colonization. Eventually, the amount of habitat restored will far exceed localized, short-term losses.

In addition, the fringe marshes of the South Bay, which will be the marshes adversely affected by this short-term marsh loss, often provide the only habitat connecting the larger patches of marsh habitat that contain the "core" populations of harvest mice. The loss of these marshes in the short term before the restored marshes have matured to vegetated high marsh could temporarily reduce the connectivity between the harvest mouse populations of the South Bay. This potential is mostly offset by marshes created on lowered levees described above. By grading these areas to approximately MHHW, pickleweed will rapidly establish and broaden the strip marshes and increase the connectivity in many places.

The short-term loss of harvest mouse habitat and connectivity from fringe marsh scour will be offset by an order of magnitude in the second decade of the proposed action when the restored marsh matures to a point that it can support harvest mice. The short-term nature of the loss of connectivity suggests that it will not adversely affect the metapopulation dynamics or genetic diversity of the harvest mouse in the South Bay.

Small-scale, localized loss of habitat for the clapper rail and harvest mouse will also occur on a small scale as a result of the placement of sediment, structures, or other materials in these species' habitats, excavation of habitat, and trampling of habitat. At any one location, the extent of habitat to be impacted will be very small compared to the proposed restoration, and the total loss of clapper rail and harvest mouse habitat due to these activities is included in the above estimate of approximately 220-250 acres of fringe marsh habitat that will be lost during the life of the project.

Examples of activities that could result in the placement of sediment, structures, or other materials in clapper rail and harvest mouse habitat are as follows:

- Incidental displacement of sediment into habitat during breaching, lowering, and maintenance of sections of existing outboard levees; excavating pilot channels through fringe marsh; dredging outboard sloughs to enlarge channel and obtain borrow ditch block material; removal or replacement of existing water control structures or installation of new ones; and reconfiguration of culvert connections

- Constructing ditch blocks in the perimeter and internal borrow ditches (if harvest mouse habitat is present inside levees)
- Side-casting of dredge spoils into adjacent marsh
- Installation of new water control structures
- Installation of fish screens
- Modifying or raising levees (e.g., for flood control)
- Constructing new levees (e.g., for flood control)
- Armoring levees
- Constructing trails, viewing platforms, interpretive stations, and boat launches

Activities that could result in the loss of clapper rail and harvest mouse habitat due to excavation include the following:

- Excavating pilot channels to sloughs through the fringe marsh outboard of outboard levee breaches
- Breaching sections of outboard levees (or inboard levees if harvest mouse habitat is present inside levees)
- Widening a channel and providing additional cross-sectional area for flow to improve floodwater conveyance
- Breaching slough levees to route more tidal flow through the sloughs/channels, to increase channel deepening and widening downstream of the breaches

Examples of activities that could result in trampling of clapper rail and harvest mouse habitat by equipment or people are as follows:

- Excavation of pilot channels
- Installation, removal, replacement, or maintenance of water control structures or fish screens
- Levee breaching, maintenance, modification, or construction
- Walking through marshes or grounding boats in marshes during monitoring/research efforts
- Constructing trails, viewing platforms, interpretive stations and boat launches
- Recreational access (e.g., unauthorized access into habitat by boaters, hunters, anglers, or pedestrians)
- Placement of traps in marsh for predator control
- Lepidium control (e.g., spraying within marsh).

In addition, where harvest mouse habitat is present inside a pond to be restored to tidal action, habitat for this species will be lost due to flooding as a result of the following activities:

- Breaching levees to restore tidal action to ponds with harvest mouse habitat present inside levees
- Raising water levels in ponds with harvest mouse habitat present inside levees
- Providing temporary floodwater storage within managed ponds to reduce flooding impacts (if salt mouse habitat is present inside levees).

During any construction or excavation activities, or levee maintenance or modification, that may result in impacts to tidal marsh habitat, the limits of work will be clearly delineated to limit effects to existing clapper rail and harvest mouse habitat. Side-casting of dredged materials into tidal marsh habitat will be limited so that a minimum amount of marsh is filled. Conservation measures incorporated into the proposed action (described previously) will be implemented to minimize effects of human activity within marshes on clapper rail and harvest mouse habitat.

Direct Loss of Individuals, Nests, Eggs, and Young

All of the specific activities listed above under "Habitat Loss" have the potential to result in the direct mortality or injury of individual harvest mice (adults and young) or clapper rails (including nests, eggs, and young). Harvest mice or clapper rails may be injured or killed by crushing or smothering during the placement of sediment or other materials in suitable habitat, or by excavation of habitat. Trampling by construction equipment or people may occur during construction, monitoring, research, or recreational activities. Adult clapper rails are unlikely to be injured or killed during such activities, as they are expected to flee an area subject to such activities before injury or mortality occurs. However, these activities could destroy or damage clapper rail nests or eggs, or result in the injury or mortality of less mobile harvest mice or young clapper rails.

During any construction or excavation activities, or levee maintenance or modification, that may result in impacts to harvest mice or clapper rails, the limits of work will be clearly delineated to limit effects to these species. Conservation measures incorporated into the proposed action, including avoidance of occupied habitat during the clapper rail breeding season and minimization of work within marsh habitat will minimize effects of human activity within marshes on clapper rails and harvest mice.

Where harvest mouse habitat is present inside a pond to be restored to tidal action, individual harvest mice will be lost due to flooding when levees are breached to restore tidal action to ponds, water levels are raised during pond management, or temporary floodwater storage within managed ponds occurs to reduce flooding impacts.

Loss of individual clapper rails and harvest mice due to predation could also be exacerbated by the proposed action, at least in localized areas. The restoration of tidal marsh habitat will increase habitat for northern harriers, which prey on small mammals such as harvest mice, and are expected to prey on clapper rail chicks as well. However, because habitat for northern harriers is suitable for clapper rails and harvest mice as well, the increase in clapper rail and harvest mouse populations due to habitat restoration in a given area will outpace any adverse effects of predation by northern harriers. Local increases in predation on clapper rails and harvest mice may occur due to marsh restoration in close proximity to colonies of California gulls; electrical towers providing nesting sites for common ravens, red-tailed hawks (*Buteo jamaicensis*), peregrine falcons (*Falco peregrinus*); upland areas providing sources or predators such as cats, rats, foxes, raccoons, loggerhead shrikes (*Lanius ludovicianus*), white-tailed kites (*Elanus leucurus*), and American crows; and landfills that attract potential avian and mammalian predators. Although terrestrial pathways used by mammalian predators to access marshes will be reduced through the breaching, lowering, and removal of levees in some areas, marshes that abut upland areas will be subject to predation by land-based predators, and avian predators will have more widespread access to clapper rails and harvest mice in restored marshes.

Breaching ponds where California gulls breed would result in the displacement of several large California gull colonies. These displaced gulls may select nesting sites in close proximity to clapper rail and harvest mouse habitat elsewhere. The displacement of gulls from areas of lower clapper rail and harvest mouse habitat quality to areas of higher habitat quality could result in increased predation pressure by gulls on these two species.

Conversely, both mammalian and avian predator control efforts are expected to increase as part of the proposed action. Currently, mammalian predators are controlled on Refuge lands, and localized avian predator control is implemented at the ELER where individual predators threaten snowy plover nesting areas. However, given the limited existing extent of salt marsh habitat for clapper rails and harvest mice, individuals of these species are concentrated in very limited areas, facilitating predation. The rate of predation of individual clapper rails and harvest mice is expected to decline during implementation of the proposed action due to increased predator control efforts and extensive tidal habitat restoration, which would reduce the concentration of individual clapper rails and harvest mice and, potentially, make it more difficult for predators to locate clapper rails and harvest mice.

Although there is some potential for clapper rails to be accidentally shot by hunters, the probability of such an occurrence is extremely low. Most hunting in the proposed action area occurs from blinds within managed ponds, where clapper rails do not occur due to a lack of vegetative cover and poor foraging habitat. Those levees that are currently open to hunting (e.g., along Ponds A5, A7, and A8N) are located in areas where few clapper rails are present due to the brackish nature of the marshes, and clapper rails rarely fly high or far enough to provide quarry for waterfowl hunters. Both the Service and CDFG law enforcement staff track the number of hunters and their harvest, and monitor for impacts to non-huntable wildlife.

With the implementation of the conservation measures described previously, the actual number of individual clapper rails and harvest mice lost due to implementation of the proposed action will be very low. Any incidental take associated with project-level activities will be identified in the tiered biological opinions.

Loss of Individuals and Reduced Reproductive Success due to Mercury Exposure

Mercury accumulation in eggs is perhaps the most significant contaminant problem affecting clapper rails in the Estuary, with the South Bay containing the highest mercury levels. Mercury is taken in by clapper rails primarily through contaminated prey. Although mercury intake is generally not acute enough to result in lethal toxosis of adults or young, mercury is extremely toxic to embryos and thus results in high levels of egg inviability and reduced clapper rail fecundity. Schwarzbach et al. (2006) found high mercury levels and low hatching success (due both to predation and, presumably, mercury) in clapper rail eggs throughout San Francisco Bay. They also suggested that mercury exposure could slow or stunt development of young, possibly increasing predation risk.

Clapper rails are currently exposed to mercury when foraging on mudflats and in sloughs with high levels of mercury contamination. The proposed action has the potential to increase the exposure of clapper rails to mercury by stirring up sediments during excavation of pilot channels in contaminated marshes, breaching levees, widening or dredging of channels, and placement of contaminated sediment in marshes (e.g., following excavation of pilot channels, during levee construction or maintenance, or during levee lowering or removal). Mercury-contaminated sediments that are currently buried too deep to adversely affect clapper rails could be mobilized by these activities, entering the food chain.

A mercury monitoring study is currently underway to ensure that mercury impacts on biota are minimized during restoration. This study focuses on the Alviso area where mercury levels are known to be high, but also includes sampling sites elsewhere in the South Bay. This study is measuring mercury levels in the sediment, water column, and various sentinel species; measuring the bioavailability of inorganic mercury in sediments; measuring mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. This study will increase the understanding of mercury cycling within the proposed action area and will inform future management decisions to further minimize mercury exposure. Monitoring of mercury cycling during Phase 1 restoration and management activities will also provide information on management or restoration activities that are desirable, or that are to be avoided, in areas of high mercury concentrations. Decisions regarding restoration or management activities involving breaching and scour in a particular area will be made only after the sediments to be mobilized by such activities are tested for mercury levels, and in the context of the results of ongoing and future studies regarding the effects of mercury.

Disturbance of Individuals, Nests, and Young

Disturbance such as loud noise or the presence and movement of people, dogs, and heavy equipment in or near clapper rail habitat may alter bird behavior in ways that result in injury, mortality, or reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to clapper rail avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high quality foraging areas are impacted; and increased movement or flushing from cover, or altered activity patterns, that reduce energy reserves and increase predation risk.

Examples of proposed action activities that will cause such disturbance, if they occur in or near occupied clapper rail habitat, include the following:

- Installation, removal, replacement, or maintenance of water control structures, water pumps, or fish screens
- Levee breaching, maintenance, modification, or construction
- Construction of islands and levees in managed ponds
- Excavation of pilot channels and dredging of inboard and outboard channels
- Construction of trails, viewing platforms, interpretive stations, and boat launches
- Walking through marshes or grounding boats in marshes during monitoring/research efforts

for adaptive management and applied studies
- Walking and driving on levees during survey, monitoring, research, or maintenance activities
- Recreational access (e.g., authorized and unauthorized access into or near nesting and foraging habitat by boaters, hunters, anglers, or pedestrians)
- Trapping, shooting, and hazing for predator control

These activities would be disruptive to clapper rail breeding efforts if they occur in or near occupied habitat during the breeding season. Disturbance could cause short-term effects such as failure to breed, nest abandonment, lower numbers of eggs, juvenile abandonment, and overall lower juvenile survivorship. In areas where high-intensity disturbance is short-lived (e.g., during pilot channel excavation, or levee breaching or construction), successful reproduction may not occur while the disturbance is ongoing, but may resume after construction is completed. In areas where disturbance will increase permanently as a result of the proposed action (e.g., due to the construction of boat launches, or construction of trails adjacent to clapper rail habitat), some clapper rails may acclimate to the new disturbance, while others may not.

Even with the implementation of conservation measures to minimize disturbance in the tidal marsh during the breeding season, clapper rails that disperse away from disturbance may not successfully establish new breeding territories and breed. Clapper rails forced to disperse would need to either maintain existing pair bonds or develop new pair bonds and establish new breeding territories in other suitable habitat areas. The ability of these clapper rails to reestablish new breeding territories would be hampered by the fact that clapper rails maintain year-round home ranges and defend established breeding territories from intrusions by other clapper rails. Loss of any female clapper rails would be compounded by the loss of potential future progeny. Reduced survival of adult clapper rails would impact the long-term viability of the population.

Disturbance that occurs during the clapper rail non-breeding season could also result in harassment, harm, or mortality of clapper rails. Clapper rails could be forced to adjust the boundaries of their territories or to disperse to other habitat areas. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation. Clapper rails disturbed by work activities also could be subjected to predation if they increase their movements within their home range or disperse to other nearby or distant tidal wetlands.

Human activity and associated pet use will increase in areas where trails, interpretive stations, and other recreational/public access features are to be opened or improved. Interpretive displays will inform the public about the potential to disturb listed species and their habitat. The ability to manage or control potential disturbances in adjacent habitat areas from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails.

Visual and physical barriers along trails may have limited effect in deterring human or pet disturbance because they can be easily crossed. Continued dog use will be dependent upon compliance with new leash restrictions; non-compliance will result in the Refuge and ELER removing dog-walking from recreational use. During the non-compliant period, harvest mice could be harmed, harassed, or killed by dogs.

Water-based disturbance of clapper rails will increase to some extent due to the construction of new boat launches. However, interpretive signage describing closed areas and boating procedures to avoid impacts to sensitive wildlife species, both at boat launches and at the mouths of restored sloughs that are closed to boat access, will help to minimize disturbance of clapper rails in restored and existing marshes.

Increased recreational trail use in areas where existing trails occur adjacent to clapper rail habitat could result in the flushing of clapper rails at high tides, increasing predation risk. Such disturbance will increase in areas where new trails will be opened to the public adjacent to existing clapper rail habitat, or where trails (new or existing) occur adjacent to new tidal marsh habitat.

Construction, maintenance, monitoring, recreational, and other activities will result in increased levels of disturbance to harvest mice from noise, vibrations from equipment, and construction activities. Disturbance will result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of harvest mice from their territory/home range in the areas where their habitat is destroyed. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance to females during the period of March through November may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

During any construction or excavation activities, or levee maintenance or modification, that may result in disturbance of harvest mice or clapper rails, the limits of work will be clearly delineated to limit effects to these species. Conservation measures incorporated into the proposed action, including avoidance of occupied habitat during the clapper rail breeding season, interpretive signage at the edges of sensitive habitat areas and seasonally closed trails, and enforcement of hunting regulations, will minimize effects of human disturbance on clapper rails and harvest mice.

Western Snowy Plover

Habitat Modification

Although snowy plovers in the San Francisco Bay occasionally nest on levees and islands, the majority of nests are currently found on flats within dry or partially dry ponds (Feeney and Maffei 1991, Fischer 1998). A few ponds, particularly in Eden Landing, as well as Ponds A22 and SF2, have long been used regularly for nesting by snowy plovers. In the past, such regular use resulted from the type and consistency of management of these ponds for salt production (e.g., the same ponds representing the same stage in the salt-making process provided conditions that were consistently suitable for use by nesting snowy plovers). Currently, under the ISP, attempts are being made to manage a few ponds (e.g., Ponds E6B, E8, E8A, and E8X) with optimal breeding conditions for snowy plovers in mind. Other ponds are used more sporadically, and in any given year there may be extensive habitat in the South Bay that is ostensibly suitable for nesting but is unoccupied by the species. Without management of ponds targeted specifically for snowy plovers, the amount of suitable nesting habitat is unpredictable, given that changes in precipitation, rate of evaporation, and pond management could make any given pond unsuitable in a given year.

Restoration of tidal marsh, or increasing water levels (e.g., to manage ponds for diving ducks or other birds), in ponds that support breeding snowy plovers will reduce the overall nesting and foraging habitat available. Flooding or removal of levees and salt flats will also reduce foraging habitat for snowy plovers. However, quantifying the predicted effect of such a habitat decline on snowy plover numbers is difficult. The extent of habitat offering dry salt pans or island nesting habitat varies from year to year due to the timing and amount of precipitation (and consequently water depth) in seasonal ponds, and much seemingly suitable habitat in any given year is unoccupied by snowy plovers. As a result, a reduction in the extent of suitable habitat need not result in a decline in numbers of snowy plovers if some ponds are managed specifically (and consistently) for nesting snowy plovers.

Proposed action activities to increase densities of nesting snowy plovers within the project area are not only expected to compensate for decreases in salt pond habitat, but also to enhance conditions for breeding snowy plovers to help contribute to the species' recovery. Enhancement of managed pond habitat by targeted management for shallow water depths and the creation of artificial islands have been found to support high nesting densities of snowy plovers at the Moss Landing Wildlife Area and in evaporation basins in the San Joaquin Valley (Eyster et al. 2003, H.T. Harvey & Associates, unpublished data). As a result, the creation of nesting islands and the management of suitable water levels, nesting island conditions (e.g., through vegetation management), and predators (e.g., at Ponds E12, E13, SF2, and A16 in Phase 1 and possibly other ponds thereafter) is expected to support high densities of nesting snowy plovers. Additional ponds will be available for management as nesting snowy plover habitat, either on islands or in seasonally managed ponds. The number of ponds managed for this species, and the manner in which they are managed (e.g., with islands or salt pans), will be informed by monitoring the results of ongoing plover habitat management at Eden Landing and the outcome of Phase 1 studies. The project has also begun planning of focused restoration designed to benefit the plover based upon results reported in the Owens Valley by Point Reyes Bird Observatory. In that location, a managed pond with a series of furrows and with water moving in channels in between the furrows resulted in very high nesting success. This design may be experimented with in Phase 2 of the proposed action.

However, the effectiveness of habitat enhancement/creation and predator control in sustaining and increasing numbers of breeding snowy plovers in the South Bay cannot be predicted with certainty. For this reason, monitoring and adaptive management will be important components of the proposed action, and will be essential in ensuring that project activities result in a net benefit to snowy plovers. Snowy plover numbers, as well as some measure of reproductive success, will be determined through comprehensive, annual South Bay surveys and monitoring during the breeding season. The effects of phased restoration activities will be predicted prior to each phase of restoration, and deviations from the projected trajectory toward achieving the proposed action's objectives regarding snowy plover numbers will be noted. If the rate of population change declines substantially from this projected trajectory, if the South Bay population declines in any given year below 2006 baseline levels, or if increases in predatory/competitive species, such as California gulls, to population or activity levels that may threaten maintaining numbers of breeding snowy plovers are noted, the adaptive management trigger will be tripped, and adaptive management actions to reverse any adverse effects on snowy plovers will be implemented.

Adaptive management actions will include the construction of additional islands, the creation of islands of a different size and/or configuration (based on an analysis of use of existing islands), adjustment of water depths, adjustment of pond management to provide more salt pan habitat, and increased levels of predator management. Other means of providing nesting habitat will also be assessed. For example, "furrowed" ponds described above, in which the pond substrate is furrowed to create small islands and ridges surrounded by shallow water, have been successful in supporting high densities of nesting snowy plovers in the Owens Valley (N. Warnock, pers. comm.); creation and management of such habitat in South Bay ponds, and comparison of nesting snowy plover densities among ponds providing different types of snowy plover nesting habitat, will allow for effective management of their habitat.

The AMP provides a mechanism to ensure that the proposed action's effects on snowy plovers and the loss of salt pond habitat are sufficiently compensated for by intensive management of the remaining managed ponds. Thus, over the life of the proposed action, any adverse effects on snowy plovers are expected to be minor and short-term, and the proposed action is expected to result in an increase in the habitat quality and population size of snowy plovers in the South Bay.

Through focused habitat restoration and existing predator management, it is expected that snowy plover numbers will achieve the draft Recovery Plan success criteria under the 50:50 managed pond/tidal habitat restoration scenario. In fact, there is potential for snowy plover numbers within the proposed action area to exceed 250 individuals under this scenario. As restoration proceeds along the adaptive management "staircase," and additional ponds are restored to tidal habitats so that the extent of managed pond habitat represents progressively less than 50 percent of the proposed action area, it is possible that the number of snowy plovers may eventually decline from their previous highs as a result of a reduction in breeding habitat acreage. However, the objective of supporting at least 250 individual breeding snowy plovers is expected to remain as restoration proceeds beyond the 50:50 scenario.

Direct Loss of Individuals, Nests, Eggs, and Young

A number of activities associated with the proposed action have the potential to cause direct mortality or injury of snowy plovers, including nests, eggs, and young. Although adult snowy plovers may forage on tidal mudflats, direct loss of adults on tidal mudflats is unlikely to occur as a result of the proposed action. Nesting, brooding, and most foraging (including virtually all foraging by chicks) in the project area occurs in shallow managed ponds and along barren or sparsely vegetated levees within and surrounding these ponds. Therefore, activities that could result in the direct loss of individual snowy plovers and their nests, eggs, and young are those that occur within the managed ponds and on surrounding levees. Examples of activities that could result in eggs or chicks being crushed, trampled, or buried include the following activities:

- Grading and nesting island creation, management, and maintenance within reconfigured managed ponds
- Incidental displacement of sediment into nesting or foraging habitat during breaching, lowering, and maintenance of sections of existing outboard levees; removal or replacement of existing water control structures or installation of new ones; and reconfiguration of culvert connections
- Constructing ditch blocks in borrow ditches
- Constructing trails, viewing platforms, and interpretive stations
- Levee breaching, maintenance, modification, armoring, or construction
- Walking or driving along levees or through ponds during facilities inspections and maintenance, surveys, and monitoring and research efforts
- Recreational access (e.g., authorized use of levees by pedestrians, or unauthorized access into managed ponds by anglers or pedestrians)
- Vegetation and predator control within managed ponds

In addition, eggs (and possibly very small young, if they are unable to swim to terrestrial refugia) may be lost if occupied nesting habitat is flooded as a result of the following activities:

- Breaching levees to restore tidal action to ponds
- Raising water levels during pond management
- Providing temporary floodwater storage within managed ponds to reduce flooding impacts

Water levels will be closely monitored in nesting areas, and particularly close attention to water levels will be paid if water control structures are opened during the breeding season so that nests are not flooded. Nevertheless, there is some risk that nests would be flooded if monitoring of water levels is not frequent enough, or if water control structures fail and cannot be repaired before nests are flooded.

To minimize such impacts, work in and adjacent to potential snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting snowy plovers, and appropriate buffers would be provided between project activities and nesting snowy plovers.

Concentration of nesting snowy plovers in fewer locations may result in increased predation pressure (e.g., if individual gulls, corvids, foxes, or other predators key in on these locations), subject larger numbers of birds to disturbance by humans or predators at any given nesting area, and provide fewer options for nesting birds in the event that pond conditions in preferred nesting areas are unsuitable (e.g., due to high water levels in wet years).

Loss of individual snowy plovers due to predation could also be exacerbated by the proposed action, at least in localized areas. The restoration of tidal marsh habitat will increase habitat for northern harriers, which prey on snowy plovers, and will concentrate nesting plovers in fewer locations. Management of pond habitat for high densities of nesting plovers in close proximity to colonies of California gulls; electrical towers providing nesting sites for common ravens, red-tailed hawks, peregrine falcons; upland areas providing sources or predators such as cats, rats, foxes, raccoons, loggerhead shrikes, white-tailed kites, and American crows; and landfills that attract potential avian and mammalian predators could increase the intensity of predation.

Breaching ponds where California gulls breed would result in the displacement of several large California gull colonies. These displaced gulls may select nesting sites on salt pond levees, on islands, or on salt pannes, all of which have been used as breeding habitat by snowy plovers. Due to the larger size of California gulls, and the potentially overwhelming numbers of gulls that may be prospecting for new nesting sites, snowy plovers may be displaced from currently used nesting areas. California gulls displaced to sites closer to nesting snowy plovers may also prey upon plover eggs and chicks.

Both mammalian and avian predator control efforts are expected to increase as part of the proposed action. Currently, mammalian predators are controlled on Refuge lands, and localized avian predator control is implemented at ELER where individual predators threaten snowy plover nesting areas. The need for predator control will be monitored at snowy plover nesting areas, both through monitoring of predator numbers and snowy plover breeding success, and predators will be removed as needed to maintain high snowy plover breeding success.

Loss of Individuals and Reduced Reproductive Success due to Mercury Exposure

Studies in San Diego County (Hothem and Powell 2000), at Point Reyes (Schwarzbach et al. 2005), and in the South Bay (Schwarzbach and Adelsbach 2003) have found elevated mercury levels in snowy plover eggs. At Point Reyes, high levels of mercury in unhatched eggs were thought to be a possible reason for the inviability of these eggs. In the San Diego County and South Bay studies, however, concentrations of mercury in snowy plover eggs were below known embryotoxic thresholds established for other species. Ongoing studies in the South Bay will provide more information on the magnitude and potential effects of mercury contamination on snowy plovers in the proposed action area.

Snowy plovers are currently exposed to mercury in managed ponds containing mercury-contaminated water or sediment, and to a lesser extent on intertidal mudflats where this species occasionally forages. Proposed action activities that stir up contaminated sediments, such as grading, excavation, levee construction or maintenance, or fill activities within managed ponds have the potential to increase snowy plover exposure to mercury, possibly reducing fecundity in contaminated ponds. Activities that stir up mercury-laden sediments in tidal habitats, as described above for the clapper rail and harvest mouse, are expected to have little effect on snowy plovers due to the infrequency with which snowy plovers forage in intertidal habitats in the project area.

A mercury monitoring study is currently underway to ensure that mercury impacts on biota are minimized during restoration. This study focuses on the Alviso area where mercury levels are known to be high, but also includes sampling sites elsewhere in the South Bay. This study is measuring mercury levels in the sediment, water column, and various sentinel species; measuring the bioavailability of inorganic mercury in sediments; measuring mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. This study will increase the understanding of mercury cycling within the proposed action area and will inform future management decisions to further minimize mercury exposure. Monitoring of mercury cycling during Phase 1 restoration and management activities will also provide information on management or restoration activities that are desirable, or that are to be avoided, in areas of high mercury concentrations. Decisions regarding restoration or management activities involving breaching and scour in a particular area will be made only after the sediments to be mobilized by such activities are tested for mercury levels, and in the context of the results of ongoing and future studies regarding the effects of mercury.

Disturbance of Individuals, Nests, and Young

Disturbance such as loud noise or the presence and movement of people, dogs, and heavy equipment in or near snowy plover habitat may alter bird behavior in ways that result in injury, mortality, or reduced nesting success. Such disturbance could result in temporary or permanent habitat loss due to the avoidance of areas that have suitable habitat but intolerable levels of disturbance; abandonment of nests, eggs, or young by nesting pairs; a reduction in foraging efficiency if high quality foraging areas are impacted; and increased movement or flushing from cover, or altered activity patterns, that reduce energy reserves and increase predation risk.

Examples of proposed action activities that will cause such disturbance, if they occur in or near occupied snowy plover habitat, include the following:

- Grading and nesting island creation, management, and maintenance within reconfigured managed ponds
- Installation, removal, replacement, or maintenance of water control structures, water pumps, or fish screens
- Internal and external levee breaching, maintenance, modification, or construction
- Excavation of pilot channels and dredging of inboard and outboard channels
- Construction of trails, viewing platforms, interpretive stations, and boat launches
- Walking or driving along levees or through ponds during facilities inspections and maintenance, surveys, and monitoring and research efforts
- Recreational access (e.g., authorized use of levees by pedestrians or hunters, authorized access into managed ponds by hunters, or unauthorized access into managed ponds by boaters, hunters, anglers, or pedestrians)
- Vegetation and predator control within and near managed ponds

These activities would be highly disruptive to snowy plover breeding efforts if they occur in or near occupied habitat during the breeding season. Disturbance could cause short-term effects such as failure to breed, nest abandonment, lower numbers of eggs, juvenile abandonment, and overall lower juvenile survivorship. In areas where high-intensity disturbance is short-lived (e.g., during island or internal levee construction or replacement of water control structures), successful reproduction may not occur while the disturbance is ongoing, but may resume after construction is completed. In areas where disturbance will increase permanently as a result of the proposed action (e.g., due to the construction of trails or interpretive stations adjacent to snowy plover habitat), some plovers may acclimate to the new disturbance, while others may not.

Even with the implementation of measures to minimize disturbance near snowy plover nesting areas during the breeding season, birds that disperse away from disturbance may not successfully establish new breeding territories and breed. Snowy plovers forced to disperse would need to either maintain existing pair bonds or develop new pair bonds and establish new breeding territories in other suitable habitat areas. Loss of any females would be compounded by the loss of potential future progeny. Reduced survival of adult snowy plovers would impact the long-term viability of the population.

Disturbance during the non-breeding season, or disturbance in or near foraging habitat during the breeding season, could reduce foraging efficiency or result in increased mortality as birds are displaced to alternative foraging areas. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation.

Human activity and associated pet use will increase in areas where trails, interpretive stations, and other recreational/public access features are to be opened or improved. Interpretive displays will inform the public about the potential to disturb listed species and their habitat. The ability to manage or control potential disturbances in adjacent habitat areas from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails.

Visual and physical barriers along trails may have limited effect in deterring human or pet disturbance because they can be easily crossed. Continued dog use will be dependent upon compliance with new leash restrictions; non-compliance will result in the Service and ELER removing dog-walking from recreational use. During the non-compliant period, snowy plovers could be harmed, harassed, or killed by dogs.

To minimize impacts, work in and adjacent to potential snowy plover nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting plovers, and appropriate buffers would be provided between proposed action activities and nesting plovers. Additional conservation measures incorporated into the proposed action (described previously), including the use of interpretive signage at the edges of sensitive habitat areas and seasonally closed trails, will minimize effects of human disturbance on snowy plovers.

California Least Tern

Habitat Modification

In the South Bay, recent breeding by least terns has occurred only at Hayward Regional Shoreline, where eight pairs nested in 2005 and 15 pairs in 2006 (Strong 2006), and at Pond E8A in the Eden Landing complex, where 5 pairs nested in 2007. Most least terns in the San

Francisco Bay Area currently nest in Alameda, and most foraging during the breeding season (e.g., to feed unfledged chicks) occurs north of the San Mateo Bridge. The action area for this Biological Opinion extends north to the Bay Bridge, and thus includes the majority of the least tern nesting areas in San Francisco Bay. However, with the exception of the 2007 colony in Pond E8A, the proposed action is expected to have little direct effect on least terns or their habitats in the immediate vicinity of their current nesting colonies, other than to increase the abundance of prey fish in the South Bay as a result of tidal habitat restoration within the SBSP footprint.

Least terns currently use the portion of the South Bay south of the San Mateo Bridge primarily as a post-breeding staging area in late summer. Here, least terns use salt ponds both for foraging (in lower-salinity ponds supporting fish) and for roosting (on levees, islands, and artificial structures such as boardwalks). Although large foraging concentrations are noted in salt ponds, this species frequently forages on the Bay as well.

If least terns do rely heavily on South Bay salt ponds for foraging habitat, the loss of this habitat due to tidal restoration would likely lead to a redistribution of foraging birds in the San Francisco Bay Area. Foraging habitat for least terns in deeper-water managed ponds is expected to decline due to the conversion of some deeper-water managed ponds to tidal or shallow-water habitats. The proportion of pond habitat managed for small migratory shorebirds and snowy plovers is likely to increase as tidal restoration increases, and shallow-water ponds managed for these shorebirds will not provide high-quality foraging habitat for least terns. Thus, foraging habitat for least terns within managed ponds is expected to decline as restoration proceeds.

However, tidal restoration is anticipated to benefit the least tern. Ponds that have been restored to tidal action, but that have not yet achieved elevations suitable for colonization by vegetation, will provide foraging habitat for least terns at high tide. The extent of subtidal habitat (which serves as potential foraging habitat for least terns throughout the tidal cycle) in tidal sloughs will increase as more ponds are restored to tidal action. Additionally, tidal marsh restoration is expected to increase fish populations in the South Bay. Tidal marsh improvements are anticipated to increase nursery areas for fish eaten by least terns and other species.

It is expected that ample roosting habitat for least terns will continue to be present on islands, levees, and boardwalks in the South Bay, regardless of the restoration alternative. It is highly unlikely that this species' Bay Area populations are limited by South Bay foraging habitat, due to the relatively low breeding abundance of the species and the extensive nature of foraging habitat. Least terns "displaced" from current South Bay foraging locations within managed ponds are expected to find alternative foraging areas, either within the South Bay or elsewhere in the Bay Area.

However, because the degree to which a reduction in foraging habitat in ponds will be offset by increases in habitat and prey abundance in the Bay and in restored sloughs is unknown, monitoring and adaptive management will be implemented to ensure that proposed action activities do not result in a net adverse effect on least terns. Monitoring of numbers of breeding least terns in the Bay Area, and least tern numbers at post-breeding staging areas, will be compared to baseline levels to determine whether (and where) any declines occur. Adaptive management triggers will include a decline (relative to the baseline) in least tern breeding abundance in the Bay Area in any given year, as determined by annual monitoring of numbers at breeding colonies, or any substantial declines in least tern numbers at post-breeding staging areas in the South Bay, either in monthly bird survey monitoring data or in incidental reports (e.g., from birders). If either of these triggers is tripped, all available monitoring data for the South Bay, Bay Area, and entire population of least terns will be analyzed to determine whether declines are likely the result of the proposed action, or the result of factors external to the proposed action. If there is evidence to suggest that declines are the result of the proposed action (e.g., if a decline in breeding numbers is noted the year following the conversion of favored staging ponds to tidal habitats), the AMP calls for applied studies of post-breeding habitat use. Based on the results of these studies, changes in management of existing ponds (e.g., to make them shallower or deeper, or lower-salinity, in order to increase prey fish numbers and availability) and possibly adjustments in restoration design (e.g., to avoid conversion of favored ponds to tidal habitats) will be considered to reverse declines.

Thus, over the life of the proposed action, any adverse effects on least terns are expected to be minor and short-term, and there is the potential for an increase in habitat quality for postbreeding least terns in the South Bay as a result of the proposed action.

Direct Loss of Individuals, Nests, Eggs, and Young

The least tern presently nests in the immediate proposed action area at Pond E8A, where 5 pairs of least terns attempted to breed in pond E8A in 2007 and 2 nests were observed in 2008 (C. Robinson pers. comm.), although the nests were depredated soon after initiation. This species had not previously nested in the immediate proposed action area since 1983. Because least terns are nesting in proposed action ponds, and because the proposed action will create and manage large numbers of nesting islands for Forster's terns, snowy plovers, and other birds, there is potential for least terns to nest more widely in the immediate proposed action footprint in the future. The provision of nesting habitat itself is expected to offset any adverse effects on nesting terns that may occur, since only 5 pairs are nesting in a single location under baseline conditions. Nevertheless, if least terns continue to breed within managed ponds in the proposed action area, a number of activities associated with the proposed action could potentially cause direct mortality or injury of least tern nests, eggs, and young. Examples of activities that could result in eggs or chicks being crushed, trampled, or buried include the following activities:

- Grading and nesting island creation, management, and maintenance within reconfigured managed ponds
- Incidental displacement of sediment into nesting or brooding habitat during breaching, lowering, and maintenance of sections of existing outboard levees; removal or replacement of existing water control structures or installation of new ones; and reconfiguration of culvert connections
- Constructing trails, viewing platforms, and interpretive stations
- Levee breaching, maintenance, modification, armoring, or construction
- Walking or driving along levees or through ponds during facilities inspections and maintenance, surveys, and monitoring and research efforts

- Recreational access (e.g., authorized use of levees by pedestrians, or unauthorized access into managed ponds by anglers or pedestrians)
- Vegetation and predator control within managed ponds

In addition, eggs (and possibly very small young, if they are unable to swim to terrestrial refugia) may be lost if occupied nesting habitat is flooded as a result of the following activities:

- Breaching levees to restore tidal action to ponds
- Raising water levels during pond management
- Providing temporary floodwater storage within managed ponds to reduce flooding impacts

Water levels will be closely monitored in nesting areas for any waterbirds, and particularly close attention to water levels will be paid if water control structures are opened during the breeding season so that nests are not flooded. Nevertheless, there is some risk that nests would be flooded if monitoring of water levels is not frequent enough, or if water control structures fail and cannot be repaired before nests are flooded.

To minimize impacts to nesting least terns, work in and adjacent to potential least tern nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting terns, and appropriate buffers would be provided between proposed action activities and nesting terns.

Management of nesting habitat for least terns in close proximity to colonies of California gulls (*Larus californicus*); electrical towers providing nesting sites for common ravens (*Corvus corax*), red-tailed hawks (*Buteo jamaicensis*), peregrine falcons (*Falco peregrinus*); upland areas providing sources or predators such as cats, rats, foxes, raccoons (*Procyon lotor*), loggerhead shrikes (*Lanius ludovicianus*), white-tailed kites (*Elanus leucurus*), and American crows (*Corvus brachyrhynchus*); and landfills that attract potential avian and mammalian predators could result in nest predation.

Both mammalian and avian predator control efforts are expected to increase as part of the proposed action. Currently, mammalian predators are controlled on Service lands, and localized avian predator control is implemented at ELER where individual predators threaten snowy plover nesting areas. The need for predator control will be monitored at any new least tern nesting areas, both through monitoring of predator numbers and least tern breeding success, and predators will be removed as needed if predation on new colonies is deemed a problem.

Because most least terns in the Bay area currently nest outside of the immediate proposed action footprint, and juveniles are highly mobile by the time they disperse into the immediate proposed action area, most least terns nesting in the Bay area will not be subject to direct, physical loss of individuals due to construction, maintenance, monitoring, and recreational activities associated with the proposed action. However, breaching ponds where California gulls breed in the South Bay would result in the displacement of several large California gull colonies. These displaced gulls may select nesting sites in areas where least terns currently breed, such as Hayward Regional Shoreline, and possibly the Alameda colony. Due to the larger size of, and earlier initiation of breeding by, California gulls, and the potentially overwhelming numbers of gulls that may be prospecting for new nesting sites, least terns may be displaced from currently used nesting areas if gulls invade. California gulls displaced to sites closer to nesting least terns may also prey upon least tern eggs and chicks. Whether by predation, encroachment, or both, California gulls were thought to be responsible for the failure of the least tern nesting attempt at Hayward Regional Shoreline in 2006 (Strong 2006). Annual monitoring of least tern and California gull colonies will continue, and any encroachment of California gulls into least tern nesting areas, or observed predation by gulls on least tern eggs or chicks, will be noted. If encroachment or predation on least terns by California gulls displaced by the proposed action becomes a problem, gull control will be initiated to protect nesting least terns.

In addition, predation on least terns in their post-breeding staging areas may increase if terns are concentrated in fewer managed pond roosting sites due to conversion of some existing ponds to tidal habitats. Predation by northern harriers, which occasionally take volant least terns, may increase due to the expected increase in northern harrier populations as their marsh nesting habitat increases. Nevertheless, any increases in predation of least terns due to proposed action activities are expected to be very low, and would likely be offset by improvements in tidal foraging habitat due to restoration and increased fish populations.

Loss of Individuals and Reduced Reproductive Success due to Mercury Exposure

Because fish bio-accumulate methylmercury, and least terns eat almost exclusively small fish, there is some potential for mercury mobilized by the proposed action to adversely affect least terns. Recent sampling of mercury levels in biosentinel fish in San Francisco Bay revealed that 40 percent had mercury concentrations higher than the proposed TMDL threshold (Greenfield et al. 2006). Many of the fish sampled exceeded the proposed TMDL threshold for the least tern, suggesting that mercury accumulation may already be affecting these terns. Ongoing studies in the South Bay will provide more information on the magnitude and potential effects of mercury contamination on piscivorous species, including least terns, in the proposed action area.

Least terns are currently exposed to mercury in the South Bay by foraging on fish in contaminated tidal habitats in the Bay, and in managed ponds containing mercury-contaminated water or sediment. Proposed action activities that stir up contaminated sediments, whether in tidal habitats as described above for the clapper rail and harvest mouse or managed pond habitats as described above for the snowy plover, therefore have the potential to increase least terns' exposure to mercury. Such exposure could potentially affect the development of chicks and juveniles that ingest mercury in food taken during the nestling or post-breeding period, and may affect fecundity in adults that ingest contaminated fish.

A mercury monitoring study is currently underway to ensure that mercury impacts on biota are minimized during restoration. This study focuses on the Alviso area where mercury levels are known to be high, but also includes sampling sites elsewhere in the South Bay. This study is measuring mercury levels in the sediment, water column, and various sentinel species; measuring the bioavailability of inorganic mercury in sediments; measuring mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. This study will increase the understanding of mercury cycling within the proposed action area and will inform future management decisions to further minimize mercury exposure. Monitoring of mercury cycling during Phase 1 restoration and management activities will also provide information on management or restoration activities that are desirable, or that are to be avoided, in areas of high mercury concentrations. Decisions regarding restoration or management activities involving breaching and scour in a particular area will be made only after the sediments to be mobilized by such activities are tested for mercury levels, and in the context of the results of ongoing and future studies regarding the effects of mercury.

Disturbance of Individuals, Nests, and Young

Disturbance such as loud noise or the presence and movement of people, dogs, boats, and heavy equipment in or near least tern nesting, roosting, or foraging habitat may alter bird behavior in ways that result in injury, mortality, or reduced nesting success. Currently, because only a few pairs of least terns nest in only a single location in the immediate proposed action footprint, disturbance is expected to result in effects on relatively few nests, eggs, or chicks. However, where least terns are nesting within the proposed action footprint, disturbance could result in the abandonment of nests, eggs, or young, or increased predation on eggs or young as well.

Disturbance in post-breeding staging areas could result in temporary or permanent habitat loss due to the avoidance of suitable roosting or foraging sites that have intolerable levels of disturbance; a reduction in foraging efficiency if high quality foraging areas are impacted; and increased movement or flushing from cover, or altered activity patterns, that reduce energy reserves and increase predation risk.

Examples of proposed action activities that will cause such disturbance, if they occur in or near occupied least tern nesting, roosting, or foraging habitat, include the following:

- Grading and nesting island creation, management, and maintenance within reconfigured managed ponds
- Installation, removal, replacement, or maintenance of water control structures, water pumps, or fish screens
- Internal and external levee breaching, maintenance, modification, or construction
- Excavation of pilot channels and dredging of inboard and outboard channels
- Construction of trails, viewing platforms, interpretive stations, and boat launches
- Walking or driving along levees or through ponds during facilities inspections and maintenance, surveys, and monitoring and research efforts
- Recreational access (e.g., boating in tidal foraging habitat, authorized use of levees by pedestrians, or unauthorized access into managed ponds by anglers or pedestrians)
- Vegetation and predator control within and near managed ponds

These activities would be highly disruptive to least tern breeding efforts if they occur in or near occupied habitat during the breeding season. Disturbance could cause short-term effects such as failure to breed, nest abandonment, lower numbers of eggs, juvenile abandonment, and overall lower juvenile survivorship. In areas where high-intensity disturbance is short-lived (e.g., during island or internal levee construction or replacement of water control structures), successful reproduction may not occur while the disturbance is ongoing, but may resume after construction is completed. In areas where disturbance will increase permanently as a result of the proposed action (e.g., due to the construction of trails or interpretive stations adjacent to least tern habitat), some terns may acclimate to the new disturbance, while others may not.

Disturbance in or near foraging habitat could reduce foraging efficiency or result in increased mortality as birds are displaced to alternative foraging areas. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation.

Human activity and associated pet use will increase in areas where trails, interpretive stations, and other recreational/public access features are to be opened or improved. Interpretive displays will inform the public about the potential to disturb listed species and their habitat. The ability to manage or control potential disturbances in adjacent habitat areas from recreational human activity may not be effectively regulated or controlled, even with the proposed conservation measures to maintain public use and activities along the developed trails.

Visual and physical barriers along trails may have limited effect in deterring human or pet disturbance because they can be easily crossed. Continued dog use will be dependent upon compliance with new leash restrictions; non-compliance will result in the Service and ELER removing dog-walking from recreational use. During the non-compliant period, least terns could be harmed, harassed, or killed by dogs if least terns are nesting within proposed action -area ponds.

To minimize impacts, work in and adjacent to potential least tern nesting habitat would be conducted outside of the nesting season to the extent practicable. If seasonal avoidance is not possible, pre-construction surveys would be conducted for nesting terns, and appropriate buffers would be provided between proposed action activities and nesting terns. Additional conservation measures incorporated into the proposed action (described previously), including the use of interpretive signage at the edges of sensitive habitat areas and seasonally closed trails, will minimize effects of human disturbance on this species.

California Brown Pelican

Habitat Modification

Brown pelicans in the South Bay forage primarily in subtidal and (at high tide) intertidal habitats, and many of the proposed action-area managed ponds are too shallow to provide suitable foraging habitat for these plunge divers. However, brown pelicans do forage in some low-salinity managed ponds with water several feet deep, and they roost in low numbers on levees within the salt ponds.

The effects of the proposed action on brown pelicans depend on the proposed action's effects on both abundance and availability of prey fish. Low-salinity salt ponds may concentrate fish, thus facilitating their capture by piscivorous birds. As a result, conversion of some low-salinity ponds to tidal habitats would reduce foraging habitat in managed ponds. However, tidal restoration is expected to result in a considerable increase in the abundance of estuarine fish in the South Bay, and the tidal sloughs and channels that would develop in restored marshes are expected to be used by foraging brown pelicans. As a result, habitat modification resulting from the proposed action is expected to have a net benefit to the brown pelican from perspective of foraging habitat, as the minor impacts from the loss of managed ponds would be far outweighed by the increase in fish abundance and tidal foraging habitat. Alteration of roosting habitat, which consists of internal pond levees, pilings, and open Bay waters, is not expected to limit South Bay brown pelican numbers.

Direct Loss of Individuals

There is some potential for brown pelicans to be injured or killed due to entanglement in fishing line from boaters who launch from new boat launches created by this proposed action. However, any increase in entanglement of brown pelicans in fishing line due to the proposed action is expected to be minimal.

Although there is some potential for brown pelicans to be accidentally shot by hunters, the probability of such an event is extremely low. Only small numbers of brown pelicans are typically present in the South Bay during the hunting season (October-January). The brown pelican's obvious difference in size, shape, and flight behavior make it unlikely that hunters would confuse pelicans with legally hunted waterfowl. Also, brown pelicans forage most often in the early morning and evening (Shields 2002), when most hunting occurs. Because brown pelicans in the South Bay forage primarily in open Bay waters, few pelicans are expected to be foraging in managed ponds when hunters are present. Both the Service and CDFG law enforcement staff track the number of hunters and their harvest, and monitor for impacts to non-huntable wildlife.

Loss of Individuals and Reduced Reproductive Success due to Mercury Exposure

Because fish bio-accumulate methylmercury, and brown pelicans eat almost exclusively fish, there is some potential for mercury mobilized by the proposed action to adversely affect brown pelicans. Recent sampling of mercury levels in biosentinel fish in San Francisco Bay revealed that 40 percent had mercury concentrations higher than the proposed TMDL threshold (Greenfield et al. 2006). Ongoing studies in the South Bay will provide more information on the magnitude and potential effects of mercury contamination on piscivorous species, including brown pelicans, in the proposed action area.

Brown pelicans are currently exposed to mercury in the South Bay by foraging on fish in contaminated tidal habitats in the Bay, and secondarily in managed ponds containing mercury-contaminated water or sediment. Proposed action activities that stir up contaminated sediments, whether in tidal habitats as described above for the clapper rail and harvest mouse or managed pond habitats as described above for the snowy plover, therefore have the potential to increase brown pelicans' exposure to mercury. Because brown pelicans occur in the Bay Area during their nonbreeding season, and juveniles are full-grown when they reach the Bay Area, such exposure is unlikely to result in developmental abnormalities in the individuals that directly ingest fish contaminated by South Bay mercury. However, accumulation of mercury in brown pelicans that feed in the South Bay could reduce fecundity during subsequent breeding seasons.

A mercury monitoring study is currently underway to ensure that mercury impacts on biota are minimized during restoration. This study focuses on the Alviso area where mercury levels are known to be high, but also includes sampling sites elsewhere in the South Bay. This study is measuring mercury levels in the sediment, water column, and various sentinel species; measuring the bioavailability of inorganic mercury in sediments; measuring mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. This study will increase the understanding of mercury cycling within the proposed action area and will inform future management decisions to further minimize mercury exposure. Monitoring of mercury cycling during Phase 1 restoration and management activities will also provide information on management or restoration activities that are desirable, or that are to be avoided, in areas of high mercury concentrations. Decisions regarding restoration or management activities involving breaching and scour in a particular area will be made only after the sediments to be mobilized by such activities are tested for mercury levels, and in the context of the results of ongoing and future studies regarding the effects of mercury.

Disturbance of Individuals

Disturbance such as loud noise or the presence and movement of people, dogs, boats, and heavy equipment in or near brown pelican roosting or foraging habitat may cause minor alterations of these birds' behavior. Roosting or foraging pelicans may be flushed due to proposed action -related disturbance, or may avoid suitable habitat areas due to such disturbance. Although flushing may increase the birds' energy demands, it is not expected to result in a substantial effect on any brown pelicans. Ample roosting habitat is present throughout the South Bay, and most foraging habitat within the Bay itself will remain relatively undisturbed by proposed action -related activities. Individual pelicans may be harassed (e.g., flushed from the water or from perches, such as pilings) by boaters who launch from the proposed action area, but such flushing is expected to have minimal effects on individual brown pelicans.

Interpretive signage describing closed areas and boating procedures to avoid impacts to sensitive wildlife species, both at boat launches and at the mouths of restored sloughs that are closed to boat access, will help to minimize disturbance of brown pelicans in tidal habitats. Monitoring and enforcement of hunting regulations will also determine whether modifications to hunt programs need to be made to avoid accidental shooting of brown pelicans by hunters.

Cumulative Effects of the Proposed Action

Cumulative effects include the effects of future state, tribal, local, or private actions affecting listed species and their critical habitat that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Final EIS/EIR for the proposed action contains a detailed analysis of past, present, and reasonably foreseeable future projects within the San Francisco Bay area, and having effects similar to those of the proposed action, were considered. Cumulative projects with which the proposed action would be evaluated in combination include related non-Federal projects such as construction projects proposed by local, regional, or state agencies in and around the proposed action area. These include other projects proposed by the CDFG within the proposed action area not covered by the proposed action (e.g., CDFG's ELER project); city and county development projects (e.g., new or expanded residential, commercial, or industrial development projects); local agency infrastructural projects (e.g., water or wastewater facilities improvements/construction, and flood protection projects); PG&E projects (e.g., transmission line/facilities construction and/or improvements); traffic signalization and roadway construction/improvement projects of local municipalities or Caltrans; and recreation-related projects proposed by local municipalities, Association of Bay Area Governments (ABAG), park districts, or other non-governmental agencies.

A number of reasonably foreseeable projects will involve tidal restoration in areas where pond-associated species such as the snowy plover do not occur. As a result, these restoration projects are expected to result in a net enhancement or increase of habitat for tidal marsh species such as the clapper rail and harvest mouse, without having the potential for net adverse effects on any listed species. Although some projects (e.g., utility, road, or development projects) may result in adverse effects to the listed species discussed in this biological opinion, it is expected that those impacts will have to be mitigated to satisfy CEQA, NEPA, and/or section 7 consultation requirements.

Because of the large geographic and temporal scale of the proposed action, this project will be the primary influence on clapper rail, harvest mouse, and snowy plover populations within the proposed action area. By comparison, other projects within the action area are expected to have much less effect on these species' populations in the South Bay. Although the proposed action will also have effects on the other listed species that are addressed in this biological opinion, actions associated with other projects and/or in other locations (e.g., at colony sites for the least tern and brown pelican) are expected to be the primary drivers of population sizes of these species in the action area.

In addition to the projects described above, climate change may also have cumulative effects on the species described in this biological opinion. The global average temperature has risen by approximately 0.6 degrees Centigrade during the 20th Century (IPCC 2001, 2007; Adger *et al.*2007). There is an international scientific consensus that most of the warning observed has been caused by human activities (IPCC 2001,2007; Adger *et al.* 2007), and that it is "very likely" that it is largely due to man made emissions of carbon dioxide and other greenhouse gases (Adger *et al.*2007). Ongoing climate change (Anonymous 2007; Inkley *et al.* 2004; Adger *et al.*2007; Kanter 2007) likely imperils the clapper rail, least tern, snowy plover, harvest mouse, and brown pelican and the resources necessary for their survival, since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitats and/or prey, and/or increased numbers of their predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

CONCLUSION

After reviewing the current status of the clapper rail, least tern, snowy plover, harvest mouse, and brown pelican, the environmental baseline within the proposed action area, and the effects of the proposed action, it is the Service's biological opinion that the extent of take anticipated at the programmatic level is not likely to result in jeopardy to these species. In the absence of the conservation measures listed in the Description of the Proposed Action of this biological opinion, the effects analysis above may support a conclusion of jeopardy for some of the listed species in the action area. However, this no jeopardy determination is based upon implementation of the proposed action as described in the Final EIS/EIR and Programmatic BA for the SBSP Project.

We based this determination on the following: (1) numerous conservation measures would be implemented to minimize the adverse effects on individual clapper rails, least terns, snowy plovers, harvest mice, and brown pelicans, and their habitats; and (2) restoration actions will be implemented over a 50-year period that will result in 6,800 to 11,880 acres of tidal habitat restoration and managed ponds that support these species, and is anticipated to more than compensate for the existing habitat lost identified in this PBO.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Sections 7(b)(4) and 7(o)(2) of the Act do not apply to listed plant species. However, protection of listed plants is provided to the extent that the Act requires a Federal permit for removal or reduction to possession of endangered and threatened plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, damage, or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

Due to the programmatic nature of this biological opinion, the project- and site-specific information necessary to determine the amount and extent of incidental take of listed species associated with the proposed action actions is incomplete. Therefore, the Service will initiate individual section 7 consultations for actions which may affect listed and proposed species. Future biological and/or conference opinions that are tiered under this PBO will estimate, evaluate, and authorize the amount and extent of incidental take associated with project-specific actions. Incidental take of listed and proposed species is not authorized in this PBO.

REPORTING REQUIREMENTS

The Service shall be notified within twenty-four (24) hours of the finding of any injured or dead clapper rails, least terns, snowy plovers, harvest mice, and brown pelicans, or any unanticipated harm to their habitat as a result of project activities. Any injured listed species shall be cared for by a licensed veterinarian or other qualified person such as a Refuge biologist. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact is Chris Nagano, Deputy Assistant Field Supervisor, Endangered Species Program in the Sacramento Fish and Wildlife Office (916) 414-6600. Any dead or injured specimen shall be preserved according to standard museum practices and deposited at an appropriate academic institution approved by the Service, or with the Service's Division of Law Enforcement, 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (916) 414-6660.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. We make the following conservation recommendations:

1. Encourage or require the use of appropriate California native species in re-vegetation and habitat enhancement efforts associated with any projects authorized by the Service.
2. Facilitate additional educational programs geared toward the importance and conservation of tidal marsh and seasonal wetlands.
3. Assist the Service in implementing recovery actions being developed for the clapper rail, least tern, snowy plover, harvest mouse, and brown pelican.
4. Sightings of any listed or sensitive species should be reported to the California Natural Diversity Database of the CDFG. A copy of the reporting form and a topographic map clearly marked with the location where the individuals were observed should also be provided to the Service.

REINITIATION – CLOSING STATEMENT

This concludes formal consultation on the proposed Programmatic South Bay Salt Pond Restoration Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Any reinitiation of consultation would be expected to result in supplemental biological opinions, which could be appended to this PBO.

PHASE 1 BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

Proposed Ravenswood Pond SF2 Restoration Action

Ravenswood Pond SF2 (Pond SF2) will be reconfigured to create islands for nesting least terns and shorebirds and shallow water habitat that will be managed for shorebird foraging. The final design for the site includes three management cells (Figure 2 in the *Final Biological Assessment for the Ravenswood Pond SF2 Restoration Action* (Pond SF2 BA)). Nesting islands would be constructed in the central and eastern cells and water levels will be managed to provide optimal depths for foraging. The third, western-most cell will be managed as a seasonal wetland (open water conditions during the winter months, shallow water conditions in the spring and fall, and dry conditions during the summer months). Water control structures will be used both to manage water levels and flows into and out of Pond SF2 from the San Francisco Bay (Bay), and between cells, for shorebird foraging habitat and to meet water quality objectives. Water would flow into and out of Pond SF2 through a new water control structure comprising five 4-foot inlet culverts that will be located near the southern end of the bayfront levee between Pond SF2 and the Bay. Weirs with adjustable flashboard risers (flashboard weirs) will be used to control flow in and out of cells, and water circulation through the bay front cell in Pond SF2 would be managed to meet water quality targets at the discharge point.

Additionally, the Pond SF2 design will incorporate recreation and public access elements, including trails and interpretative displays (Figure 2 in the Pond SF2 BA). The design elements within Pond SF2 will be the subject of an applied study which will test the effects of different island spacing and shapes on use by and reproductive success of nesting birds, as well as use by roosting birds. In addition, different water management regimes will be tested to determine the best method for managing the pond for the target wildlife during both the bird breeding and non-breeding seasons. Approximately 300 to 600-foot buffers have been built in to the design to limit the impacts of recreational activities on nesting and roosting birds.

Project Location

Pond SF2 is adjacent to the Dumbarton Bridge (Highway 84) and the Bay. Pond SF2 is bordered by diked marsh to the southwest and the southeast, and a small section of upland habitat borders the pond to the south. The northeast portion of the pond borders a narrow fringe marsh along the Bay. The north portion of the pond is bordered by a paved public access trail, an access road, and the Dumbarton Bridge, while the East Palo Alto section of University Avenue borders the west side. Pond SF2 is mostly owned by the Service and is currently managed as a seasonal pond. Cargill retains a small parcel around its Trans-bay pump in the northwest corner of the pond. In addition, the Midpeninsula Regional Open Space District owns a short section of the bayfront levee between the Highway 84 frontage road and the adjacent tidal marsh.

Proposed Design Elements

The Pond SF2 design includes the following features intended to create islands for nesting birds and shallow water habitat for shorebird foraging, as well as compatible public access features:

- Nesting islands
- Earth berms
- Pilot channels
- Water control structures
- Borrow ditch filling
- Levees
- Revegetation
- Infrastructure
- Public utilities protection
- Recreation

These features are described in more detail in the following sections.

Nesting Islands. Up to 36 nesting islands would be constructed within Pond SF2 management cells by depositing and contouring soil to form several different island designs. Material needed to construct islands will be borrowed onsite, with a minimum 20-foot bench left between the borrow area and toe of the new island (the width of the borrow area will be limited to a maximum of 80 feet from this bench). It is estimated that due to soil characteristics, the windward slope of the island may need to be 5:1 or flatter to maintain a stable slope. Currently, 18 circular islands and 18 linear islands are proposed in Pond SF2. The islands will be constructed by creating a fill height of 4.5 feet above existing grade (approximately 4 feet above the average water level assuming an average water depth of 6 inches) requiring at least two soil lifts with some wait time in between.

These islands are being designed as nesting habitat for Forster's terns (*Sterna forsteri*), Caspian terns (*Sterna caspia*), American avocets (*Recurvirostra americana*), and black-necked stilts (*Himantopus mexicanus*), modeled after existing islands currently used by these species in California's Central Valley and the Bay. Although the islands are not designed specifically for use by snowy plovers or least terns, it is possible that these species could initiate nesting on the islands. Snowy plovers have nested on the dry pond bottom of Pond SF2 for the past few years, but least tern nesting has never been documented in this pond. To avoid potential human disturbance to nesting birds, including snowy plovers and least terns, nesting islands would not be constructed within 300 feet of a PG&E boardwalk or public use trail, or 600 feet from public access viewing platform locations.

Earth Berms. Approximately 10,000 linear feet of berms will be constructed to a crest of 8 feet North American Vertical Datum (NAVD) (approximately 2 to 5 feet above the existing grade) to create three cells in Pond SF2 by constructing low "check" berms around the cells, ranging in height from approximately 2 to 6 feet above the pond bottoms. The berms would be constructed by excavating fill material on-site. Fill placement is expected to require at least two fill lifts with wait time in between, which may require at least two construction seasons. Filter fabric use will reduce the amount of fill required to reach the finished grade. Pond bottom elevations vary by approximately 0.5 feet and slope toward the southwest corner of Pond SF2. Berms would be placed to separate higher elevation pond areas from lower elevation areas; allow water levels to vary between different cells; and create cells with similar shallow water depths over the sloping pond bottom. The berm and cell system in Pond SF2 would facilitate water flows throughout this elongated pond, which may result in improved water quality by preventing water stagnation in low elevation areas of the pond. Water depths in the central and eastern portions of Pond SF2 would be managed from approximately 2 inches to 1 foot deep to provide foraging habitat for both smaller and larger shorebirds and potentially dabbling ducks. Water would be circulated into and between cells to maintain good foraging opportunities for target bird species.

Pilot Channels. Pilot channels will be excavated to the Bay through the fringe marsh outboard of the new water control structures in the Pond SF2 levee to facilitate flow of water into and out of the pond. Each pilot channel will be about 1,000 feet in length. The invert elevation through the outboard marsh will be negative (-) 1.5 feet NAVD and the invert elevation across the mudflat will be 0.5 feet NAVD. The bottom width of the pilot channels will be approximately 40 feet through the outboard marsh and 50 feet across the mudflat. Material excavated from the pilot channels will be placed within Pond SF2 or disposed off-site. Within Pond SF2, material will be placed in the borrow ditch, inboard of the bayfront levee. Material may also be placed on the pond bed (e.g., lower elevation areas in the southern portions of the cells). Except in locations where the material may be used to construct berms or islands, material will not be placed above elevation 5.0 feet NAVD.

Water Control Structures. Water control structures for the Pond SF2 restoration will include culverts and flashboard weirs. The new Pond SF2 intake structure between the Bay and Pond SF2 will be located near the southern end of the bayfront levee. The intake structure will consist of five new 4-foot intake culverts with combination slide/flap gates on each end of the culvert. Six new 4-foot outlet culverts, with combination slide/flap gates on both ends of each culvert will be installed between the Bay and Pond SF2. Water would flow out of Pond SF2 during low tides through the outlet structure located in the northern portion of the bayfront levee. Within Pond SF2, intake and outlet canals would be created to convey flow into and out of individual cells. The canals would be located along the northwest edge of the pond and the southeast edge of the pond in portions of the deep existing borrow ditch. The seasonal wetland area will have one intake and one outlet structure. The intake structure will consist of four 4-foot long flashboard weirs while the outlet structure will consist of one culvert with a flashboard weir box on the seasonal wetland area side and a tide gate on the outlet canal side (to prevent the outlet canal from flowing into the seasonal wetland area during high tides). In addition to the cell intake and outlet weir structures, four cell outlet culvert structures will be located where the berms cross deeper, historic channels and borrow ditches (giving a total of five of these structures including the seasonal wetland area outlet structure). These culvert structures are included to drain deeper water from these channels for periodic maintenance and as a water quality management approach. Water would be circulated through the cells in Pond SF2 at rates sufficient to meet water quality objectives. The water quality objectives for Pond SF2 would be to maintain adequate dissolved oxygen (DO) levels, salinity, and pH in the cells and at the outlet structure.

Borrow Ditch Filling. Imported fill material will be used to fill the existing borrow ditch on the east side of Pond SF2 (inboard of the bayfront levee), if and when fill material of acceptable quality is readily available. Material excavated from the pilot channels may also be placed in borrow areas. New borrow areas excavated to construct nesting islands and earth berms may also be filled. Filling these areas may create additional shallow water foraging area and improve water quality. Only borrow ditches serving as intake and outlet canals (see above) would be retained. Filling borrow ditches within the cells is expected to improve water quality by reducing the potential for water column stratification and hypoxic conditions in the bottom layer. The borrow ditches will be filled in stages through an adaptive management process, involving filling different sections of the borrow ditches to different elevations. Water quality monitoring will be conducted in borrow ditches filled to different elevations (or not filled) to evaluate the effectiveness of using borrow ditch fill to improve water quality.

Levees. Approximately 3,650 linear feet of the bayfront levee/trail from the northeast corner of the pond to the viewing platform on the southeast side of the pond will be raised and widened. Imported fill material will be used to raise the levee crest elevation to 12.5 feet NAVD (approximately 1 to 2 feet above the existing crest elevation, which has an average elevation of approximately 10.5 feet NAVD).

Revegetation. The perimeter of Pond SF2 will be actively revegetated to increase the aesthetics of the area while providing some limited habitat values and an additional buffer from anthropogenic disturbances along the trail and the adjacent highway. A symbolic post-and-cable fence will be included in the design to further minimize intrusion into the managed pond area.

This transitional zone will be actively planted with native upland grasses and high marsh species such as sea lavender (*Limonium californicum*), pickleweed (*Sarcocarnia pacifica*, formerly *Salicornia virginica*), alkali heath (*Frankenia salina*), salt grass (*Distichlis spicata*), and marsh gumplant (*Grindelia stricta* var. *angustifolia*). Measures would be taken to favor the growth of native species and limit the competitive advantage of invasive species, such as pepperweed (*Lepidium latifolium*), Russian thistle (*Salsola soda*), stinkwort (*Dittrichia graveolens*) and fennel (*Foeniculum vulgare*), which could otherwise thrive. These measures could include amending the soils or other steps, such as mulching which helps to define the planting areas and suppress weed growth. Establishing native vegetation in this area would also reduce the potential seed source of the non-native invasive species, which is important for the long-term vegetation maintenance of the constructed nesting islands within Pond SF2.

Installation and irrigation detailed design of these elements will be developed with the intention of having volunteers perform the installation. Coordination with volunteer organizations such as Save the Bay is currently underway to ensure project success. Additional species and project elements may arise out of future coordination.

Infrastructure. *Cargill Salt Division.* Cargill's existing 36-inch siphon between Ponds SF2 and R2 to the north, and a pipe that runs along the northwest edge of Pond SF2, connecting the siphon to the Transbay Pipeline will remain. This section of connecting pipe is buried on the edge of the Pond SF2, in the shoulder of the existing bike trail and levee, and daylights at the northeast corner of the pond before connecting to the Transbay Pipeline. The Transbay Pipeline connects the West Bay (Redwood City) salt ponds to Cargill's Newark plant in the East Bay. Cargill expects to decommission the West Bay salt ponds and these pipes in approximately 5 years. To allow Cargill access for pipeline maintenance at the Transbay Pipeline, the proposed action would create a bermed area in the northeast corner of the pond. The proposed action is not expected to affect Cargill's access to the siphon and buried pipe. Once Cargill's operations are decommissioned, the existing siphon may be reconfigured to provide tidal flow between Pond SF2 and Ravenswood Slough.

PG&E. The proposed action is not expected to affect PG&E's access to the existing PG&E power towers because the restoration includes maintaining the area with the towers and boardwalk as seasonal wetland. A section of the existing PG&E boardwalk, approximately 35 feet in length, will be modified to construct the seasonal wetland ditch and allow access over the ditch.

Recreation. Recreation activities include upgrading the existing Bay Trail spur along the bayside of Pond SF2, installing chemical toilets enclosed in an all-weather shelter and an informational kiosk with adjacent seating at the Pond SF2 trailhead, construction of two viewing platforms and interpretative stations along the upgraded Bay Trail spur, and construction of the Bayfront Park (City of Menlo Park) viewing area located at the high elevation point in the northeastern corner of Bayfront Park.

The public access and recreation plan for this area includes an upgrade of the existing Bay Trail spur along the bay front of Pond SF2, and the construction of two viewing platforms and interpretive stations along this trail that describe the restoration process of developing a managed pond as well as the relationship to the Bay and future tidal marsh restoration in this location (Figure 2 in the Pond SF2 BA). The rehabilitated trail will be incorporated within the existing levee and the process will involve regrading and resurfacing for Americans with Disabilities Act (ADA) compliance. The trail follows an existing levee that would be rehabilitated to provide a width of 6 to 8 feet of compacted earth, allowing multi-use but excluding equestrians. The viewing platforms would be raised above the existing grade of the levee trail to allow visitors a panoramic view of the Bay and the large expanse of adjacent managed ponds.

The existing piles of discarded materials and unused or broken structures around Pond SF2 would be removed to visually enhance the area, and transitional plantings between the highway corridor and the adjacent restoration lands would be provided (see *Revegetation* above). In addition, a low fence will be built before revegetation on the levee to provide an additional buffer for wildlife against recreation and vehicle traffic along Highway 84 and University Avenue, the northern and western perimeters of Pond SF2.

Pond SF2 Viewing Platform East. The first viewing platform is located at the eastern edge of Pond SF2, off the rehabilitated levee trail at the edge of the pond. Providing views towards the managed pond in the west and the Bay in the east, the platform is located close to the levee edge over the pond to allow vehicular traffic to pass. To minimize impacts to the pond the platform will be raised 4 feet above the existing grade of the levee. The platform is accessed by an ADA-compliant ramp and a set of stairs, which are configured to minimize circulation areas while maximizing useable gathering space and viewing edges. A railing system will be designed for safety and to facilitate a comfortable birding experience. The use of cable wires provides more un-interrupted views and makes the structure appear lighter and thus less intrusive in the relatively open landscape.

An interpretive station and seating is also provided. The interpretive station follows the design prototype being used at Eden Landing and Alviso with a view portal, educational symbols and storyboarding, and be constructed of a combination of wood and steel and sized based on the site location. The station will describe the process of developing and maintaining a managed pond, as well as the value of this management to native wildlife and the relationship to future SBSP Project tidal marsh restoration.

Pond SF2 Viewing Platform South. The second viewing platform is located at the southern edge of Pond SF2, off the rehabilitated levee trail on its pond edge. The platform is strategically located to be at the transition between the managed pond and tidal habitats. The platform is similar in design and configuration to that at the eastern edge and incorporates all of the same amenities and interpretive opportunities.

Access for Construction

Access to Pond SF2 for both workers and equipment will be off of Highway 84. Equipment will be transported to the site on trucks via existing levee roads. Water-based access will be through the Bay. However, since high site elevations may preclude the use of floating equipment for many construction activities, construction of temporary earth embankments may be required to allow pond access for land-based heavy equipment for construction of internal site features such as islands and berms.

Construction Process

Equipment and personnel to be used during construction will generally be as described in the PBO. Due to the location of the Pond SF2 restoration project, construction methods, equipment, and access are more constrained than at a typical construction site. To assist with construction access and methods, Pond SF2 may be drained prior to construction. Draining the pond may incrementally consolidate the surface mud, increasing workability for fill operations. The use of traditional construction equipment is not expected to be feasible for the construction of berms and nesting islands within the ponds. Low-ground pressure equipment and mats and/or amphibious construction equipment are expected to be required. Site observations indicate that, due to the relatively high elevation of the site and low summer water levels, the thickness of desiccated, firm surface mud is greater than typical in some other former salt ponds. This indicates that special, low ground pressure equipment on mats may be able to work effectively. However, we presume amphibious equipment will likely be used. Marine construction equipment such as shallow-draft barges will be allowed within the pond, but may not be feasible because the high elevation of the pond may limit the water level and draft in the pond. Marine equipment is expected to be required to excavate the pilot channels.

Islands and berms will be the primary earthwork components of the Pond SF2 restoration. Borrow material varies in this location and is not always optimal for earthwork construction. If pond draining and drying are insufficient, borrow material may have a high water content. Due to this and other soil characteristics, material may be prone to slumping during construction. Therefore, material will need to be placed in a minimum of two lifts, with wait time in-between. Cargill has achieved approximately 18 inches per lift in previous, similar island and levee construction. Any new island and berm heights will need to be over-built 20 percent or more to allow for settling after construction.

Culvert pipe water control structures in existing levees will be installed by cutting a trench in the levee. Culvert pipes will be placed directly onto bay mud to eliminate a possible source of piping and soil loss experience in some ISP structures. Construction of inlet and outlet structures will be accomplished using traditional land-based construction equipment. Backfill will be compacted in lifts. Wood headwalls and wingwalls on either side of the levee will be supported by wood piles. Sheetpile cofferdams will be needed on the bay side of the structures. The need for limited dewatering is anticipated while the trench is open. The presence of a granular Bay sediment layer (i.e., sand layer) near the invert elevation of the culverts will require further consideration in final design.

Pre-cast concrete flashboard weirs will be placed in new berms within Pond SF2. Cell water control structures will likely require amphibious equipment or barges for construction. Construction may take place in the "wet" without dewatering. Compaction of fill material will likely not be possible. The contractor will determine whether flashboard weirs are placed first and the berm built around them, or vice versa.

Construction Preparation

- Water control will be necessary to drain the site for land-based equipment and/or maintain depth for floating equipment.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see access section).
- Sheet pile will be installed around the water control structure locations and construction area will be de-watered with portable pumps.

Design Element Construction Details

- Construct low check berms to create a series of three cells. Check berms will range in height from approximately 2 to 5 feet. The berms will be constructed by excavating fill material on-site.

- Install water control structures, such as flashboard weirs, in the berms to regulate flow into and out of the cells.
- Install new intake/outlet water control structures with tide gates between the Bay and Pond SF2.
- Install simple water control structures, such as flashboard risers, in the check berms to convey water in and out of cells.
- Construct intake and outlet canals to convey water to and from individual cells.
- Construct up to 36 nesting islands (18 circular and 18 linear, varying in density) within two cells. Each island will be approximately 3 feet high and have a surface area of approximately 15,000 square feet. The islands will be constructed using fill material excavated from the windward side of the islands.
- Construct viewing platforms between 5 to 10 feet above the existing grade of the levee using steel and recycled wood with ramps and railings as needed.
- Construct a fence along the western and northern borders of the pond to create a buffer for wildlife from recreation and vehicle traffic.
- Raise and widen bayfront levee/trail as a levee maintenance measure and to improve the levee surface for a public access trail.
- Revegetate the northern perimeter of Pond SF2, along the slope between the trail and the intake canal, with native high marsh vegetation.
- Manage water levels to provide an average depth of 6 to 12 inches, though with some deeper areas around islands, in borrow ditches, and in other portions of the pond.

Construction Schedule

Restoration construction is expected to occur over two seasons within a 24-month period, unless an additional construction period is required to place additional soil for berms and/or islands. The construction schedule and duration will be determined as the design elements are finalized. Nesting birds in the area will be the primary factor that will dictate the window of time during which construction may occur. Unless measures are implemented to prevent sensitive species from nesting in the project area, the timing of construction (construction window) will avoid impacts to nesting listed species, such as snowy plovers, and other sensitive species, including terns, avocets, and stilts.

Snowy plovers may move around during the breeding season, and can have two broods per season, occasionally having chicks into August or early September. In general the snowy plover breeding season extends from 1 March through 14 September. If the pond needs to be dry during work, some sort of hazing, beginning prior to nesting, may be employed to try to prevent nesting. Once the pond is dry, pre-construction surveys will be performed before work begins to make sure that no snowy plovers (or other nesting birds, such as recurvirostrids) will be disturbed. Using disturbance-free buffers (600 feet) around active nests might be acceptable if there are few nests (allowing the work to occur outside the buffers). After the snowy plovers have chicks, work on portions of the pond can be performed as long as the chicks are able to move well away from the work area and safely forage (possibly with some monitoring to ensure that the snowy plovers stay away from the work area).

Construction activities in the seasonal wetland area will occur between September 20 and February 1. Inundating the pond between February 1 and September 20 can occur only if pre-construction surveys (and monitoring, if snowy plovers are detected within the pond) determine that no snowy plovers are actively nesting within the pond (i.e., there are no nests with eggs) and all young have fledged. Start dates between February 1 and September 1 for construction activities that do not involve inundating the pond will be allowed only if pre-construction surveys and monitoring determine that no snowy plovers are actively nesting within the pond and all young have fledged, or that active nest sites with eggs are located more than 600 feet from the construction site. After the snowy plovers have chicks, work in specific portions of the pond, not involving inundating the pond, can be performed as long as the chicks are able to move well away from the work area and safely forage (possibly with some monitoring to ensure that the snowy plovers stay away from the work area).

Most nesting Forster's terns, avocets, and stilts typically finish nesting by August 1 in most years, but a few late pairs may have young through August. Construction activities in tern, avocet, and stilt nesting areas will generally occur between September 1 and February 1. Inundating the pond between February 1 and September 1 (during the nesting season) can occur only if pre-construction surveys determine that no terns, avocets, or stilts are actively nesting within the pond and all young have fledged, or if it is determined (in consultation with the Service and CDFG) that inundation will not adversely affect any terns, avocets, or stilts that are nesting on existing islands within the pond. Start dates between February 1 and September 1 for construction activities that do not involve inundating the pond will be allowed only if pre-construction surveys determine that no terns, avocets, or stilts are actively nesting within the pond and all young have fledged, or that active nest sites are located more than 300 feet from the construction site.

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key uncertainties related to ecosystem restoration. Specific applied studies that may be conducted in Pond SF2 include studies to test the effects of island density, shape, and distribution on bird nesting use and reproductive success. Additional studies may be performed to study the effectiveness of management approaches to control vegetation encroachment on the nesting islands and shallow water foraging areas and to control mammalian and avian predation on listed species. Additional applied studies will be implemented as part of Phase 1 to look at the potential impacts of landside public access on birds or other target species within Pond SF2.

SF2 Action Area

The action area for Pond SF2 activities includes: (1) Pond SF2 and adjacent outboard marshes and mudflats; (2) access roads adjacent to the Dumbarton Bridge; (3) diked marsh to the southwest and southeast of Pond SF2; (4) portions of Bay that will be affected by discharge of water or sediment from Pond SF2 during construction and pond operation or that will be traversed by water-based equipment accessing Pond SF2; (5) and any other areas in the immediate vicinity of Pond SF2 that could be directly or indirectly affected by noise, dust, or other factors resulting from the proposed action.

Proposed Eden Landing Pond E12-E13 Restoration Action

Eden Landing Ponds E12 and E13 (Pond E12 and E13) will be reconfigured and managed to create 230 acres of high quality shallow water foraging areas at varying salinities, as well as six nesting and roosting islands (Figure 2 in the Pond E12 and 13 BA). This will include the operation of a new water pump, installation of four new water control structures, development of an internal water circulation system using a series of small levees (berms) and small flashboard weirs, and the construction of six nesting and roosting islands. Ponds E12 and E13 will be divided into seven total cells, with six cells in tandem managed for progressively increasing salinity levels in each paired set of cells. Of the six cells, two cells will be managed to maintain low salinity levels (approximately 20 to 40 parts per thousand (ppt) similar to Bay salinity levels; two cells will be managed to maintain moderate salinity levels (approximately 40 to 80 ppt); and the remaining two cells will be managed to maintain high salinity levels (approximately 80 to 120 ppt) during the dry season. Salinities of these ponds will decrease in the rainy season depending upon the amount and timing of rainfall. However, these same general salinity ranges will continue to be the targets throughout the year. The water depths within each cell will be managed to provide optimal shallow water habitat for shorebird foraging. One island will be constructed in each of the six cells to create habitat for nesting birds. The seventh cell is a muted tidal mixing basin designed to reduce water salinities prior to discharge. Consistent with the adaptive management approach of the SBSP Project, Ponds E12 and E13 allow for multiple flow paths and management flexibility.

In addition, trails and viewing areas will be constructed around these ponds (Figure 3 in the Pond E12 and 13 BA). Both year-round and seasonal trails will link to the Bay Trail spine segment that will be constructed as part of an earlier Eden Landing Ecological Reserve (ELER) Restoration Project, a separate project which borders the northern perimeter of the pond complex. This segment connects the Bay Trail spine from the north along Highway 92 and the Hayward Regional Shoreline (East Bay Regional Parks District) to the east and south towards Union City and Coyote Hills Regional Park. The historic Oliver Salt Works will be accessible to the public by the new trail, and will be open year-round. A viewing platform with an interpretive station will be designed to tell the history of the salt works at this location, explain how salt is produced, and explain the salt work's cultural, economic, and social linkage to the greater Bay Area.

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key project uncertainties related to ecosystem restoration. Additional studies and future research projects may be conducted as the results of monitoring and initial applied studies indicate areas that are in need of future research. The primary design criteria for Ponds E12 and E13 was to test the effects of salinity (low, moderate, or high) on shorebird species composition and density utilizing the ponds, on foraging behavior by these birds, and on the species composition and density of the prey on which these shorebirds feed. Other applied studies will test the effects of trail use on shorebirds using Pond E12 and E13 foraging habitats.

Project Location

Ponds E12 and E13 are part of the ELER, which is owned and managed by CDFG. ELER is located to the south of Highway 92 (and the San Mateo Bridge) in Hayward, on the east side of the Bay. Pond E12 is bordered on the south by Pond E13 and on the north and east by Mount Eden Creek. Pond E13 is bordered by Pond E12 to the north, Mount Eden Creek to the west and pond E14 to the south. Both of these ponds are currently managed as seasonal ponds.

Proposed Design Elements

The Pond E12 and E13 design includes the following features intended to create shallow water foraging habitat for migratory shorebirds, with a range of salinities, and six islands for nesting and roosting waterbird habitat:

- Earth berms
- Islands
- Levees
- Water control structures
- Pilot channel
- Recreation

These features are described in more detail in the following sections.

Earth Berms. Earth berms (small levees) will be constructed in Ponds E12 and E13 to create a distribution canal, six managed cells (three in each pond), a discharge mixing basin, and to segregate the historic Oliver Salt Works area (Figure 2a in the Pond E8A-E9-E8X BA). As part of the Ponds E8A, E8X, and E9 restoration (see *Proposed Eden Landing Pond E8A-E8X-E9 Restoration Action* below), the first lift of the east-west berm between Pond E12 and E13 will be built to facilitate snowy plover management during construction. Berm design may vary slightly between berms along the distribution channel and those between cells. One berm along the distribution channel will be approximately 10 feet wide in order to provide vehicle access, while other berm sections may be up to 6 feet wide to allow ATV access. Material needed to construct the berms will be borrowed onsite, with a minimum 10-foot bench between the borrow area and toe of the new berm. The berms will range in height from approximately 2 to 6 feet. It is estimated that berm side slopes will also need to be 5:1 or flatter. Due to possible berm settlement, maintenance may be required in 5 to 10 years.

Nesting Islands. One island will be created in each of the six cells to provide nesting and roosting waterbird habitat. Nesting islands are expected to be used by avocets, stilts, Forster's terns, snowy plovers, and possibly least terns. Each island will be approximately 3 feet high, 300 feet long, and 50 feet wide. The islands will be constructed using fill material (on-site borrow) excavated from the windward side of the islands. Water depths will be deeper on the windward side and shallower on the leeward side of the islands to provide shallow water foraging habitat that is sheltered from the wind. To isolate islands from recreational trails and land-based predators, they will be at least 300 feet from outboard levees, 100 feet from internal berms, and

600 feet from the public viewing platforms and the kayak launch site.

Levees. In total, three miles of new trail may be constructed along existing levees as part of the Phase 1 public access plan at ELER. As part of the Pond E8A, E8X, and E9 actions, the existing levee between Pond E13 and Pond E14 will be re-constructed along its original alignment (see *Proposed Eden Landing Pond E8A-E8X-E9 Restoration Action* below). The levee will be improved, widened, and resurfaced to create a maintenance road, public access trail, and emergency vehicle access as part of Pond E12 and E13 restoration. The existing levee around the rest of Ponds E12 and E13 are adequate for vehicle access and recreational use. All of the trails proposed at ELER for Phase 1 actions will be 6 to 8 feet wide on an existing managed pond levee, and will have firm and stable, hardened surfacing to allow for hikers, wheelchairs and cyclists.

Water Control Structures and Pilot Channel. Water levels and flows in Ponds E12 and E13 will be managed using passive water control structures, such as concrete "rice-box" type weirs or slide flap and weir structures, with supplemental pumping as needed. The elevation of the ponds gently slopes from east to west and averages 5.7 feet NAVD, which is approximately 1.3 feet below mean higher high water (MHHW). As Ponds E12 and E13 are high in elevation relative to the tides, the potential for gravity flows into the ponds is limited, especially during neap tides when high tides are below MHHW. Gravity flows will occur through new intake structures located between Mount Eden Creek and Pond E12, and between the northern extension of Pond E8X and Pond E13. The structures are still in design, but conservatively may consist of up to five new 4-foot intake culverts with combination slide/flap gates on each end of the culvert. Water from Mount Eden Creek and the pump forebay will flow into the low salinity cells. The existing Pond E13 and E14 culverts will be replaced with new water control structures with combination slide/flap gates, as it will provide overflow and/or storage capacity (if necessary) from Ponds E12 and E13.

The narrow northern extension of Pond E8X, along the eastern edge of Pond E14 will connect Ponds E12 and E13 to North Creek. The existing pump house will be fashioned with a new pump which could be used to pump water into Ponds E12 and E13 from the narrow northern extension of Pond E8X and the ELER marsh area to the east to supplement gravity as needed. The northern extension of Pond E8X will likely silt in and become vegetated if restored to tidal action; therefore, as part of Ponds E8A, E8X, and E9 restoration actions, a new culvert with tide gates will be installed between Pond E8X and the northern extension to create a managed forebay (see *Proposed Eden Landing Pond E8A-E9-E8X Restoration Action*). This pump forebay will limit tidal sedimentation and provide storage for both passive flows into Pond E13 and pumping into Ponds E12 and E13. Pond E14, located immediately south of Pond E13, may be used to provide additional storage for gravity flows and pumping into Ponds E12 and E13. Pond E14 is currently managed as a seasonal pond and is connected to Pond E13, the northern extension of Pond E8X, and Pond E9 by existing culverts.

As part of the Phase 1 actions at ELER, the existing culverts will be replaced with new culverts with adjustable tide gates. Pond E14 may be managed adaptively to provide seasonal or year-round pond habitat. Within Ponds E12 and E13, earth berms will be constructed to separate the ponds into six cells (see *Berms* above). Passive water control structures, such as flashboard weirs, will be used to maintain water depths ranging from approximately 2 inches to 1 foot, with an average depth of less than 6 inches, to provide shorebird foraging habitat. The shallowest areas will support smaller *Calidris* sandpipers (such as western sandpipers, *C. mauri*) and the deeper areas will support larger shorebirds. Gaps will be excavated through the existing remnant structures (wood fences separating former salt crystallizer cells) to improve circulation within the cells.

A water distribution canal will be constructed (see *Berms* above) between Ponds E12 and E13, with water control structures connecting the canal to each of the six cells, the historic salt works, and the discharge mixing basin. This distribution canal will allow bay salinity water to be pumped directly into any cell in order to dilute the higher salinity water as needed to maintain salinity targets. The canal will be created by constructing a new earth berm south of the existing borrow ditch between Ponds E12 and E13 and rebuilding the remnant levee north of the borrow ditch as needed. Part of the berm (first lift) will be built as part of the Ponds E8A, E8X, and E9 restoration, prior to Pond E12 and E13 actions, to segregate Pond E12 from E13. This will enable Pond E12 to be managed for snowy plovers during Ponds E8A, E8X, and E9 restoration actions.

The discharge mixing basin will allow managers to reduce salinity levels of water discharged from the six cells, by mixing with lower salinity water from the distribution canal. Also, the mixing basin will allow for adequate water quality parameters, including DO, to be met prior to discharge into Mount Eden Creek. The structures between the salinity cells and the mixing basin will be culverts with weir boxes and flap gates. Water will be discharged through a new outlet structure that will be installed in the Pond E13/Mount Eden Creek levee. This structure will consist of eight new 4-foot outlet culverts, with combination slide/flap gates on both ends of each culvert.

Pilot Channel. A pilot channel will be excavated through the Mount Eden Creek outboard marsh to facilitate flow. The pilot channel will be approximately 220 feet long and will have side slopes of 3:1, with a depth of approximately 8 feet. The pilot channel top width will be approximately 150 feet. The pilot channel will be excavated by either land- or water-based equipment. Excavated material will be strategically placed in nearby borrow ditches.

Recreation. Currently, no regular public access (except for restricted hunting) is allowed at the ELER. Phase 1 restoration plans for the Pond E12 and E13 project include recreational access for hikers, cyclists, kayakers and wheelchairs.

Trails. Approximately 3 miles of new year-round and seasonal trails may be constructed along existing levees as part of the Phase 1 public access plan at ELER. The existing managed pond levee between Pond E13 and Pond E14 will be improved, widened, and resurfaced to create a maintenance road, public access trail, and emergency vehicle access. The existing levee around the rest of Ponds E12 and E13 are adequate for vehicle access and recreational use. All of the trails proposed at ELER will be on an existing managed pond levees to allow for hikers, wheelchairs and cyclists. Decomposed granite surfacing will be incorporated into the existing gravel surface to create a firm and stable trail surface approximately 6 feet wide. Fencing will be installed where appropriate to prevent human disturbance to sensitive habitat areas. Dogs (*Canis lupis familiaris*) are not permitted at the reserve except for waterfowl hunting and as per CDFG regulations. The trails will be open to the public during typical hours of operation, from sun up to sun down and will include amenities along the trail such as seating.

The proposed 0.80-mile year-round trail is located along the existing levee at the north end of Pond E12, and connects the ELER staging area with the historic Oliver Salt Works Complex. The 1.50-mile year-round shoreline trail, connects the salt works with the Bay, along the southern edge of Mount Eden Creek, and will be incorporated into the existing levee. The trail will terminate at the Pond E9 breach with a viewing area (see *Shoreline Viewing Area* below). A spur trail off the main trail will provide access to the Archimedes viewing area between Ponds E13 and E14. The proposed 1.5 mile seasonal loop trail will be located along the Pond E12 and E13 levee. This trail will be subject to closure depending on the presence/absence of sensitive species during the nesting season. It will connect the historic Oliver Salt Works Complex with the Archimedes viewing area looping between Ponds E13 and E14.

Kayak Launch Site. A kayak launch area in Mount Eden Creek will be located off the main spur trail from the staging area in the northern portion of the pond complex (Figure 3 in the Pond E12 and E13 BA). A turnaround and drop-off zone will allow temporary vehicular access to the launch area. The design incorporates an 8-foot wide launch ramp and a 10-foot wide floating dock, and an ADA-compliant ramp during portions of high tide that provides access to the dock. The launch will be in an area of reduced vegetative cover with a vertical drop of approximately 6.5 feet between the existing levee and the water elevation at low tide. Interpretive signs will be incorporated at the site, as well as a seating area and launch preparation space.

Saltworks Viewing Platform. Access to the Oliver Salt Works viewing platform will be located at the northwestern edge of Pond E12, and will be situated into the salt works remains to provide uninterrupted views of the foundation remains. The platform is designed to have a long and narrow gangplank style walk which will split into easterly and westerly directions over the salt works. The platform will be elevated 3 feet above the levee trail and will be accessed by an ADA-compliant ramp. Three interpretive stations will be implemented into the platform, along with benches. The railings will be designed to provide for a comfortable bird-watching experience, while ensuring safety. Two separate viewing areas will be created at the ends of the east/west platform at different elevations and will have canopy structures placed overhead to provide shade.

Archimedes Viewing Area. A viewing area will be located on the seasonal levee trail between Ponds E13 and E14, overlooking the remains of the Archimedes screws in pond E14. The viewing area will be built at the elevation of the levee and extend into Pond E12 and E13, providing views of the Oliver Salt Works to the north and Archimedes screws to the south. Interpretive stations and seating will be provided.

Shoreline Viewing Area. A viewing area will be located at the terminus of the year-round shoreline trail, approximately 1.5 miles from the staging area. The viewing area will be an extension of the levee surface, drawing users up slightly from the existing levee elevation and providing panoramic views of the Bay and the newly breached mouth of Mount Eden Creek, which is part of the Pond E8A, E8X, and E9 restoration action. An interpretive station and seating will be located at the site.

Access for Construction

Access to the Pond E12 and E13 site for both workers and equipment will be either off Highway 92 to the Clawiter Road exit just east of the San Mateo Bridge or from Interstate 880 to the Industrial Parkway exit, proceeding west on Industrial Parkway to Arden then Clawiter Road to the ELER gate. Water based access will be through Mount Eden Creek if the creek depth allows for the equipment draft. At water access locations, hydraulic dredging may be used for pilot channel excavation

A staging area will be constructed to store and refuel construction equipment. Staging will take place in the vicinity of the proposed parking area at the north end of Pond E12 near the entry point from Eden Landing Road. Conservation measures will be followed to enclose fueling areas and limit construction impacts, in accordance with State and County requirements, and conservation measures listed in the PBO for the SBSP Project.

Construction Process

Equipment to be used and personnel requirements for the construction will generally be as described in the PBO. Due to the location of Pond E12 and E13, construction methods, equipment, and access are more constrained than at a typical construction site. Prior to construction in the Ponds E8A, E8X, or E9, a berm will be built between Pond E12 and E13 to allow for independent water management. Water control during construction will be implemented with existing and portable water pumps, which will be necessary to allow for land- and water-based equipment access. During construction, conservation practices such as silt fence, Environmentally Sensitive Area fence, and fiber rolls will be used to keep construction equipment in designated areas and prevent impacts to areas not in the designated construction zone.

Islands, berms, and levees will be the primary earthwork components of the Pond E12 and E13 restoration. It is expected that multiple lifts, beginning during the Pond E8A, E8X, E9 restoration, will be required for earthen structures. The removal of existing water control structures and installation of new structures will also be a primary component of the restoration process. Culvert pipes will be installed by cutting a trench in the levees. Culverts will be placed directly onto bay mud to eliminate a possible source of piping and soil loss experience in some ISP structures. Backfill will be compacted in lifts. Construction of inlet and outlet structures will be accomplished using traditional land-based equipment. The Mount Eden Creek pilot channel will be excavated using water- or land-based equipment and the material will be used for restoration features, such as berms. Wood headwalls and wingwalls on either side of the levee will be supported by wood piles. Sheetpile cofferdams will be needed on the bay side of structures, as well as areas on the pond side of structures that are flooded. The need for de-watering is anticipated while the trench is open.

Culverts and/or weirs will be placed in new berms within Ponds E12 and E13. Cell water control structures will likely require amphibious equipment or barges for construction. Construction may take place in the "wet" without dewatering. This may be required to eliminate snowy plovers from nesting near construction sites.

Construction preparation

- Water control will be necessary to drain the site for land-based equipment and/or maintain depth for floating equipment.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see *Access* above).

Design element construction details

- If it is determined that construction cannot be completed outside the snowy plover breeding season, Ponds E12, E13, and E14 to be flooded prior to snowy plover nesting season (1 March to 15 September) to preclude snowy plovers from nesting in or near construction areas.
- The check berms between cells will range in height from approximately 2 to 6 feet, with side slopes will also need to be 5:1 or flatter.
- Each of the six nesting islands will be approximately 3 feet high, 300 feet long, and 50 feet wide.
- A new pump will be installed in the existing pump house.
- The Mount Eden Creek pilot channel will be 220 feet long and will have side slopes of 3:1, with a depth of approximately 8 feet.
- Water control structures, such as flashboard or concrete "rice-box" weirs, will maintain water depths ranging from approximately 2 inches to 1 foot, with an average depth of less than 6 inches, to provide shorebird foraging habitat.
- Approximately 3 miles of trails may be built on existing levee; the trails will have firm and stable trail surfaces and will be approximately 6 to 8 feet in width.
- The Oliver Salt Works viewing platform will be raised 3 feet above the existing levee grade and will have three interpretive stations. The railings will be designed to provide for a comfortable bird-watching experience, while ensuring safety. Two separate viewing areas will be created at the ends of the east/west platform elevations and will have canopy structures placed overhead to provide shade.
- The kayak launch will have an 8-foot wide launch ramp and a 10-foot wide floating dock, and an ADA-compliant ramp during portions of high tide that provides access to the dock.

Construction Schedule

The contractor will be allowed to select the construction schedule and sequencing within the restrictions specified by permits. The construction schedule may depend on weather conditions and contractor's preferences. At this time, construction of the Pond E12 and E13 berm is scheduled in 2009 as part of the Pond E8A, E8X, E9 action (see *Proposed Eden Landing Pond E8A-E8X-E9 Restoration Action* below). This berm will be used to segregate Pond E12 from E13 to provide snowy plovers with nesting habitat during Pond E8A, E8X, E9 construction. The first lift for nesting islands and other berms in Ponds E12 and E13 are expected to occur in the dry season of 2010, but could begin sooner if local borrow is used, or if work is able to be done during the 2009 rainy season. The second lift for the earth berms and islands, and installation of water control structures, is expected to occur in the dry season of 2011. Construction of the trails, viewing platforms, kayak launch, and other public access components is expected to occur in 2011 or later.

As required by permits, the timing of construction (construction window) will avoid impacts to listed species, such as clapper rails, snowy plovers, and least terns, and other sensitive species including nesting birds such as avocets and stilts. Construction activities will be conducted outside the breeding season (March 1 to September 15) if practicable. If the contractor determines that work outside the plover nesting season is not possible, Ponds E12, E13, and E14 will be shallowly inundated prior to March, when snowy plover nesting selection is expected to occur, to preclude snowy plovers from nesting on the pond beds in or near the project site. Inundating ponds can occur only if pre-construction surveys determine that no snowy plovers, or other birds, are actively nesting within the pond and all young have fledged, or if it is determined (in consultation with the Service and CDFG) that inundation will not adversely affect any birds that are nesting on existing islands within the ponds. In either scenario, pre-construction surveys will confirm the presence or absence of snowy plovers in the area. If snowy plovers are located in a pond or on a levee, a 600-foot buffer will be maintained around any plover nests or chicks. Using disturbance-free buffers around active nests might be acceptable if there are few nests (allowing the work to occur outside the buffers). After the snowy plovers have chicks, work on portions of the pond can be performed as long as the chicks are able to move well away from the work area and safely forage (possibly with some monitoring to ensure that the snowy plovers stay away from the work area).

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key project uncertainties related to ecosystem restoration. Specific applied studies that may be conducted in the project area could include studies to test effects of salinity on shorebird species composition and density, on foraging behavior by these birds, and on the species composition and density of the prey on which these shorebirds feed. The nesting islands may provide some information regarding nesting bird use at the different salinity levels in the pond. Phase 1 applied studies will also include research on the effect of trail use on shorebirds using the Pond E12 and E13 foraging habitats.

Pond E12 and E13 Action Area

The action area for the Pond E12 and E13 activities includes: (1) Ponds E12, E13 and E14; (2) Mount Eden Creek; (3) portions of outboard marshes; (4) staging areas north of the Pond E12 and land-based access areas, via Eden Landing Road; (5) water-based access areas for barge-supported equipment, which will include the access route for water-based equipment; and (6) any other areas in the immediate vicinity of the project site that could be directly or indirectly affected by noise, dust, or other factors resulting from the proposed action.

Proposed Eden Landing Pond E8A-E8X-E9 Restoration Action

Eden Landing Ponds E8A, E8X, and E9 (Ponds E8A, E8X, and E9) restoration will introduce tidal action to create approximately 630 acres of tidal marsh and tidal channel habitat through levee breaching, levee lowering, and the installation of borrow ditch blocks (Figure 2a in the Pond E8A-E9-E8X BA). Tidal action will be restored to existing historic channels in the ponds by a series of outboard breaches and pilot channels, as well as internal levee breaches. An earthen levee will be constructed between Ponds E12 and E13 in order to provide habitat for snowy plovers in Pond E12, while other ponds will be flooded to dissuade snowy plovers from nesting in, and adjacent to, construction areas. Parts of levees will be lowered to create pickleweed marsh habitat, including outboard levees along Old Alameda Creek and North Creek and internal levees between Ponds E8A, E8X and E9. Depressions will be excavated in lowered internal levees to create tidal marsh pond habitat, similar to historic marsh ponds that previously existed in the area. Levee improvements will be made along the existing alignments of the Ponds E9-E8X-E14 and E13/E14 levees. The Pond E10 levee will be realigned further to the north and the Mount Eden Creek slough channel will be widened and deepened to minimize channel scour to the Pond E10 levee.

Although Ponds E8A, E8X and E9 have been diked for salt production, minimal subsidence has occurred. Because typical bed elevations of Ponds E8A, E8X, and E9 are relatively high in the tidal frame, the restoration action would likely facilitate salt marsh vegetation colonization and reoccupation of remnant tidal channels shortly after levee breaching. Over time, tidal sedimentation and the accumulation of plant biomass would raise the marsh plain to the elevation of adjacent mature marshes (approximately MHHW). The gypsum layer in Pond E8A may inhibit vegetation establishment and therefore will receive some pre-treatment to expedite marsh establishment.

Applied research studies will be implemented as part of Phase 1 of the SBSP Project to answer questions regarding key project uncertainties related to ecosystem restoration. Additional studies and future research projects may be conducted as the results of monitoring and initial applied studies indicate areas that are in need of further research. The key research questions for the pond E8A, E8X, and E9 restoration include an examination of sediment accretion in restored tidal areas, the effectiveness of marsh restoration in decreasing flood hazards, and the ecological value of tidal marsh ponds.

Project Location

The Pond E8A, E8X, and E9 complex is part of the ELER, which is owned and managed by CDFG. ELER is located to the south of Highway 92 in Hayward, on the east side of the Bay. The complex is bordered by Old Alameda Creek to the south and a tidal salt marsh (Whale's Tail Marsh) to the west. The complex is bordered by Mount Eden Creek on the northwest edge, pond E14 to the north, and North Creek to the east. Ponds E8A, E8X, and E9 are currently managed under the ISP as system ponds.

Proposed Design Elements

The Ponds E8A, E8X, and E9 design includes the following features intended to promote tidal marsh evolution:

- Levee lowering
- Earth berms
- Levee improvements
- Tidal marsh ponds
- Internal channels
- Ditch blocks
- Gypsum pre-treatment
- Water control structures
- Mount Eden Creek channel excavation
- Pilot channels
- Levee breaches (outboard and internal)

These features are described in more detail in the following sections.

Levee Lowering. Up to approximately 18,400 feet (3.5 miles) of levees may be lowered to the marsh plain elevation (MHHW or 7.0 feet NAVD). This length includes the outboard perimeter levees along Old Alameda Creek and North Creek and the internal levees between Ponds E8A, E8X, and E9. The outboard levee along Whale's Tail marsh will not be lowered; it will remain in place to limit wave transmission from the Bay into the ponds. The northwestern segment of the pond E9 levee from the Pond E9 breach to Pond E14 will not be lowered; it will be used as a portion of a public access trail (see *Proposed Eden Landing Pond E12-E13Restoration Action* above).

Material removed from levees during levee lowering will be used to construct ditch blocks, placed in borrow ditches, or used for other restoration features. In the first year of construction (Year 1), material will be excavated from the internal levees and the pond side of the outboard levees so that the outboard levees continue to prevent tidal inundation during construction. A minimum width of approximately 15 feet of the existing levee crest will be maintained in Year 1.

Levees will only be lowered to the extent necessary to provide enough fill material for the restoration of the features that are described below. Priority will be given to lowering the levees between Pond E8A and Old Alameda Creek (Pond E8A/Old Alameda Creek levee), Ponds E8A and E8X and North Creek (Ponds E8A/E8X/NC levee), Ponds E8A and E9 (Ponds E8A/E9 levee), and Ponds E9 and E8X (Ponds E9/E8X levee), respectively. Material from the Pond E8A/Old Alameda Creek and Ponds E8A/E8X/NC levees is expected to be needed for levee improvements (see *Levee Improvements* below).

Earth Berm. An earthen berm approximately 4,500 linear feet long will be constructed between Ponds E12 and E13 in order to segregate these two ponds. Over the course of Pond E8A, E8X, and E9 construction, Pond E12 will remain dry in an effort to provide some habitat for snowy plovers, while Ponds E8A, E8X, E9, E10, E13, and E14 will be flooded to dissuade snowy plovers from nesting in, or adjacent to, project construction areas.

The Pond E12 and E13 earthen berm will be built to a height of approximately 3 feet, with side slopes of approximately 5:1. An additional lift will be required during the Ponds E12 and E13 construction process (see *Proposed Eden Landing Pond E12-E13Restoration Action* above). The berm will be built on remnant material of the old Pond E12/E13 levee, with the exception of the easternmost portion, which will connect to the existing pump house to the southeast.

Levee Improvements. *Ponds E9/E8X/E14 Levee Improvement.* The Ponds E9/E8X/E14 levee will be re-constructed along its current alignment, which is approximately 6,300 feet (1.2 miles) in length. The existing levee alignment will be maintained to take advantage of the existing levee material and soil compaction. The improved levee will be constructed over 2 years to address settlement of the weak underlying bay mud. The levee will be constructed to a crest elevation of 11 feet NAVD. Up to approximately 4 feet of fill will be placed above the existing grade. The constructed levee crest elevation will include approximately 25 percent overbuild to allow for settlement to approximately 10 feet NAVD. The outboard (Ponds E9 and E8X) side slope will be approximately 7:1 or shallower and the inboard side-slope will be approximately 4:1. The levee top width will be a minimum of 8 feet and the bottom width at the pond bed will be approximately 60 feet.

The existing levee material and underlying bay mud are very weak, soft, and wet and are expected to constrain levee construction. Low ground pressure equipment and special construction techniques are expected to be required since traditional construction equipment is not expected to be feasible during the initial stages of construction. Gypsum removed from the surface of Pond E8A and/or Pond E9 (see *Gypsum Pre-treatment* below) may be used to strengthen portions of the levee sub-grade.

Fill material will be obtained from the lowering of other levees. Fill will be placed in lifts of approximately 1 to 2 feet. Each lift will have an overbuild to allow for compaction. Lifts will be compacted to a relative compaction of at least 85 percent (of the maximum compacted density). The levee will be constructed to the design dimensions in Year 1. Approximately 0.5 feet of settlement is expected to occur between the completion of construction in Year 1 and the beginning of construction in Year 2. In Year 2, the settled levee will be raised back to the design dimensions (which also includes an overbuild).

The top of the levee may be planted with native high marsh and native grass species. The preliminary design includes planting the portion of the levee above elevation 8 feet NAVD, which is an area of approximately 5.4 acres. Planting will be performed by volunteers if possible. The project team may coordinate with Save the Bay during final design to arrange the volunteer process and effort.

Ponds E13/E14 Levee Improvement. The Ponds E13/E14 levee will be re-constructed along its current alignment, which is approximately 6,000 feet (1.1 miles) in length. The existing levee alignment will be maintained to take advantage of the existing levee material and soil compaction. The Ponds E13/E14 levee design considerations and design approach are expected to be similar to those discussed above for the Ponds E9/E8X/E14 levee improvement.

The levee will be constructed to a crest elevation of 12 feet NAVD. Up to approximately 5.5 feet of fill will be placed above the existing grade. The constructed levee crest elevation will include approximately 20 percent overbuild to allow for settlement to approximately 11 feet NAVD. The levee slopes will be approximately 4:1. The levee top width will be a minimum of 10 feet and the bottom width at the pond bed will be approximately 55 feet.

Fill material will be obtained from the lowering of other levees (see *Levee Lowering* above). The levee will be constructed to the design dimensions in Year 1. Approximately 0.8 feet of settlement is expected to occur between the completion of construction in Year 1 and the beginning of construction in Year 2. In Year 2, the settled levee will be raised back to the design dimensions.

Pond E10 Levee Realignment. The segment of the Pond E10 levee downstream of the Pond E9 breach will be realigned by lowering the existing levee and constructing a new levee segment farther to the north (Figure 2a in the Pond E8A-E9-E8X BA). The Mount Eden Creek slough channel will be widened by excavating a portion of the lowered levee. The existing Mount Eden Creek breach will be widened and deepened by removing a portion of the remnant Pond E10 levee. The Mount Eden Creek slough channel will be deepened by dredging the channel bottom from the mudflat sill (bayward of the Mount Eden Creek breach) to the Pond E9 pilot channel (see *Mount Eden Creek Channel Excavations* below).

A new 1,020-foot segment will be constructed across the Pond E10 bed over the 2 years of construction. Fill material will be obtained by lowering the existing pond E10 levee and from the inboard side of a 1,200-foot segment of the levee in Year 1. All of the stockpiled material will be excavated in Year 1. The inner portion of the existing levee will be excavated down to near the pond bed elevation (approximately 5 feet NAVD). A minimum crest width of 10 feet at elevation 11 feet NAVD will remain during Year 1, with a slope of approximately 2:1 or shallower on the inboard (pond) side. Fill material will also be excavated by enlarging the Mount Eden Creek breach in Year 1 (see below). In Year 2, the remaining levee will be lowered down to the approximate mature marshplain elevation (MHHW or 7 feet NAVD).

Fill will be placed in lifts of approximately 1 to 2 feet. Each lift will have an overbuild to allow for compaction. Lifts will be compacted to a relative compaction of at least 85 percent (of the maximum compacted density). In Year 1 (first lift), approximately 6 feet of fill will be placed to construct the base of the levee to an elevation of approximately 10.5 feet NAVD. Due to the workability of the soils, placing more than about 6 feet of fill in Year 1 is expected to be difficult. Some levee settlement (about 1 foot) is expected between construction in Years 1 and 2. In Year 2, the levee will be raised to crest elevation 12.6 feet NAVD. This design crest elevation includes approximately 20 percent overbuild to allow for settlement, ultimately resulting in a crest elevation of approximately 11 feet NAVD. The outboard (Mount Eden Creek) side slope will vary from approximately 4:1 to 5:1. The inboard side-slope will vary from approximately 3:1 to 4:1. The levee base width will be approximately 80 to 90 feet.

Pond E10 may be drained through the existing Pond E10 water control structure to facilitate construction. A flap gate will be temporarily installed on the Bay side of at least one of the three culverts to allow for drainage. The other culverts will be blocked to prevent intake. It is assumed that the existing flap gates on the pond side of two of the three culverts or from the Pond E9 water control structure can be removed and installed for drainage. The wood box culvert between Ponds E10 and E11 will be closed to separate the two ponds and Pond E11 will be managed via the water control structure between Pond E11 and Mount Eden Creek.

Low ground pressure equipment is expected to be required. The preliminary design includes placement of geofabric on the levee subgrade to enhance the ability to place fill.

Tidal Marsh Ponds. Eight tidal marsh ponds, in addition to the existing pond feature adjacent to Old Alameda Creek, will be excavated in the lowered levee between Ponds E8A and E9 (Figure 2a in the Pond E8A-E9-E8X BA). Four different combinations, of two ponds each, of adjacent marsh plain elevation and pond depth will be excavated from the levee. The differing pond characteristics will be used to test if constructed tidal marsh ponds will remain as ponds, or ultimately become vegetated and form higher marshes. Subsequent bird use of these tidal marsh ponds may be examined and used to inform future restoration designs. Minimum slopes (i.e., approximately 40:1 to 50:1 for 0.5-foot deep ponds and 20:1 to 25:1 for 1-foot deep ponds) are desired for pond habitat; however, if these shallow slopes are considered infeasible during construction, steeper slopes may be used to facilitate construction.

Each pond will be approximately 40 to 50 feet wide and 80 to 100 feet long, with areas of approximately 3,200 to 5,000 square feet. The top width of the lowered levee is expected to vary from approximately 100 to 120 feet. A minimum of 10 feet of lowered levee will remain around the pond excavation to provide a compacted perimeter and reduce the potential for erosion into the pond. Levee lowering material will be sidecast on the levee slopes at the pond locations to widen the perimeter. Material excavated from the ponds will be mounded on the windward (northwest) sides of the ponds. The pond bottoms will be compacted by track walking equipment over the excavated area.

Internal Levee Breaches. The existing internal levee between ponds E8A and E9 will be breached in five locations to reconnect remnant historical channels and facilitate tidal drainage (Figure 2a in the Pond E8A-E9-E8X BA). The western-most internal levee breach will reconnect the historic sinuous tidal channel between Old Alameda Creek and Mount Eden Creek and will be larger than the four other breaches, which will all have the same design dimensions. The breach excavations will extend beyond the levee toe into either the internal borrow ditch or the remnant historical channel. The western breach will have a top width of 90 feet, a bottom width of 10 feet, a bottom elevation of -3 feet NAVD, and a side slope of 4:1. The other four breaches will have top width of 50 feet, a bottom width of 3 feet, a bottom elevation of -1 foot NAVD, and a side slope of 3:1. The easternmost internal breach will involve the removal of a water control structure, which will be salvaged if possible (see *Water Control Structure*s below). Material excavated from the internal levee breaches (and internal levee lowering) will be used for restoration features including internal ditch blocks.

Internal Channels. *Interior Connector Channels.* Wood structures and compacted fill will be excavated to remove channel obstructions and create four internal connector channels. Internal connector channels will be excavated to the expected long-term equilibrium channel depth and to the width of the adjacent remnant tidal channels. Internal connector channels in Pond E9 will be excavated to approximately -4.5 feet NAVD, with widths of approximately 100 feet. In Pond E8A, channels will be excavated to approximately -2 feet NAVD, with widths of approximately 60 feet. These design dimensions are based on the width-to-depth ratio expected for South Bay tidal channels.

Interior Starter Channel. The large shallow remnant historical tidal channel west of the oxbow in Pond E8A will be excavated to deepen and widen the channel. The channel will be excavated to approximately 3.5 feet NAVD, with a top width of approximately 20 feet and a bottom width of 3 feet and side slopes of approximately 3:1. These dimensions are smaller than expected equilibrium dimensions and the channel is expected to scour over time. Excavated material will be placed on the pond bed to help expedite marsh development. Material will not be placed above MHHW (elevation 7.0 feet NAVD). Placement on the pond bed will be controlled to avoid blocking channels and destabilizing slopes and grades, and also to leave gaps where tributary channels can form.

Ditch Blocks. Borrow ditch blocks will be constructed in the internal borrow ditches on either side of the Ponds E8A/E9 levee and the western perimeter borrow ditch in Pond E9. The desired elevation of the top of the ditch blocks is MHHW (7.0 feet NAVD), which is expected to provide pickleweed marsh habitat. The amount of fill needed to achieve this elevation and account for settlement will be determined during final design. The length of the ditch blocks will extend 100 feet beyond the borrow ditch onto the pond bed. Top width will be 40 feet and side slopes will be 5:1 for slope stability. Ditch blocks will be constructed from onsite material generated from levee lowering and/or levee breaches. Additional excavation from the remnant channels will be allowed for borrow ditch block construction, if necessary.

Gypsum Pre-treatment. Portions of the hard gypsum layer in Pond E8A will be broken up using non-traditional construction equipment. The gypsum layer will be cracked, shifted, flipped over, and/or removed to expose the underlying mud and provide rooting pathways for marsh vegetation. Gypsum may be removed and placed at the base of the Pond E9-E8X/E14 levee (see *Levee Improvement* above).

The preliminary design includes gypsum pre-treatment for 100 acres of Pond E8A. The maximum area of gypsum pre-treatment will be approximately 240 acres, which includes the entire area of Pond E8A. Areas will be targeted where the gypsum is thickest and where new channel formation is desired. Gypsum in the large historical tidal channel to the west of the historical oxbow channel will be pre-treated. Gypsum pre-treatment will be controlled to avoid blocking channels and destabilizing slopes and grades.

Traditional land-based equipment is not expected to be effective in breaking the gypsum layer. Land-based equipment is expected to sink into the mud once it breaks through the gypsum layer or in areas where soft mud is not covered by a thick gypsum layer. Low ground pressure or amphibious equipment is expected to be required. Potential methods to break up the gypsum layer are to use a ripper shank, an impact hammer, or possibly a 3,000-pound dead blow weight (used in static compaction). As portions of the gypsum layer are thin or soft enough to break under foot, running amphibious equipment over these areas may be sufficient.

The amount of time required to break up the gypsum layer depends on the layer's thickness and hardness, which is expected to vary spatially, but estimated at a production rate of approximately one acre per day.

Water Control Structures. The existing water control structures between Pond E9 and Mount Eden Creek (Pond E9 structure), Pond E8A and North Creek (Pond E8A structure), and Pond E8X and North Creek (Pond E8X structure) will be removed. The removal of the Pond E9, E8A, and E8X structures will function as breaches in the outboard levees (see *Outboard Levee Breaches* and *Pilot Channels* below) and facilitate tidal flow in the restoration project. Additionally, two internal water control structures in the Pond E8A/E9 levee will be removed and possibly salvaged. The existing structure on the western side of the Pond E9/E14 levee will be replaced.

The Pond E9 and Pond E8A culverts have combination slide/flap gates on both ends. The Pond E8X culvert has a slide/flap gate on one end and a concrete weir box on the other end. The pipes, gates, and other materials (e.g., rip-rap) from these structures will be salvaged and used for Ponds E8A, E8X, and E9 and Ponds E12 and E13 restoration project features. The Ponds E8A, E8X, and E9 restoration includes replacing the existing water control structure between Ponds E14 and E9 (Pond E14 structure). The existing Pond E14 structure consists of two 58-inch square wood box culverts with wood slide gates. This structure will be replaced with pipe culverts with combination slide/flap gates to facilitate management of Pond E14 when Pond E9 is restored to tidal inundation.

A water control structure will be installed between Pond E8X and the northern extension of Pond E8X (known as the pump forebay) for the Ponds E12 and E13 restoration (see *Proposed Eden Landing Pond E12-E13Restoration Action* above). The narrow northern extension of Pond E8X will provide a connection between North Creek and the existing pump station that will be used for the Ponds E12 and E13 restoration. The Ponds E9/E8X/E14 levee will be extended across the northern extension of Pond E8X and a new water control structure with pipe culverts and combination slide/flap gates on each end will be installed. The northern extension of Pond E8X will be used as a managed forebay to store water from Pond E8X and North Creek to be pumped into the Ponds E12 and E13 reconfigured ponds. This pump forebay will limit tidal sedimentation and provide storage for both passive flows into Pond E13 and pumping into Ponds E12 and E13.

For the new Pond E14 and Pond E8X forebay structures, new pipes in, addition to the salvaged pipes, may be required to extend through the Pond E9-E8X/E14 levee.

Mount Eden Creek Channel Excavations. *Mount Eden Creek Breach Enlargement.* In Year 1, the southern extension of the remnant Pond E10 levee on the north side of the existing Mount Eden Creek breach will be excavated to widen and deepen the breach. The levee will be excavated down to the equilibrium Mount Eden Creek channel depth (-6.5 feet NAVD) and a 3:1 slope will be excavated from the top of the levee to the toe of excavation. The breach will be widened by approximately 110 feet at MHHW.

Mount Eden Creek Channel Widening. After lowering the existing Pond E10 levee in Year 2, material will be excavated from the outboard side of the lowered levee to widen the Mount Eden Creek channel by approximately 25 feet. Material will be excavated down to approximately 3.5 feet NAVD and will be placed on the inboard side of the lowered levee to backfill the area up to marsh plain elevation. A width of approximately 20 feet of the lowered levee will not be excavated to allow for construction access during channel widening.

Mount Eden Creek Channel Deepening. The Mount Eden Creek channel will be deepened by approximately 8 feet by dredging the channel bottom to approximately -6.5 feet NAVD. The channel width will be approximately 25 feet at the bottom and 60 feet at mean lower low water (MLLW), with side slopes of approximately 3:1. Channel dredging will extend approximately 150 feet outboard of the Mount Eden Creek breach through the mudflat sill. The mudflat channel will be dredged to approximately -1 foot NAVD (i.e., below MLLW or -0.75 feet NAVD), with a channel bottom width of approximately 50 feet and side slopes of 3:1. Bucket and/or hydraulic dredging techniques will be used. Dredge material will be placed in either Pond E10 or Pond E9. Material may be placed in the borrow ditches and on the pond bed. In Pond E9 and the portion of Pond E10 that will be breached to tidal action, material will not be placed above MHHW (elevation 7.0 feet NAVD). Placement will be controlled to avoid destabilizing slopes and grades. In the case of hydraulic dredging, the spoils would be pumped into the pond to locations that would avoid excessive turbidity after restoration.

Outboard Levee Breaches and Pilot Channels. Eight breaches through outboard levees will be excavated at locations of major remnant historical tidal channels to facilitate tidal drainage (Figure 2a in the Pond E8A, E8X, and E9 BA). Two of the breaches will result from the removal of water control structures (see *Water Control Structures* above). At the breaches, pilot channels will be excavated through the outboard marsh to the adjacent sloughs. The breach dimensions are based on the long-term equilibrium channel dimensions expected once the restored site fills with sediment and develops mature vegetated marsh. These dimensions are adjusted to give a trapezoidal breach cross section with side slopes of approximately 3:1 to 5:1 and a minimum bottom width of 4 feet.

The pilot channels will be excavated, with side slopes of 3:1, to the depth of the breach (long-term equilibrium depth). The pilot channel widths will be approximately 60 to 80 percent of the breach width at MHHW (long-term equilibrium width). Marsh vegetation will be excavated down to the root zone over the long-term equilibrium width to reduce the resistance to pilot channel bank erosion; construction equipment will be allowed to operate within this width. The pilot channel for the breach from Pond E9 to Mount Eden Creek (Pond E9 breach) will be constructed by enlarging the existing ditch at this location.

Material excavated from the outboard levee breaches and pilot channels will be used for restoration features, such as ditch blocks, but will not be allowed to completely block and isolate any portion of the borrow ditch channel due to possible fish entrainment. In breach locations where there is no borrow ditch, material will be placed on the pond bed to help expedite marsh development. Material will not be placed above MHHW (elevation 7.0 feet NAVD). Placement on the pond bed will be controlled to avoid blocking channels and destabilizing slopes and grades.

For shorter pilot channels (up to approximately 30 feet long), the pilot channels are expected to be within the reach of an excavator operating on the levee. However, at the Pond E9 breach to Mount Eden Creek, the existing ditch between the water control structure and Mount Eden Creek will be enlarged to accommodate the increased tidal prism. This longer pilot channel will require re-handling the excavated material or hydraulic dredging. Material re-handling will involve transporting materials from the excavation site via truck to areas where the materials are ultimately placed. In the case of hydraulic dredging, the dredge slurry would be pumped into the pond to locations that would avoid excessive filling of remnant channels and turbidity after restoration.

Access for Construction

Land access is anticipated for construction; however, the preliminary design allows for both land and water access. The land access route to Ponds E8A, E8X, and E9 will be via a combination of Clawiter Road and Eden Landing Road, across the Mount Eden Creek Bridge, and along the Ponds E12/E13/E14 levees. The land access route may require grading and widening improvements for construction access. The Mount Eden Creek Bridge is intended to provide access for maintenance and construction equipment. Heavy vehicles will avoid crossing the Mount Eden Creek Bridge and water control structures in the levees along access routes if the vehicle exceeds the weight bearing capacity of the structure. If this is not possible, engineer-approved precautions will be taken to avoid damaging the structure.

Water access will be at the Pond E9 breach and/or at the western breach of Pond E8A. The dimensions of Old Alameda Creek and Mount Eden Creek may limit or preclude barge access. At water access locations, hydraulic dredging will be used to excavate pilot channels and establish water access channels. Excavation for water access will exceed the dimensions and extent of Mount Eden Creek dredging and pilot channel excavation, with water access channel widths of up to 150 feet, depths of up to 8 feet, and side slopes of up to 3:1, unless otherwise specified. Excavation of the Mount Eden Creek channel, the existing lowered levee along the southern bank of Mount Eden Creek, and a channel across the mudflat from the Bay to the existing Mount Eden Creek breach would provide water access. Additional excavation of the Pond E9 pilot channel will also occur. Any structure built to provide water access (e.g., dock, piles, etc.) will be temporary and will be removed.

A staging area will be constructed to store and refuel construction equipment. The staging area will be located either at the Eden Landing Road entrance or on a portion of the pond levees that is within an acceptable distance from sensitive species and their habitats. Conservation measures as described in the PBO will be followed to enclose fueling areas and limit construction impacts, in accordance with State and County requirements.

Construction Process

Equipment and personnel to be used during construction will generally be as described in the PBO. Due to the location of Pond E8A, E8X, and E9 restoration, construction methods, equipment, and access are more constrained than at a typical construction site. Low ground pressure equipment and mats and/or amphibious construction equipment are expected to be required. During construction, conservation measures such as silt fence, Environmentally Sensitive Area fence, and fiber rolls will be used to keep construction equipment in designated areas and prevent impacts to areas not in the designated construction zone.

The primary earthwork components of Pond E8A, E8X, and E9 restoration include the lowering of levees, levee improvements, berm building, excavation of marsh ponds, ditch block, and tidal channels, and levee breaching. The removal of existing water control structures and installation of new structures will also be a primary component of the restoration process. Culvert pipe water control structures will be installed by cutting a trench in the levee. Culvert pipes will be placed directly onto Bay mud to eliminate a possible source of piping and soil loss experienced in some ISP structures. Construction of inlet and outlet structures will be accomplished using traditional land-based construction equipment. Backfill will be compacted in lifts. Wood headwalls and wingwalls on either side of the levee will be supported by wood piles. Sheetpile cofferdams will be needed on the bay side of structures, as well as areas on the pond side of structures that are flooded. The need for limited dewatering is anticipated while the trench is open.

Construction preparation

- Water control will be necessary to drain the site for land-based equipment and/or maintain depth for floating equipment.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see *Access for Construction* above).

Design element construction details

- During the snowy plover non-breeding season (i.e., mid-September to late February, unless surveys confirm the absence of nesting snowy plovers from Ponds E12 and E13), a berm will be constructed between Ponds E12 and E13 to segregate Pond E12. The berm will be approximately 3 feet high with side slopes of 5:1.
- Prior to the snowy plover breeding season (March 1), Ponds E13, E14, E8A, E8X, and E9 will be flooded to prevent snowy plovers from nesting in these ponds during construction.
- The Pond E9/E8X/E14 levee will be reconstructed to a crest elevation of 11 feet NAVD, with a top width of 8 feet and a bottom width of 60 feet. The outboard (Ponds E9 and E8X) side slope will be approximately 7:1 and the inboard slope will be 4:1.
- The Pond E13/E14 levee will be improved along its current alignment. It will be constructed to a crest elevation of 12 feet NAVD, up to approximately 5.5 feet above the existing grade.
- Five internal breaches will be excavated in the ponds to reconnect remnant historical channels and facilitated tidal drainage. The western breach will have a top width of 90 feet, a bottom width of 10 feet, a bottom elevation of -3 feet NAVD, and a side slope of 4:1. The other four breaches will have top width of 50 feet, a bottom width of 3 feet, a bottom elevation of -1 feet NAVD, and a side slope of 3:1.

- Approximately 1.5 miles of the internal levees between Ponds E8A, E8X, and E9 will be lowered to the marsh plain elevation of 7.0 feet NAVD.
- Eight tidal marsh ponds will be excavated in the lowered Pond E8A/E9 levee. Each pond will be 40-50 feet wide, 80-100 feet long, with areas of 3,200-5,000 square feet.
- Internal connector channels will be excavated to the width of expected long-term equilibrium channel depths. In Pond E9, channels will be excavated to -4.5 feet NAVD, with widths of 100 feet. In Pond E8A, channels will be excavated to -2 feet NAVD, with widths of 60 feet.
- Borrow ditch blocks will be constructed in internal borrow ditches at an elevation of 7.0 feet NAVD. Top width will be 40 feet and side slopes will be 5:1.
- Approximately 100 to 240 acres of hard gypsum in Pond E8A will be mechanically broken using low ground pressure or amphibious equipment.
- Pond E9, Pond E8A, and Pond E8X water control structures will be removed.
- Pond E14 water control structure will be replaced with four 48-inch pipe culverts that will be salvaged from the Pond E9 structure; additional new pipes may be required.
- A water control structure will be installed between Pond E8X and the northern extension of E8X (forebay), which will serve as a connector between North Creek and Ponds E12 and E13. Existing Pond E8A and E8X pipe sections will be used for this structure; additional new pipes may be required.
- A new segment, approximately 1,020 feet long, of the Pond E10 levee will be realigned approximately 350 feet to the north at a height of 11 feet NAVD and a levee top width of 15 feet.
- The Mount Eden Creek channel will be deepened by approximately 8 feet to -6.5 feet NAVD. The channel width will be approximately 25 feet at the bottom and 60 feet at MLLW, with side slopes of approximately 3:1.
- The Mount Eden Creek mudflat channel will be dredged to approximately -1 feet NAVD, with a channel bottom width of approximately 50 feet and side slopes of 3:1.
- The Mount Eden Creek breach will be enlarged to -6.5 feet NAVD, with side slopes of 3:1. The breach will be approximately 11 feet at MHHW.
- Approximately 2.0 miles of outboard levee will be lowered to the marsh plain elevation of 7.0 feet NAVD, including the perimeters levees along Old Alameda Creek and North Creek. These excavations will be accomplished over two seasons.
- Pilot channels will be excavated to the depth of the levee breach. The channel side slopes will be 3:1 and the width will be approximately 60 to 80 percent of the breach width at MHHW.
- Eight outboard levee breaches will be excavated to long-term equilibrium. The breaches will have trapezoidal cross sections with side slopes of 3:1 to 5:1 and a minimum bottom width of 4 feet.

Construction Schedule

The contractor will be allowed to select the construction schedule and sequencing within the restrictions specified by this Phase 1 BO, the PBO, and other permits. The construction schedule may depend on weather conditions and the contractor's preferences. At this time, construction is scheduled to begin in July 2009 and may extend into 2012 or 2013. The preliminary design assumes that construction can occur during the summer bird nesting season, when the weather is dry, within restrictions specified below and by permit conditions. The construction schedule and sequence described below will be refined during the final design.

The snowy plover breeding season extends from March 1 through September 15. During the snowy plover non-breeding season (i.e., mid-September to late February, unless surveys confirm the absence of nesting snowy plovers from Ponds E12 and E13), a berm will be constructed between Ponds E12 and E13 to segregate Pond E12. Pond E12 will be drained to provide snowy plover nesting habitat while Ponds E8A, E8X, E9, E10, E13, and E14 will remain shallowly inundated during construction to discourage snowy plovers and other birds from nesting on the pond beds and allow for construction of the levee improvements during the summer season. The ponds will be inundated prior to March, when snowy plover nest selection is expected to occur. To achieve this for Ponds E8A, E9, E8X, and E13, the ponds will likely not be drained after the wet season and pond water levels will be managed by taking in bay water via the existing Pond E9 water control structure. The berm proposed for the distribution canal between Ponds E12 and E13 will be built at the beginning of construction (e.g., July 2008). Pond E12 would be drained using the Pond E12 and E13 pump, a temporary pump, or a new water control structure. The new Pond E14 water control structures will be installed prior to or during construction of the Ponds E9/E8X/E14 and Ponds E14/E13 levee improvements to facilitate water management during construction.

Mobilization for the levee improvements would likely occur in March. Vehicles will need to be allowed to traverse the Pond E12 levee during the snowy plover nesting season for access and delivery of materials. Pre-construction surveys or monitoring of the locations of nesting snowy plovers will be performed before work begins to ensure that no plovers (or other nesting birds) will be disturbed. Using disturbance-free buffers around active nests might be acceptable if there are few nests (allowing the work to occur outside the 600-foot buffers). After the snowy plovers have chicks, work on portions of the pond could be performed as long as the chicks are able to move well away from the work area and safely forage (possibly with some monitoring to ensure that the snowy plovers stay away from the work area and that access is not endangering chicks).

The preliminary design assumes that construction of the Ponds E9/E8X/E14 and Ponds E13/E14 levee improvements and lowering of the Pond E8A/E9 and North Creek levees will begin as soon after the wet season as possible (after March 15 in most years). As the ponds will be inundated, initial fill placement for the levee improvements will occur below water. Construction equipment will traverse the levees between Pond E9, Whale's Tail Marsh, and North Creek during the clapper rail nesting season (i.e., February 1 to August 31). Levee lowering along Old Alameda Creek will not occur during the early and middle portions of the nesting season so as to avoid disturbing active clapper rail nests, unless surveys are conducted and determine that no rails are present along the north side of the creek within 700 feet of the construction area, or within 200 feet on the south side of the creek. If surveys indicate the presence of clapper rails, or if surveys are not conducted, lowering of this levee will not occur before mid-July. However, because the majority of clapper rail nests in the Bay have hatched by mid-July (Joy Albertson, USFWS, pers. comm.), levee lowering along Old Alameda Creek will occur beginning July 15. Up to half of the material from the Old Alameda Creek and North Creek levees will be excavated in Year 1 (from the inner portion of the levees).

Gypsum pre-treatment and construction of internal connector channels may be performed using amphibious equipment during the summer when the ponds are wet. Alternatively, these activities may be performed after the ponds are drained, which would occur in late summer or fall after monitoring has determined that snowy plover nesting has been completed for the year. Similarly, ditch blocks and levee breaches could be constructed when the ponds are wet or dry. The first soil lift for the new Pond E10 levee would ideally occur after Pond E10 is drained (e.g., fall of Year 1), but could occur when the pond is wet.

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key SBSP Project uncertainties related to ecosystem restoration. Specific applied studies that may be conducted in the project area could include studies to test the rate of sediment accretion in restored tidal areas, the effectiveness in decreasing flood hazard along Old Alameda Creek, and the formation of pond and panne habitats in tidal marsh to provide long-term habitat for shorebirds and waterfowl.

Pond E8A-E8X-E9 Action Area

The action area for the Ponds E8A, E8X, and E9 restoration activities includes: (1) Ponds E8A, E8X, E9, E10, E12, E13, and E14; (2) Old Alameda Creek, North Creek and Mount Eden Creek; (3) the outboard marshes and water-based access areas for barge-supported equipment, which will include the access route for water-based equipment; and (4) any other areas in the immediate vicinity of the project site that could be directly or indirectly affected by noise, dust, or other factors resulting from the proposed action.

Proposed Alviso Pond A6 Restoration Action

Alviso Pond A6 (Pond A6) will be restored to tidal habitat by breaching and lowering the outboard levee, excavating pilot channels through the fringe marsh outboard of the breaches, and constructing ditch blocks in the perimeter borrow ditch (Figure 2 in the Pond A6 BA). Since the time Pond A6 was leveed to create a salt pond, it has subsided by approximately 5 feet to an average elevation of 2.3 feet NAVD. The elevation of Pond A6 is below mean tide level (3.3 feet NAVD) and below the elevation at which marsh vegetation colonizes emerging mudflats. Pond A6 restoration would initially create large areas of emergent mudflat habitat. Over time, tidal channel and vegetated salt marsh habitats are expected to develop in Pond A6 as tidal channels reform and as sediment accumulates and vegetation establishes on the emerging mudflats.

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key SBSP Project uncertainties related to ecosystem restoration. The key research questions for Pond A6 and the associated applied studies activities include the rate of sediment accretion following restoration of tidal action and the impacts of California gulls (*Larus californicus*) on nesting birds and other key species.

Project Location

Pond A6 is located in the Bay and is bordered by Coyote Creek to the north, Alviso Slough to the east, Alviso Ponds A5 and A7 to the south, and Guadalupe Slough to the west. Pond A6 is owned by the Service and is part of the SFBNWR.

Proposed Design Elements

The Pond A6 design includes the following features:
- Outboard levee breaches
- Pilot channels
- Levee lowering
- Internal levee breaches
- Ditch blocks
- PG&E boardwalk

In addition, four short segments of new PG&E boardwalk and a pad for laydown of PG&E equipment that may be transported to the site via helicopter are proposed as part of this proposed action. These are described in more detail in the following sections.

Outboard Levee Breaches and Pilot Channels. Breaches through the outboard levee and pilot channels through the outboard marsh will be excavated at the locations of the four major remnant historic tidal channels (Figure 2 in the Pond A6 BA). The breach locations are:

- Alviso Slough north breach (LB-AN)
- Alviso Slough south breach (LB-AS)
- Guadalupe Slough north breach (LB-GN)
- Guadalupe Slough south breach (LB-GS)

Breach dimensions are based on the predicted channel dimensions once the restored site fills with sediment and develops mature vegetated marsh. These dimensions are adjusted to give a trapezoidal breach cross section with side slopes of 4:1 to 5:1 and a minimum bottom width of 10 feet. On the inboard side of the levee, the breach excavation will extend to the levee toe and meet the existing grade in the borrow ditch. Most of the breach excavations will be 30 feet wide at the top of the levee and 5 feet deep below the top of the levee (0.7 feet NAVD invert elevation). Two of the breaches will be larger, with top widths of 80 to 100 feet and depths of 8 feet (-2.3 feet NAVD invert elevation). Additional excavation from the borrow ditch and remnant channel will be allowed for borrow ditch block construction.

The pilot channels will be excavated to the depth of the breach (long-term equilibrium depth), with side slopes of 3:1. The pilot channel widths will be approximately 60 percent to 80 percent of the breach width at MHHW (long-term equilibrium width). Internal pilot channels will be excavated to 0.7 feet NAVD ± 0.5 feet and have widths at the pond bed of approximately 15 to 20 feet. The pilot channel widths will be approximately 60 percent to 80 percent of the breach width at MHHW (long-term equilibrium width). Marsh vegetation will be excavated down to the root zone which will reduce the resistance to pilot channel bank erosion. Construction equipment will be allowed to operate within this width.

Material excavated from the levee breaches will be used to construct ditch blocks at LB-AN and LB-GN. At LB-AS and LB-GS, excavated material will be placed in the borrow ditch, but will not be allowed to block the borrow ditch channel. Excess earth and other material generated from excavation will be disposed within Pond A6 up to an elevation not to exceed 7.5 feet NAVD (MHHW). Excess earth disposal will be controlled to avoid blocking channels and destabilizing slopes and grades.

The pilot channels may be dredged hydraulically; if so, the spoils would be pumped into the pond to locations that would avoid excessive filling of remnant channels and turbidity after restoration. Pilot channel excavation material will not be side-cast on the adjacent marsh plain. For the Pond A6 pilot channels, the area between the top of the pilot channel excavation and the long-term equilibrium channel width is insufficient for placement of side-cast material.

Levee Lowering. Up to approximately 2,200 feet of the levee between Pond A6 and Guadalupe Slough (Guadalupe Slough levee) will be lowered to the marshplain elevation (MHHW or 7.5 feet NAVD) by excavating the levee. Levee lowering will occur between LB-GN and LB-GS levee breaches. Up to approximately 1,300 feet of the Alviso Slough levee will be lowered adjacent to LB-AN levee breach. Material generated from lowering these levees will be used to construct the ditch blocks. Additionally, up to approximately 150 feet of the Alviso Slough levee will be lowered adjacent to LB-AS levee breach to provide high tide conveyance (Figure 2 in the Pond A6 BA).

Material generated from levee lowering of Alviso Slough and Guadalupe Slough may be side-cast into the borrow ditch, but blocking of the borrow ditch will not be allowed in locations other than the ditch blocks.

Other portions of the Pond A6 outboard levees will not be lowered. Portions of the levee that remain high may continue to provide nesting habitat for California gulls and are expected to limit wave action. The bayfront levee between Pond A6 and Coyote Creek is expected to limit wave action at the Pond A6 south levee until the bayfront levee completely erodes. The Alviso Slough levee is expected to limit wave action at the Pond A9 levee east of Alviso Slough (i.e., opposite Pond A6). Increased wave action is expected across the lowered portion of the Alviso Slough levee, which may result in the need for more frequent maintenance on the Pond A9 levee.

Internal Levee Breaches and Internal Borrow Ditch Block. In anticipation of SBSP Phase 1 activities at Pond A6 (but part of a separately approved project to raise the electrical towers), PG&E has already breached the existing low internal levee and an access road in several locations to reconnect remnant historic channels. The breach excavations extend beyond the levee toe into either the internal borrow ditch or the remnant historic channel. Internal pilot channels were excavated to connect IB-4 to the remnant channel and to connect the remnant channel between IB-3 and IB-4 (Figure 2 in the Pond A6 BA).

As part of the SBSP Phase 1 project, excavated material will be placed in the internal borrow ditch to restrict water flow through the borrow ditch. For IB-8 and IB-11, earth can be side-cast onto the pond bed at least 10 feet from channels. A larger internal ditch block, similar to ditch blocks at LB-GN and LB-AN, will be constructed with material from IB-4 and the internal pilot channel by lowering a portion of the internal levee down to the pond bed. Other portions of the internal levee will not be lowered because the internal levee is at the appropriate elevation to provide vegetated marsh habitat. The new PG&E access road is at a similar elevation and is expected to provide marsh habitat over time, and therefore does not need to be removed. At locations where the road crosses artificial borrow ditches, culverts will be removed and the ditch will be back-filled to block flow in the ditch.

Outboard Breach Ditch Blocks. Two borrow ditch blocks, will be constructed at both LB-AN and LB-GN. The desired elevation of the top of the ditch blocks is MHHW (7.5 feet NAVD). At this elevation, the ditch blocks are expected to rapidly provide pickleweed marsh habitat. The fill elevation needed to practically achieve this elevation and account for settlement will be determined during final design. The length of the ditch blocks will extend 100 feet beyond the borrow ditch onto the pond bed. Top width will be 20 feet and side slopes will be 5:1 for slope stability. The ditch blocks will be spaced far enough apart to allow for the maximum potential channel width expected due to channel scour.

Ditch blocks will be constructed from onsite material generated from levee breaches and/or levee lowering. Some material has been excavated from the internal remnant historic channels by PG&E. Due to the depth and width of the borrow ditches, the desired ditch block dimensions are relatively large. The design dimensions were limited based on available earth within a reasonable haul distance.

PG&E Boardwalk. PG&E completed construction of new tower footings in 2007 to raise the footings to above the tide level by adding concrete prior to restoration of Pond A6. PG&E performed the tower raising work under a separate permit process, in coordination with the Service.

As part of Phase 1 of the SBSP Project, four new segments of boardwalk will be constructed to allow access to PG&E's electrical transmission towers and to provide access to two platforms that will be constructed by PG&E. These 40 x 40-foot platforms will be used for laydown of materials transported to the site by helicopter. The new boardwalk segments include a 40-foot extension of the existing boardwalk into Guadalupe Slough, a 100-foot extension of the existing boardwalk into Coyote Slough, and two 100-foot boardwalk segments extending perpendicular from the existing boardwalk within Pond A6 to the new platforms. In addition to the 100-foot extension of the existing boardwalk into Coyote Slough, the existing 200-foot long boardwalk at this location may need to be rebuilt.

The boardwalks will be supported by two 4 x 4-inch supports for every 10 feet of boardwalk constructed. No fill material will be used during construction. All of the boardwalk material below the water line (i.e., supports and sways) will be plastic, and untreated lumber will be used for the headers and boardwalk planks.

Access for Construction

Land and water access will be allowed for construction. Land access to the Pond A6 site for both workers and equipment will be off of Highway 237 via a combination of North First, Hope, Mill, Gold, and Elizabeth Streets. The land access route will depend on the timing of the Pond A8 Phase 1 action. If Pond A6 restoration is constructed before implementation of the Pond A8 Phase 1 action (see *Proposed Alviso Pond A8 Restoration Action* below), the existing access route along the "Hoxie Highway" (the dirt access road through Pond A8), Pond A8/A5 levee, and Pond A5/A7 levee will be used. The Pond A8 Phase 1 action will establish a new access route along the Pond A8 south levee and the Pond A5/Guadalupe Slough levee. This access route will be used if the Pond A8 Phase 1 action is implemented before the Pond A6 restoration. Both land access routes may require grading and widening improvements for construction access. Heavy vehicles will avoid crossing water control structures in the levees along access routes if the vehicle exceeds the weight bearing capacity of the structure. If this is not possible, engineer-approved precautions will be taken to avoid damaging the structures; these precautions will be specified in final design. The construction contractor shall be responsible for repairing any damages resulting from their operations.

Water access will be allowed at each breach location. Alviso Slough and Guadalupe Slough possess sufficient dimensions to provide limited barge access. If the new Alviso marina, a proposed project at the Alviso Marina County Park (Santa Clara Valley Water District {SCVWD)), is completed before the commencement of restoration activities at Pond A8, barges may be able to embark from that location, and traverse the intervening reach of Alviso Slough to reach the site. Otherwise, they will depart from the deepwater port at Redwood City and traverse the intervening access route through the Bay. Hydraulic dredging at the pilot channel locations may occur to excavate the pilot channels and establish water access channels. Excavation for water access will be allowed to exceed the pilot channel excavation dimensions, with water access channel widths of up to 150 feet, depths of up to 8 feet, and side slopes of up to 3:1, unless otherwise specified. Any structure built to provide water access (e.g., dock, piles, etc.) will be removed after construction is complete.

A staging area will be constructed to store and refuel construction equipment. The staging area will be located on a portion of the Pond A5 and Pond A7 levees and may be enlarged using fill material. A second or alternative staging area may be located at the Gold Street entrance to the pond complex. A berm will be constructed to enclose fueling areas, in accordance with State and County requirements.

Construction Process

Equipment and personnel used during construction will generally be as described in the PBO. Due to the location of the Pond A6 restoration project, construction methods, equipment, and access are more constrained than at a typical construction site. To assist with construction access and methods, water in Pond A6 may be drained for land-based equipment or maintained for floating equipment.

The lowering of outboard levees, excavation of pilot channels, and the breaching of outboard levees will be the primary earthwork components of the Pond A6 restoration. The outboard levees along Guadalupe and Alviso Slough will be lowered to the elevation of MHHW to create pickleweed marsh habitat. Borrow ditch blocks will be constructed with excavated materials from the lowered levees.

Construction Preparation

- The PG&E boardwalks and platforms will be constructed.
- Water control will be necessary to drain the site for land-based equipment and/or maintain depth for floating equipment.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see *Access for Construction* above).

Design Element Construction Details

- Up to approximately 2,200 feet of the levee between Pond A6 and Guadalupe Slough (Guadalupe Slough levee) will be lowered to the marshplain elevation (MHHW or 7.5 feet NAVD).
- Up to approximately 1,300 feet of the Alviso Slough levee will be lowered adjacent to LB-AN.
- Most of the breach excavations will be 30 feet wide at the top of the levee and 5 feet deep below the top of the levee (0.7 feet NAVD invert elevation).
- Two of the breaches will be larger, with top widths of 80 to 100 feet and depths of 8 feet (-2.3 feet NAVD invert elevation).
- Internal pilot channels will be excavated to 0.7 feet NAVD ± 0.5 feet and have widths at the pond bed of approximately 15 to 20 feet.
- Breach dimensions will have a trapezoidal cross section with side slopes of 4:1 to 5:1 and a minimum bottom width of 10 feet.
- The pilot channels will be excavated to the depth of the breach, with side slopes of 3:1.
- The pilot channel widths will be approximately 60 percent to 80 percent of the breach width at MHHW (long-term equilibrium width).
- Two borrow ditch blocks will be constructed at both LB-AN and LB-GN. The desired elevation of the top of the ditch blocks is MHHW (7.5 feet NAVD).
- The length of the ditch blocks will extend 100 feet beyond the borrow ditch onto the pond bed. Top width will be 20 feet and side slopes will be 5:1 for slope stability.

Construction Schedule

Restoration construction is expected to occur over 2 to 3 seasons within a 24 to 36-month period. Unless measures are implemented to prevent sensitive species from nesting in the project area, the timing of construction (construction window) will avoid impacts to special-status species, such as clapper rails, and other sensitive species, including nesting birds such as California gulls.

Snowy plovers breed in Pond A8, including areas in close proximity to the "Hoxie Highway" (i.e., the levee through Pond A8). The snowy plover breeding season extends from 1 March through 14 September. During this period, the "Hoxie Highway" will not be used for accessing Pond A6 unless pre-activity surveys or ongoing monitoring by Service staff or others has confirmed that no nesting snowy plovers are present.

Gulls are expected to be finished nesting (or nearly so) by August 1. Construction work prior to breaching will be allowed when the gulls have chicks and they are mobile enough to move away from the disturbance (e.g., if the chicks can move further down a levee or out into the pond away from the disturbance). Due to inter-annual variability of California gull nesting, breaching and inundating Pond A6 will not be allowed before September 1 without first conducting pre-construction surveys to check that all chicks are mobile.

There is virtually no breeding habitat for clapper rails around Pond A6 due to the narrowness of the outboard marsh. An abbreviated call-count survey protocol will be conducted to confirm the absence of clapper rails prior to any construction or excavation work that will take place during the breeding season (i.e., February 1 to August 31). If these surveys indicate the presence of clapper rails, construction activities between February 1 and August 31 will be allowed only at a distance greater than 700 feet from clapper rails in adjacent marsh areas and a distance greater than 200 feet from clapper rails across a major slough channel from the construction site (i.e., the opposite side of Guadalupe Slough or Alviso Slough). Otherwise, such construction and excavation activities will take place during the non-breeding season.

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key SBSP Project uncertainties related to ecosystem restoration. Additional studies and future research projects may be conducted as the results of monitoring and initial applied studies indicate areas that are in need of further research. The key research questions for Pond A6 and the associated applied studies activities include the rate of sediment accretion and the impacts of gulls on nesting birds and other key species.

Pond A6 Action Area

The action area for the Pond A6 restoration activities includes: (1) Pond A6; (2) the lowermost reaches of Alviso Slough and Guadalupe Slough; (3) Ponds A5 and A7, and outboard marshes adjacent to Pond A6; (4) staging areas on a portion of the Pond A5 and Pond A7 levees, and possibly at the Gold Street entrance to the pond complex; (5) land-based access areas, which will include either the "Hoxie Highway" through Pond A8, the Pond A8/A5 levee, and the Pond A5/A7 levee, or a new access route along the Pond A8 south levee and the Pond A5/Guadalupe Slough levee, as described under *Access for Construction* above, areas that will be traversed by water-based equipment accessing Pond A6; (6) any other Bay locations within the action area for the larger programmatic action area where California gulls, displaced from construction activities and/or tidal inundation in Pond A6, could take up residence, thus potentially affecting listed species in other areas; and (7) any other areas in the immediate vicinity of Pond A6 that could be directly or indirectly affected by noise, dust, or other factors resulting from the project.

Proposed Alviso Pond A8 Restoration Action

The proposed Alviso Pond A8 (Pond A8) restoration action will introduce muted tidal action to create approximately 1,400 acres of shallow subtidal habitat in Ponds A5, A7, and A8 through the construction of a 40-foot notch at the southern end of Pond A8, and modified management of existing water control structures on Ponds A5 and A7 (Figure 2 in the Pond A8 BA). Pond A8 is often referred to in two sections: A8N (north) and A8S (south), and is divided by the "Hoxie Highway". Water levels in Pond A8N (409 acres) would exceed elevations of internal levees and spill into adjacent Ponds A5, A7, and A8S (1,023 acres), modifying the existing hydrologic regime in these ponds as well. Water levels during the tidal cycle would fluctuate evenly across all the ponds, but depths would vary due to differences in bed elevations. Depths would generally exceed those at which the ponds are presently managed (less than 1 foot in most areas) over the majority of the project site. The expected 1-foot increase in water depths will also require improvements to the small levee around the sump inlet pond (a.k.a., "donut") in Pond A4.

Assuming a 40-foot wide notch operation, water levels (though not depths) would be nearly uniform across Ponds A8, A5, and A7 and fluctuate approximately 0.5 feet about a mean elevation of approximately 4 feet NAVD. During periods when Pond A8 is subject to muted tidal action, flow across the notch will not be obstructed by gates or other structural elements. Partial restoration of tidal prism in these ponds will promote channel scour and increase salinity along Alviso Slough. The expected potential increases in channel width and salinity, and likely increase in salt marsh dominated vegetation over the existing freshwater marsh dominated vegetation, will improve navigation access in Alviso Slough in a sustainable fashion.

Operations of the existing Ponds A5 and A7 water control structures will be intake-only during the summer. During the winter, when salmonids are most likely to be present in Alviso Slough, 2-way flows through these structures will be maintained to reduce fish entrainment by allowing any fish that enter the ponds to exit through these structures.

Exchange between Pond A8 and Alviso Slough will be managed as needed during the wet season to maintain flood storage capacity presently offered by the ponds and avoid fish entrainment by eliminating tidal exchange during this period. This will be implemented by reducing the open notch width or completely eliminating tidal exchange at the Pond A8 notch. Initially, the notch would be closed February to May to avoid fish entrapment. Pending monitoring data (i.e., if monitoring indicates that fish entrainment is not a problem) notch operations could be adjusted to allow for additional bays to be opened year-round. Tidal exchange during the summer and fall months will be initially limited by opening only one of the several "bays" in the notch. Additional bays would be opened subsequently if monitoring confirms that tidal scour does not threaten to erode downstream levees.

Restoration of tidal action at Pond A8 is designed to be reversible so that in the event that unacceptable ecological impacts begin to occur, such as an increase in mercury bioavailability, tidal exchange in Pond A8 can be eliminated to prevent long-term adverse impacts, and water management at Ponds A5 and A7 can revert to ISP operations. If unacceptable long-term ecological impacts do not occur in the Pond A8 project, the next phase may be initiated, which would involve introducing a larger tidal prism to the site, ultimately leading to the creation of fully tidal marsh habitat. However, this Phase 1 BO only pertains to the muted tidal conditions that will be introduced as part of Phase 1 activities.

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key project uncertainties related to ecosystem restoration. Additional studies and future research projects may be conducted as the results of monitoring and initial applied studies indicate areas that are in need of further research. The key research questions for Pond A8 and the associated area include assessment of mercury levels in sentinel species found in both ponded and tidal marsh habitat, and fish entrainment studies associated with the water management regime and configuration of the ponds.

Project Location

Pond A8 is located at the upstream end of Alviso Slough near the community of Alviso. Tidal marsh, mostly brackish, borders the outboard northern and eastern edges of Pond A8, the northern edge of Pond A7, and the southern edge of Pond A5. Ponds A5 and A7 border the western edge of Pond A8, and private property on a former landfill borders the southern edge of Pond A8. Pond A8 is currently managed as a seasonal pond, and Ponds A5 and A7 are operated as managed ponds. Ponds A5, A7, and A8 are owned by the Service (Figure 2 in the Pond A5, A7, and A8 BA). Pond A4, where a levee surrounding the sump inlet pond will be raised by 1-2 feet, is located on the southwest side of Guadalupe Slough, southwest of Pond A8. Pond A4 is owned by the SCVWD.

Proposed Design Elements

The Pond A8 design includes the following features:

- Armored notch
- Outboard pilot channel
- Infrastructure modification and protection
- Levee improvements

These features are described in more detail in the following sections.

Armored Notch. Muted tidal connection would be provided by construction of an armored notch through the perimeter levee that separates Pond A8 and upper Alviso Slough. Earth excavated to construct the notch would be placed within Pond A8 or used for maintenance of nearby levees. This structure would be designed to allow the width of the notch (i.e., the opening that allows water to flow in and out of the pond) to be adjustable, with a maximum width of approximately 40 feet. The depth of the notch would extend to approximately 1 foot above the average bed elevation of Pond A8 (-0.5 feet NAVD). The size of this structure has been selected to maximize the potential volume of water exchange between the slough and the pond while controlling water levels within the pond. Due to structural considerations, the notch would consist of eight 5-foot bays that can be opened and closed independently, allowing tidal exchange between the Pond A8 and Alviso Slough to be adjusted based on monitoring data.

Flow through the notch would occur during both flood and ebb tides. Operations of the existing Ponds A5 and A7 water control structures will be intake-only during the summer. During the winter, when salmonids are most likely to be present in Alviso Slough, 2-way flows through these structures will be maintained to reduce fish entrainment by allowing any fish that enter the ponds to exit through these structures. In combination with management of the Ponds A5 and A7 culverts as "flood only" culverts in the summer, the notch would enable ebb-dominated tidal asymmetry within the ponds to limit pond water levels while maximizing tidal prism in Alviso Slough. Concrete armoring of the sides and bottom of the notch structure would be required to prevent unintentional widening and/or deepening of the notch.

Water exchange would be limited, and tidal range within the three ponds would be muted during the dry summer and fall months. Water level fluctuation in the ponds over a tidal cycle would be small (approximately 0.5 feet) compared to the range of tidal change in the slough (over 8 feet).

Water levels in Pond A8N (409 acres) would exceed elevations of internal levees and spill into adjacent Ponds A5, A7, and A8S (1,023 acres), modifying the existing hydrologic regime in these ponds as well. Water levels during the tidal cycle would fluctuate evenly across all the ponds, but depths would vary due to differences in bed elevations. Depths would generally exceed those at which the ponds are presently managed (less than 1 foot in most areas) over the majority of the project site.

The 2-way (ebb and flood) flows across the open notch would minimize the potential for fish trapping inside the pond. When Pond A8 is subject to muted tidal action (see below for a discussion of the seasonality of notch closure), flow across the notch would not be obstructed by gates or other structural elements.

From modeling the Pond A8 action (during summer time when there would be no upstream flow), the estimated tidal prism increase during ebb and flood tides would be about 400 acre-feet. This 400 acre-feet would be exchanged between high-low to high-high water (during flood tides) and high-high to low-low water (during ebb tides). However, there may be a substantial difference in the duration of these flows between flood tides (about 4.8 hours) and ebb tides (8.4 hours). Assuming that 400 acre-feet is conveyed evenly across the 4.8 and 8.4 hour durations, the estimated flow rates of the "diverted" water differ for water into (approximately 1,000 cubic feet per second (cfs)) and out of (approximately 575 cfs) Pond A8.

These flows into and out of Pond A8 are on the same order of magnitude of the peak flow of a typical winter storm (approximately 2,600 cfs), but still ¼ to ½ of the stream flow total. Based on USGS gauge data (from 1930 through 1997), the average annual peak instantaneous flow is 2,600 cfs (mode) and 3,500 cfs (mean); the Corps established the 2-year peak instantaneous flow as 2,300 cfs. After a typical winter storm, the percentage of stream flow that is diverted into Pond A8 greatly increases over the modeled summer flows.

Partial restoration of tidal prism in these ponds would promote channel scour and increase salinity along Alviso Slough by shifting the tidal influence of the Bay farther upstream. The expected potential increases in channel width would improve navigation access in a sustainable fashion, which is a key objective of the Alviso Slough Restoration Project (a separate project under consideration by the SCVWD that may implement dredging and/or vegetation removal in the slough to improve navigation).

Exchange between Pond A8 and Alviso Slough will be managed as needed during the wet season to maintain flood storage capacity presently offered by the ponds and avoid fish entrapment by eliminating tidal exchange during this period, when salmonids are most likely to be present in Alviso Slough. This will be implemented by reducing the width or completely eliminating tidal exchange at the Pond A8 notch. Initially, the notch would be closed February to May in order to avoid fish entrapment. Pending monitoring data, notch operations could be adjusted to allow for additional bays to be opened year-round. Tidal exchange during the summer and fall months will initially be limited to only one of the "bays' in the notch. Additional bays would be opened subsequently if monitoring confirms that tidal scour does not threaten to erode downstream levees.

Outboard Pilot Channel. An approximately 475-foot pilot channel would be excavated through the fringe freshwater marsh of Alviso Slough immediately outboard of the armored notch. This channel would facilitate tidal exchange through the notch by providing an initial flow path and removing erosion-resistant marsh vegetation so the channel can gradually enlarge through tidal scour. The top width of the constructed pilot channel will be over-excavated to approximately 130 feet to minimize the erosion of sediment that may be contaminated with mercury. The depth of the pilot channel will extend through the erosion-resistant vegetation and root mass to approximately 9 feet below existing grade. Rock armor will be placed immediately adjacent to the notch to limit erosion.

Infrastructure Modification and Protection. Under existing conditions, power lines suspended by wooden piles provide electricity to the Pond A8/A7 pump. These piles and transmission lines would be removed under restoration actions since electricity will not be needed and the Pond A8 and A5/A7 interior levee would be overtopped on a daily basis. The Pond A8/A7 pump would be salvaged for other purposes. In the event that the Phase 1 implementation were reversed and pumping required for water management in Pond A8, new power lines would have to be installed. Vehicular access along the Pond A8 and A5/A7 levee, and the Pond A8N/A8S interior levee would not be maintained under these restoration actions. Vehicular access would be limited to the perimeter levees of Ponds A8S, A5 and A7.

The expected 1-foot increase in water depths will require improvements to the small levee around the sump inlet pond (a.k.a., "donut") in Pond A4. The SCVWD periodically uses this sump to convey water from Pond A4 to Pond A5 via a siphon under Guadalupe Slough. Under baseline conditions, freeboard in the Pond A4 sump inlet pond is minimal, and increasing the elevations of the receiving water in Pond A5 will require the levee surrounding the sump to be increased by 1 to 2 feet.

As part of the Phase 1 construction, a nested monitoring well (one well location with three well casings inside) at Pond A7 will need to be properly abandoned. This work will be contracted out to a qualified drilling contractor. Depending upon well diameter and well depth, the typically accepted monitoring well destruction methods are to either drill down over the existing well to the total depth of the original boring and backfill the borehole with an approved sealing material, or to pressure grout the well in place.

Levee Improvements. Some portions of the existing levees along the southern perimeter of Pond A8S will be improved to provide alternative vehicle access to Ponds A5, A6, and A7, since the flooding of Pond A8 will eliminate access through the "Hoxie Highway." In addition, as mentioned above, the Pond A4 'donut' levee will need to be raised to prevent overtopping.

Access for Construction

Land access to the Pond A8 site for both workers and equipment will be off of Highway 237 via a combination of North First, Hope, Mill, Gold, and Elizabeth Streets. Land access to the Pond A4 site for both workers and equipment will be off of Highway 237 via East Caribbean Drive. Water based access will be through Alviso and Guadalupe Sloughs. If the new Alviso marina, a proposed project at the Alviso Marina County Park, is completed before the commencement of restoration activities at Pond A8, barges may be able to embark from that location. Otherwise, they will depart from the deepwater port at Redwood City and traverse the intervening access route through Bay.

A construction staging area will be located at the Gold Street entrance to the pond complex and a berm will be constructed to enclose fueling areas, in accordance with State and County requirements.

Construction Process

Equipment and personnel to be used during construction will generally be as described in the PBO. Due to the location of Pond A8, construction methods, equipment, and access are more constrained than at a typical construction site. During construction, conservation measures such as silt fence, Environmentally Sensitive Area fence, and fiber rolls will be used to keep construction equipment in designated areas and prevent impacts to areas not in the designated construction zone.

Existing water control structures in Ponds A5 and A7 will remain, with their management being altered to intake-only during the summer with a return to 2-way flows in the winter. Electrical lines and wooden power line poles will be removed in Pond A8N.

Construction Preparation

- Prior to March 1 (the beginning of the snowy plover nesting season) during the year in which construction occurs, Ponds A8N and A8S will be flooded to a depth adequate to prevent snowy plovers from nesting in areas where they will be disturbed by construction activities. These water levels will be maintained throughout the duration of construction or the duration of the snowy plover breeding season, whichever is shorter.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see *Access for Construction* above).

- Sheet pile will be installed around the water control structure locations and the construction area will be dewatered with portable pumps.

Design Element Construction Details

- The depth of the notch would extend to approximately 1 foot above the average bed elevation of Pond A8 (-0.5 feet NAVD).
- The notch would consist of eight 5-foot bays that can be opened and closed independently.
- An approximately 475-foot long pilot channel would be excavated through the fringing freshwater marsh of Alviso Slough immediately outboard of the armored notch.
- The top width of the constructed pilot channel will be over-excavated to approximately 130 feet and its depth would extend through the vegetation and root mass (approximately 9 feet).
- Rock armor will be placed in the pilot channel near the notch to limit erosion.
- Some portions of the existing levees along the southern perimeter of Pond A8S will be improved to provide alternative vehicle access.
- The Pond A4 'donut' levee will be raised to prevent overtopping.

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key project uncertainties related to ecosystem restoration. Additional studies and future research projects may be conducted as the results of monitoring and initial applied studies indicate areas that are in need of further research. The key research questions for Pond A8 and the associated area include assessment of mercury levels in sentinel species found in both ponded and tidal marsh habitat, and fish entrainment studies associated with the water management regime and configuration of the ponds.

Pond A8 Action Area

The action area for the Pond A8 restoration area includes: (1) Ponds A5, A7, and A8; (2) a portion of Pond A4, where the small ring levee surrounding the sump will be raised; (3) Alviso Slough and Guadalupe Sloughs and associated outboard marshes; (4) land based access areas, including access via Highway 237 and North First, Hope, Mill, Gold, Elizabeth and East Caribbean Streets; (5) an equipment staging area at the Gold Street entrance; (6) areas that will be traversed by water-based equipment accessing Pond A8; and (7) any other areas in the immediate vicinity of Pond A8 that could be directly or indirectly affected by noise, dust, or other factors resulting from the proposed action.

Proposed Alviso Pond A16 Restoration Action Description

Alviso Pond A16 (Pond A16) will be reconfigured to create islands for nesting birds and shallow water habitat for foraging shorebirds (Figure 2 in the Pond A16 BA). Water in Pond A16 will be managed with three new water control structures (including a new intake structure between

Coyote Creek and Pond A17, where water will enter the Pond A16-A17 system), and development of an internal water circulation system using a series of berms and control structures such as flashboard weirs. In addition, a viewing platform and two interpretive stations will be constructed at Pond A16. Buffers between nesting islands and outboard levees have been built into the design to limit the impacts of recreational activities on nesting and roosting birds.

The design elements within Pond A16 will be the subject of an applied study which will test the effects of different island spacing and shapes on use by, and reproductive success of, nesting and roosting birds. In addition, different water management regimes will be tested to determine the best method for managing the pond for the target wildlife during the breeding and non-breeding seasons. The effects of public access on bird use of, and reproductive success on, nesting islands will also be studied.

Project Location

Pond A16 is located in the Bay and is bordered by Pond A17 and Coyote Creek to the north; Artesian Slough to the east; New Chicago Marsh and the Refuge's Environmental Education Center (EEC) to the south; and the New Chicago Marsh intake channel, Union Pacific Railroad (UPRR), and Alviso Ponds A15 and A13 to the west. Pond A16 is owned by the Service.

Proposed Design Elements

The Pond A16 design includes the following features intended to create islands for nesting birds and shallow water habitat for foraging shorebirds, as well as to allow public access and interpretive public education at this site:

- Nesting islands
- Earth berms
- Water control structures
- Borrow ditch filling
- Recreation

These features are described in more detail in the following sections.

Nesting Islands. Up to 50 circular and linear nesting islands will be constructed within Pond A16 to provide bird nesting habitat. Material needed to construct islands will be borrowed onsite, from the windward side of the islands, with a minimum 10-foot bench between the borrow area and toe of the new island. It is estimated that due to soil characteristics, side slopes will need to be 5:1 or flatter to construct stable islands. Currently 25 circular islands and 25 linear islands are proposed in Pond A16. Each island will be approximately 3 feet high, have a surface area of approximately 15,000 square feet, and a minimum distance of 100 feet from other islands. To isolate islands from recreational trails and land-based predators, they will be at least 300 feet from outboard levees, 100 feet from internal berms, and 600 feet from the public viewing platform.

The nesting islands are expected to settle over time due to the weak and soft condition of the Bay mud. Maintenance is expected to be required within about 5 to 10 years to raise the nesting islands, unless the lower, subsided nesting island elevations are used successfully by nesting birds.

In locations where the borrow areas for the nesting islands are near historic channels in the cells, the borrow areas will be excavated to connect to these channels. This is expected to facilitate circulation within these borrow areas. In other locations, connections will not be excavated to borrow areas except to facilitate construction access.

Earth Berms. Earth berms will be constructed in Pond A16 to divide the pond into three cells. Berm design may vary slightly for berms along the intake canal, outlet canal, and those between cells. As with islands, material needed to construct the berms will be borrowed onsite, with a minimum 10-foot bench between the borrow area and toe of the new berm. The berms will range in height from approximately 2 to 6 feet. It is estimated that berm side slopes will also need to be 5:1 or flatter. As discussed for the nesting islands, maintenance is expected to be required within about 5 to 10 years to raise the berms due to settling of the material.

Water Control Structures. Water control structures for Pond A16 restoration will include culverts and flashboard weirs. The water control structures are designed to achieve an average cell water depth of approximately 6 inches (range: 2 inches to 1 foot), provide adequate flushing for bird habitat and water quality objectives, prevent salmonid entrapment, and minimize manual management while increasing management flexibility. The preliminary design includes the water control structures described below.

Pond A17 intake structure. Water will enter the Pond A16-A17 system through a new Pond A17 intake structure between Coyote Creek and Pond A17. This structure will consist of two new 4-foot intake culverts with combination slide/flap gates on each end (i.e., on both sides of the culverts), in addition to the single existing 4-foot culvert with combination slide/flap gates. The culverts will have trash racks on the Coyote Creek side.

A pilot channel will be excavated from Coyote Creek to the structure through the existing fringe marsh. The preliminary design includes a 20-foot long trapezoidal pilot channel with 3:1 side slopes. The channel is anticipated to have a 75-foot top width and a 28-foot bottom width. The channel will be excavated to a depth of approximately 7.5 feet below the adjacent marsh plain; the channel bottom will be about 1 foot below the culvert invert.

The currently proposed location of the intake structure is the northwest corner of Pond A17, near the western end of the levee between Coyote Creek and Pond A17; however, the final location of this structure, and the potential for flow to the structure to cause scour at the Coyote Creek railroad bridge, are still being evaluated. The outboard marsh is narrowest in this location, therefore installing the culvert in this location will reduce the area of outboard marsh excavation required for the pilot channel.

Pond A16 intake structure. Three new 4-foot intake culverts, with combination slide/flap gates on the ends of each will be added between Pond A17 and Pond A16. This structure will be located in the existing channel cut between the ponds. The new Pond A16 intake structure is recommended to provide flexibility and ease of managing water levels in Pond A17.

The existing channel cut between Ponds A17 and A16 could remain open without installing culverts; however, Pond A17 water levels would need to be managed by adjusting the Pond A16 cell intake structures (multiple weirs as discussed below). As the restoration will increase flows between Ponds A17 and A16, measures would be required to reduce scour of the levees along the existing channel cut, such as enlarging or armoring the channel. Hydraulic modeling indicates that the existing channel would need to be enlarged to twice the existing dimensions. The option of leaving the channel cut between Ponds A16 and A17 open (and possibly widening it), rather than installing new Pond A16 intake culverts in this channel, will be further evaluated as the design progresses.

Cell intake and outlet structures. Weirs with adjustable flashboard risers (flashboard weirs) will be used to control flow in and out of cells. Each cell in Pond A16 will have two intake and two outlet structures, each consisting of multiple 4-foot wide weirs. Cell 1 will have two 4-foot wide flashboard weirs per intake and outlet structure, and Cells 2 and 3 will have three 4-foot wide flashboard weirs per intake and outlet structure. Additional flashboard weirs may be included and buried in the adjacent berm to provide stability.

In addition, Cells 2 and 3 will have "auxiliary" structures to provide management flexibility for seasonal operations and intermittent management (e.g., draining). Some cell outlet structures will be located where deeper historic channels and borrow ditches cross the berms. These structures will include culverts to flush deeper water from these channels. These culvert structures will also have flashboard weirs to control flows and water levels. Similar structures will connect the intake canal to the outlet canal in two locations.

Pond A16 outlet structure. Six new 4-foot outlet culverts, with combination slide/flap gates on both ends of each culvert, will be added between Pond A16 and Artesian Slough. This new structure will be located to the south of the existing outlet culvert, which is a single 4-foot outlet culvert with combination slide/flap gates. A pilot channel will be excavated through the existing fringe marsh from the structure to the Artesian Slough side channel along the southeastern edge of Pond A16. The preliminary design includes a 50-foot long trapezoidal channel with 3:1 side slopes. The channel is anticipated to have a 105-foot top width and a 48-foot bottom width. The channel will be excavated to a depth of approximately 9.5 feet below the adjacent marsh plain; the channel bottom will be about 1 foot below the culvert invert.

Borrow Ditch Filling. Imported fill material will be used to fill the borrow ditches, if and when fill material of acceptable quality is readily available. Filling the borrow ditches is expected to improve water quality by reducing the potential for water column stratification and hypoxic conditions in the bottom layer. The borrow ditches will be filled in stages through an adaptive management process. This process will require different sections of the borrow ditch to be filled to varying elevations in stages. The section of the borrow ditch used as the Pond A16 intake canal will be filled first to improve cell intake water quality. Water quality monitoring in sections of the borrow ditches, with different fill elevations (or no fill), will determine the effectiveness of, and need for, additional borrow ditch fill in the pond. Borrow ditches provide island-nesting birds with some protection against mammalian predators, and thus, filling these ditches could increase predation risk for these birds to some extent. However, predator control will be implemented in conjunction with the SBSP Project, and predation problems noted at Pond A16 will be addressed appropriately.

Approximate fill elevations and volumes are based on neat line quantity estimates and do not include the effect of settlement of underlying Bay mud, which is expected to decrease fill elevations over time. The fill elevations are intended to decrease borrow ditch depths while maintaining the hydraulic function of the intake and outlet canals and berm stability (i.e., not filling the intake canal borrow ditch above the elevation of the pond bed). Determining the optimal amount of fill will require additional analysis, and a review of the trade-offs between improving water quality and maintaining the canals as deterrents to access of nesting islands by mammalian predators. Stage order and fill elevations may change due to adaptive management and fill availability.

Recreation. The recreational features within the Alviso pond complex would be managed by the Service as part of the current public access program. Currently, the Service allows pedestrian and bicycle access (no dogs) on the Alviso Slough Trail, including the levees around A16 and A17. Phase 1 will continue to allow the same public access around these ponds. However, studies of the effects of public access on use of islands by nesting birds, and reproductive success of nesting birds, will be conducted, and results of those studies will be used to determine whether periodic closures of trail segments to protect sensitive wildlife are needed.

The public access and recreation plan for Pond A16 includes a proposed viewing platform and two interpretive stations that would be accessible from the existing levee along the Pond A16 and Artesian (Mallard) Slough levee trail network that currently encircles Ponds A16 and A17. These recreational features would be accessed from the EEC, or possibly from the trail network originating at the Alviso Marina County Park. The interpretive stations would be located at strategic locations along this existing trail network to provide visitors with unique viewing, birding and educational opportunities, as well as information about the transformation of Pond A16 as a managed pond. These interpretative stations will be constructed of a combination of wood and steel and sized based on the site location. A portion of the levee will need to be resurfaced to provide a firm and stable surface to conform to ADA standards.

Pond A16 Viewing Platform. The Pond A16 viewing platform would be installed at the southern edge of Pond A16, approximately 0.75 mile from the existing EEC boardwalk, allowing visitors relatively easy access to this station. The platform would be raised between 5 and 10 feet above the existing grade of the levee, allowing visitors to overlook the managed pond restoration in Pond A16. An interpretive station would be incorporated into the design of the viewing platform. The year-round trail from the EEC to the viewing platform will be incorporated into the levee along the southern edge of Pond A16 and will bisect Pond A16 and New Chicago Marsh. The platform would be constructed of steel and recycled plastic and accessed by an ADA-compliant ramp and a set of stairs, which are configured to minimize circulation areas while maximizing useable gathering and viewing space. A railing will be designed to provide a safety edge and to facilitate a comfortable birding experience. An interpretive station and seating is integrated into the platform.

Pond A16 Interpretive Station. A second interpretive station would be located adjacent to the freshwater marsh area along the eastern edge of the pond, approximately 0.8 mile from the existing boardwalk. The exact location of the station will be based on field conditions of the site. The interpretive station would be adjacent to the existing trail and would augment information provided at the other station.

Access for Construction

The land access route for both workers and equipment will be via Zanker Road, off Highway 237, and through the EEC entrance to the Pond A16 levees. The levees may require grading and widening improvements for construction access. The water access route to the site will be from the Bay via Coyote Creek, Artesian Slough, and/or the ponds to the north of Pond A16. Water access from the Bay is constrained by the UPRR railroad bridges. The Coyote Creek Bridge can no longer be opened, however the Mud Slough Bridge can be opened to provide barge access. From Mud Slough, barge access to the site will be allowed through the Island Pond A20 dredge lock, borrow ditch, and breach to Coyote Creek, if the contractor determines that this is possible. This route was used by Cargill prior to breaching the Island Ponds. Small modular barges may be assembled after being transported to the site. Small barges may also be launched at the San Jose boat ramp in Artesian Slough. Amphibious equipment may access the site through the ponds to the west of the UPRR and the road crossing the UPRR between Ponds A15 and A16. This road may require grading and widening improvements for access.

Water access to the Pond A16 site may occur at the new Pond A17 intake structure, new Pond A16 outlet structure, and the existing Pond A16 and Pond A17 dredge locks. Hydraulic dredging at the structure locations will be used to excavate the pilot channels and establish water access channels. Excavation for water access may exceed the pilot channel excavation dimensions, with water access channel widths of up to 150 feet, depths of up to 8 feet, and side slopes of up to 3:1, unless otherwise specified. Any structure built to provide water access (e.g., dock, piles, etc.) will be removed as part of demobilization.

A staging area will be constructed to store and refuel construction equipment. The staging area will be located on a portion of the Ponds A16 and A17 levees and may be enlarged using fill material. A second or alternative staging area may be located near the EEC.

Construction Process

Equipment and personnel to be used during construction will generally be as described in the PBO. Due to the location of the Pond A16 restoration project, construction methods, equipment, and access are more constrained than at a typical construction site. To assist with construction access and methods, Pond A16 will be drained prior to construction. Draining the ponds will incrementally consolidate the surface mud, increasing workability for fill operations. It is expected that this will not allow sufficient drying of the pond bottom for the use of conventional construction equipment or even low ground pressure equipment. If reconnaissance prior to construction bidding shows that sufficient drying is unlikely to take place by the start of construction, then it is anticipated that the ponds will be inundated and amphibious and/or water-based (marine) construction equipment will be required.

Islands and berms will be the primary earthwork components of Pond A16 restoration. Borrow material varies in this location and is not always optimal for earthwork construction. If draining and drying are insufficient, borrow material may have a high water content. Due to this and other soil characteristics, material may be prone to slumping during construction. Islands and berms will require a minimum of two lifts, with wait time in between, to achieve the desired elevation. Cargill has achieved approximately 18 inches per lift in previous island and levee construction. Construction of the existing Pond A16 islands was done in-the-wet. New island and berm heights will need to be over-built 20 percent or more to allow for settlement after construction.

Culvert pipe water control structures in existing and new levees will be installed by cutting a trench in the levee. Culvert pipes will be placed on a layer of rock base over a geofabric layer between the underlying Bay mud and the rock. Backfill will be compacted in lifts. Wood headwalls and wingwalls on either side of the levee will be supported by wood piles. Sheetpile cofferdams will probably be needed on the creek and slough sides of the Pond A17 intake structure and Pond A16 outlet structure. The need for limited dewatering is anticipated while the trench is open. The fish screen at the Pond A17 intake structure will be placed close enough to the existing levee so that it can be removed for maintenance with a backhoe. Pre-cast concrete flashboard weirs will be placed in new berms within Pond A16. The contractor will determine whether flashboard weirs are placed first and the berm built around them, or vice versa.

Construction Preparation

- Water control will be necessary to drain the site for land-based equipment and/or maintain depth for floating equipment.
- Equipment will be transported to the site on trucks via existing levee roads or sloughs (see *Access for Construction*).
- Sheet pile will be installed around the water control structure locations and the construction areas will be de-watered with portable pumps.

Design Element Construction Details

- Low check berms will be constructed to create a series of three cells. Check berms will range in height from approximately 2 to 6 feet. The berms will be constructed by excavating fill material on-site.
- Water control structures, such as flashboard weirs, will be installed in the berms to regulate flow into and out of the cells.
- New intake/outlet water control structures with tide gates will be installed (or existing water control structures will be modified) between Coyote Creek and Pond A17, and between Pond A16 and Artesian Slough.
- Intake and outlet canals will be created in Pond A16 to convey flow in and out of individual cells. The canals will be located around the perimeter of the cells in portions of the deep existing borrow ditch and remnant tidal channels in Pond A16.

- Intake and outlet canals will be constructed to convey water to and from individual cells.
- A fish screen will be installed on the existing Pond A17 culvert and any new Pond A17 culverts if required by NMFS.
- Up to 50 nesting islands (25 circular and 25 linear) will be constructed within the four cells. Each island will be approximately three feet high and have a surface area of approximately 15,000 square feet. The islands will be constructed using fill material excavated from the windward side of the islands.
- Water levels will be managed to provide an average depth of approximately 6 inches, with depths ranging from approximately 2 inches to 1 foot though with some deeper areas around islands, in borrow ditches, and in other portions of the pond.
- A viewing platform will be constructed in the southwestern corner of Pond A16. The platform will be raised above the existing grade of the levee 5 to 10 feet and will be constructed of steel and recycled wood with ramps and railings as needed.
- An additional interpretive station will be located on the eastern edge of Pond A16 in a central location, approximately 0.8 mile from the existing boardwalk.

Construction Schedule

Construction at Pond A16 is expected to occur over 2 to 3 seasons within a 24 to 36 month period. Unless measures are implemented to prevent sensitive species from nesting in the proposed action area, the timing of construction (construction window) will avoid impacts to listed species, such as snowy plovers, and other sensitive species, including nesting birds such as Forster's terns, avocets, and stilts that currently nest on existing island in Pond A16.

Construction can start at the beginning of the dry season if nesting is prevented. Nesting may be prevented by hazing or by removing the existing islands prior to the breeding season. Regardless, when the pond is drained for construction, it may serve as nesting habitat for some species, most likely including gulls, terns, avocets, stilts, and potentially snowy plovers. Therefore, the construction windows and/or pre-construction surveys for nesting gulls, Forster's terns, avocets, stilts, and snowy plovers will be implemented.

If the pond needs to be dry during work, hazing, beginning prior to nesting, may be employed to try to prevent nesting. Once the pond is dry, pre-construction surveys will be performed before work begins to make sure that no snowy plovers (or other nesting birds) will be disturbed. Using disturbance-free buffers around active nests might be acceptable if there are few nests (allowing the work to occur outside the 600-foot buffers). After the snowy plovers have chicks, work on portions of the pond can be performed as long as the chicks are able to move well away from the work area and safely forage (possibly with some monitoring to ensure that the snowy plovers stay away from the work area). If construction occurs with amphibious or floating equipment, then the pond may be flooded to prevent nesting in the pond bottom prior to construction. In this case, a combination of hazing prior to nesting, pre-construction surveys, and/or buffers around existing nests would be implemented with respect to the possibility of nesting on the existing islands, or these islands would be removed prior to the breeding season.

After construction has been completed, inundation of the pond during the snowy plover nesting season of March 1 to September 15 (which encompasses the nesting season of other potential pond-breeding birds) can occur only if pre-construction surveys (and monitoring, if snowy plovers are detected within the pond) determine that no snowy plovers are actively nesting within the pond (i.e., there are no nests with eggs) and all young have fledged. Start dates between September 20 and February 1 for construction activities that do not involve inundating the pond will be allowed only if pre-construction surveys and monitoring determine that no snowy plovers are actively nesting within the pond and all young have fledged, or that active nest sites with eggs are located more than 600 feet from the construction site. After the snowy plovers have chicks, work in specific portions of the pond, not involving inundating the pond, can be performed as long as the chicks are able to move well away from the work area and safely forage (with some monitoring to ensure that the snowy plovers stay away from the work area). These same considerations will be made for other waterbirds, including Forster's terns, avocets, and stilts, that may breed in Pond A16. These species are finished nesting by August 1 in most years, but a few late pairs may have young through August.

An abbreviated call-count survey protocol (e.g., two surveys using tape playbacks during the February to mid-March primary calling period) will be conducted to confirm the absence of clapper rails prior to any construction or excavation work that will take place along Coyote Slough during the breeding season (i.e., February 1 to August 31). If these surveys indicate the presence of clapper rails, construction activities between February 1 and August 31 will be allowed only at a distance greater than 700 feet from clapper rails in adjacent marsh areas and a distance greater than 200 feet from clapper rails across a major slough channel from the construction site. Otherwise, such construction and excavation activities will take place during the non-breeding season.

Phase 1 Applied Studies

A number of applied research studies will be implemented as part of Phase 1 to answer questions regarding key project uncertainties related to ecosystem restoration. Specific applied studies that may be conducted in Pond A16 include studies to test the effects of island density, shape and distribution on bird nesting use and reproductive success. As part of Phase 1, applied studies will be implemented to examine the potential impacts of landside public access on birds or other target species within Pond A16. Additional studies may be performed to study the effectiveness of management approaches to control vegetation encroachment on the nesting islands and shallow water foraging areas and to control mammalian and avian predation on waterbirds.

Pond A16 Action Area

The Pond A16 action area includes: (1) Ponds A16 and A17; (2) the adjacent reaches of Artesian Slough and Coyote Creek; (3) outboard fresh and brackish marshes, adjacent portions of New Chicago Marsh and Triangle Marsh; and (4) staging areas on Pond A16 and A17 levees (Figure 2 in the Pond A16 BA). Water access may be gained from Mud Slough via the Island Pond A20 dredge lock, a borrow ditch and breach to Coyote Creek, from Pond A15, from the road crossing between Ponds A15 and A16, or via the City of San Jose boat ramp at Alviso Slough. Land access to Pond A16 levees may also occur from Highway 237, Zanker Road, and the EEC. The action area also includes portions of the Bay that will be affected by discharge of water or sediment from Pond A16 during construction and pond operation or that will be traversed by water-based equipment accessing Pond A16, and any other areas in the immediate vicinity of Pond A16 that could be directly or indirectly affected by noise, dust, or other factors resulting from the proposed action.

Proposed Operations and Maintenance Activities for the Service and CDFG

On-going O&M activities will be performed periodically for all SBSP Project facilities, including reconfigured and managed ponds, recreational/public access facilities, and (less frequently) tidal habitat restorations. Operations, management, and maintenance activities are currently being performed in a manner partially described in the 1995 biological opinion issued to Cargill (Service File Number 1-1-95-F-0047) but the operations of the former salt ponds were changed when ownership was transferred to the Service and CDFG. A new operational plan was developed, termed the ISP, and most of the infrastructure was put in place to implement that plan. Since that time the operation of water management within the ponds has changed somewhat, and will continue to change in response to conditions. Additionally, a series of ponds (the Phase 1 actions) are variously changing to tidal or more intensively managed, therefore water management and operations are also changing. Levees, ponds, and water control structures will be routinely operated and maintained according to the best management practices described herein.

The scope of this Phase 1 BO includes the on-going O&M for all the ponds and the adjoining habitats that are within the programmatic SBSP Project area and attempts to capture all current and future actions that may occur as part of ISP and Phase 1 activities. Levees need to be maintained for flood protection and habitat protection purposes, water control structures require maintenance for proper operation, trails will need to be maintained, inlet and outlet channels through tidal marsh to these structures require periodic dredging, trash racks and fish screens need to be cleaned, islands created for nesting and roosting habitat will need periodic vegetation control and rebuilding with sediment, and the Service and CDFG will need to respond to emergency situations. Each of these activities will require access (by land and/or water), staging areas, and storage areas.

Project Location

The O&M aspects of the project include the entire SBSP Project area located in the Bay in Northern California within San Mateo, Santa Clara, and Alameda Counties. A detailed description of the SBSP Project area is discussed in the PBO and is hereby incorporated by reference.

Operation and Maintenance of the SBSP Project

Water Management Operations. Since 2004, the ponds within the SBSP Project area have been managed to provide habitat values while the long-term restoration plan is being developed. Bay waters have continued to be circulated through water control structures and existing levees have been maintained. Additionally, some ponds have been managed for bird or other wildlife habitat as seasonal ponds, which fill with rain water in the winter, and which dry through evaporation in the summer months. Other ponds have been operated as high salinity ponds. The Island Ponds (Ponds A19, A20 and A21) in the Alviso pond complex were breached to tidal action in March 2006. The detailed design for the restoration was completed by SCVWD and included two breaches to Pond A19, one breach to Pond A20, and two breaches to Pond A21. All breaches were on the south side of the ponds, connecting the ponds to Coyote Creek.

Phase 1 restoration actions will directly impact the design and management of Ponds A5, A6, A7, A8, A16, A17, SF2, E8A, E8X, E9, E12, E13, and E14. Most of the remaining ponds are managed to maintain open water conditions. Without the introduction of Bay water, these ponds will dry down during the summer and become seasonal ponds in the winter, which will significantly reduce open water habitat heavily utilized by migratory and resident birds. Subsequent sections describe the operations of each pond system in more detail.

Alviso Complex. Below is a description of how the Service will operate ponds within the Alviso Slough complex of the SBSP Restoration Project area. To maximize water circulation patterns within ponds, the Refuge generally plans to operate all ponds that are unaffected by Phase 1 actions as directional systems, as described below. Each of the water control structures in these directional systems will be operated in a 1-way fashion, with water entering through the intake in one pond, then flowing through the entire system until exiting through a 1-way outlet in another pond. However, some systems, particularly Pond A3W, may occasionally be operated as 2-way, muted tidal systems in order to aid water quality within the systems. Additionally, flows may be reversed, for 2-4 week durations, during winter or summer months to flush out sediment that accreted in trash racks and other water control structures.

Alviso System A2W. The intake Pond A1 receives water at its northwesterly end from Charleston Slough via an existing 60-inch gate structure. From Pond A1, a 72-inch siphon that runs under Mountain View Slough transfers water to Pond A2W. The outlet Pond A2W discharges pond water at its northerly end to the Bay through a 48-inch gate structure.

Alviso System A3W. The intake Pond AB1 receives water from the Bay via a 36-inch gate structure and from a 48-inch culvert. The outlet Pond A3W discharges pond water through three 48-inch gates to Guadalupe Slough near the Sunnyvale Water Pollution Control Plant (WPCP) outfall. The normal flow in this system follows two routes. One route is from AB1 to A2E to A3W. The second route is from AB1 to AB2 and then to A3W. To improve water quality and maintain desired water levels, the outlet at A3W will occasionally be operated in a 2-way fashion. This system also includes pond A3N, which operates as a seasonal pond.

Alviso System A5. The intake at Pond A5 receives water from Guadalupe Slough through two 48-inch gate structures; and occasionally from Pond A4 (owned by the Santa Clara Valley Water District) through a siphon under Guadalupe Slough. From Pond A5 water is routed to Pond A7. The outlet at Pond A7 discharges water through two 48-inch gate structures to Alviso Slough. Over the past few years, Pond A8 has been operated as a seasonal pond. Restoration actions will introduce muted tidal action to this pond complex through the construction of a 40-foot notch at the southeastern end of Pond A8, and modified management of existing water control structures on Ponds A5 and A7. Water levels will be nearly uniform across Ponds A8, A5, and A7 and fluctuate approximately 0.5 feet about a mean elevation of approximately 4 feet NAVD. Operations of the existing Ponds A5 and A7 water control structures will be intake-only during the summer. During the winter, when salmonids are most likely to be present in Alviso Slough, continuous flow through these structures will be maintained to reduce fish entrainment by allowing any fish that enter the ponds to exit through these structures. Exchange between Pond A8 and Alviso Slough will be managed as needed during the wet season to maintain flood storage capacity presently offered by the ponds and avoid fish entrainment by eliminating tidal exchange during this period. Initially, the notch will be closed February to May to avoid potential fish entrapment. Pending monitoring data (i.e., if monitoring indicates that fish entrainment is not a problem) notch operations could be adjusted to allow for additional bays to be opened year-round. Tidal exchange during the summer and fall months will be initially limited by opening only one of the several "bays" in the notch. Additional bays will be opened subsequently if monitoring confirms that tidal scour does not threaten to erode downstream levees. Restoration of tidal action at Pond A8 is designed to be reversible so that in the event that unacceptable ecological impacts begin to occur, such as an increase in mercury bioavailability, tidal exchange in Pond A8 can be eliminated to prevent long-term adverse impacts, and water management at Ponds A5 and A7 can revert to ISP operations.

Alviso Pond A6. Pond A6 is operated as a seasonal pond, with no inlet or outlet structures. During Phase 1 of the SBSP Project, Pond A6 will be restored to full tidal action.

Alviso System A14. This system consists of seven ponds. The Pond A9 intake receives water from Alviso Slough through two 48-inch gates. The outlet at Pond A14 discharges water through two 48-inch gate structures into Coyote Creek. The route of flow through this system is from A9 to A10 to A11 to A14. Over the past few years, Ponds A12, A13, and A15 have been operated as batch ponds to maintain higher salinity levels, although there is seasonal variation in water levels and salinity in this pond complex. To avoid potential salmonid entrainment, this system does not intake water from the Alviso Slough between December and April. The intake structure at Pond A9 will be closed during the winter to avoid entraining migrating salmonids, resulting in relatively small discharge from this system in these months.

Alviso System A16. This consists of two ponds (A17 and A16) that are operated under continuous flow, with intake water from Pond A17 entering from Coyote Creek through a 48-inch gate and discharge entering Artesian Slough through a 48-inch gate structure. To avoid potential salmonid entrainment in winter, flows are reversed with water entering the A16 structure and discharge occurring at A17. Under Phase 1 implementation, Pond A16 will be reconfigured to create islands for nesting birds and shallow water habitat for foraging shorebirds. Water in Pond A16 will be managed with three new water control structures (including a new intake structure between Coyote Creek and Pond A17, where water will enter the A16/A17 system), and an internal water circulation system using a series of berms and control structures such as flashboard weirs. Water control structures will allow for an average cell water depth of approximately 6 inches (range 2 inches to 1 foot), provide flushing for bird habitat and water quality objectives, and a fish screen will be installed to prevent salmonid entrainment.

Ravenswood Complex Operations. Below is a description of how the Service will operate ponds within the Ravenswood complex of the SBSP Project area.

Ravenswood System R1, R2, R3, R4, R5 and S5. The Ravenswood ponds on the north side of Highway 84 have been managed as seasonal ponds during ISP operations, with rainfall as the only source of water, and allowing the ponds to dry seasonally. In particularly dry summers, water is taken in from the bay through existing water control structures to Pond R1 to cover the pond bottom to prevent blowing dust from causing air quality concerns. This management is expected to continue for the foreseeable future. Alternatively, water control systems may be installed to allow interim management. If so, the goal will be to reduce pond salinities for the following 3 years, and subsequently operate the ponds as five separate sub-systems, as follows:

1. Operate Ponds R1, R2, and R3 as independent single pond systems each with inlet/outlet structures; and
2. Operate Ponds S5, R5, and R4 as a system, taking in Bay water through Pond S5, then to Pond R5 and discharging through Pond R4.

These scenarios would require the construction of new water control structures. Water control structures in Ponds R1, R2, and R3 would be 2-way, with gravity intake flows at high tide and outflows occurring at low tide. The Ponds S5, R5, and R4 would be operated as a 1-way, continuous flow system.

Ravenswood System SF2. Pond SF2 is currently managed as a seasonal pond. Pond SF2 will be reconfigured to create islands for nesting and roosting birds and shallow water habitat for shorebird foraging. The pond will include two management cells within which water levels will be managed to provide optimal depths for shorebird foraging, and nesting islands will be constructed within both cells. The third, western-most cell will be managed as a seasonal wetland. Water control structures will be used both to manage water levels and flows into and out of Pond SF2 from the Bay, and between cells, for shorebird foraging habitat and to meet water quality objectives. Water will flow into and out of Pond SF2 through a new water control structure comprising up to six 4-foot inlet culverts that will be located near the southern end of the bayfront levee. Weirs with adjustable flashboard risers (flashboard weirs) will be used to control flow in and out of cells, and water circulation through the bay front cell in Pond SF2 will be managed to meet water quality targets at the discharge point.

Eden Landing Complex Operations. Below is a description of how the CDFG will operate ponds within the ELER complex of the SBSP Project footprint.

Eden Landing Systems E2 and E2C. The E2 system consists of four ponds, and the E2C system consists of eight ponds. In 2005, CDFG linked these systems together. The objective of system E2-E2C is to maintain year-round open water habitat in Ponds E1, E2, E6, E5, and E2C and winter open water habitat in all of the Ponds (E1, E2, E7, E4, E6, E5, E2C, E1C, E4C, E5C, and E6C). Pond E3C, owned by Cargill, is still part of the E2C system and will be operated as year-round open water habitat until it is decoupled from circulation patterns. In the Pond E2 system, the intake pond E1 receives water from Old Alameda Creek through four 48-inch gates. A 30,000 gallon per minute (gpm) pump could also provide supplemental intake, although it is rarely used due to high electricity costs, except to perform monthly preventative maintenance.

During the winter months, the inflow from Pond E1 circulates through Ponds E7, E6, E5, E4, and E2 before discharging to the Bay. Two 48-inch gates allow supplemental intake to Pond E2. In the summer months, CDFG intakes water at Pond E1 and transfers water from Pond E1 to Pond E2, while operating Pond E2 under muted tidal conditions. During the summer and fall, CDFG links systems E2 and E2C by routing water from Ponds E7 or E4 to Ponds E6 and E5 to make up for evaporation losses, or system E2 and E2C are linked during seasonal transition to begin re-flooding dry ponds in the E2C system (Ponds E6C, E4C, E5C, and E1C).

As described above, CDFG operates Ponds E6 and E5 as batch ponds allowing Ponds E6 and E5 to have low salinity in the spring and increased salinity during the summer months. The high salinity waters in Ponds E6 and E5 are routed, in the winter months, to Ponds E4 or E6C and diluted before reaching discharge locations. In the E2C system, CDFG operates Pond E2C under muted tidal conditions (intake and discharge at the same structure) to Alameda Flood Control Channel.

CDFG operates Ponds E6C, E4C, E5C, and E1C as seasonal ponds with open water conditions during the winter months, shallow water conditions in the spring and fall, and dry conditions during the summer months. To moderate salinity levels and improve dissolved oxygen levels in the E2C system, CDFG increases intake volumes at E2C by periodically draining pond waters to adjacent seasonal ponds (primarily E5C, although E4C and E1C may begin to flood as E5C gets deeper) to improve turnover of pond system waters.

Eden Landing System E6A. This system consists of Ponds E6A, E6B, and E8. The ponds in this system are managed seasonally, with varying salinities typically ranging from low to medium levels. During the summer months, each pond can be operated independently or in series to allow intake to provide breeding habitat and shallow water foraging habitat for the snowy plover. In other words, during the summer months, CDFG operates this system to enhance seasonal ponding via limited intake at Pond E6A. During the fall, CDFG will begin to fill the ponds with water so it can operate these ponds as open water habitat during the winter months, with Pond E6A operating under muted tidal conditions, or as flow through ponds in series.

Eden Landing System E8A. This system consists of Ponds E9, E8A, E8X, E12, E13, and E14. Currently, operating conditions change depending on the season. During the summer months, Pond E9 operates under muted tidal conditions (i.e., it receives and discharges water through four 48-inch gates from Mount Eden Creek), while during the winter months, the normal route of flow in this system is from Pond E9 to Pond E8A then to Old Alameda Creek. Typically, Pond E8A will be dry during the summer months with circulation flow occurring in borrow ditches that comprise about 10 percent of its area. Ponds E12, E13, and E14 operate as seasonal ponds. Pond E8X is very small and is operated to provide shallow water and mudflat habitat for waterbirds. The quantity of intake at Pond E9 has improved with the restoration in November 2006 of tidal action to Mt. Eden Creek. The discharge culvert in the northeast corner of Pond E8A also acts as a supplemental intake during the summer when muted tidal intake/discharge operations are used to minimize adverse water quality conditions. To moderate salinity levels and improve dissolved oxygen levels in the pond E8A system, CDFG has increased intake volumes at Pond E9 and periodically drained intake waters to adjacent seasonal ponds (Ponds E13 and E14, or E12 as needed) to improve turnover of pond system waters.

As part of Phase 1 actions, Ponds E8A, E8X, and E9 will be opened to tidal action through levee breaching and levee lowering. Tidal action will be restored to existing historic channels in the ponds by a series of outboard breaches and pilot channels, as well as internal levee breaches. Ponds E12 and E13 will be reconfigured into a managed pond with six cells of varying salinity for shorebird foraging habitat, as well as a discharge mixing basin. Of the six cells, two cells will be managed to maintain low salinity levels (approximately 20 to 40 ppt) similar to Bay salinity levels; two cells will be managed to maintain moderate salinity levels (approximately 40 to 80 ppt); and the remaining two cells will be managed to maintain high salinity levels (approximately 80 to 120 ppt) during the summer evaporation season. The water from the higher salinity cells will be routed to the discharge/mixing basin which will have sufficient intake to dilute pond water to salinity suitable for discharge. The water depths within each cell will be managed to provide optimal shallow water habitat for shorebird foraging. Water levels and flows in Ponds E12 and E13 will be managed using passive water control structures, such as culverts and/or flashboard weirs with gravity flows driven by the tides, and supplemental pumping as needed. Water levels and flows in Ponds E12 and E13 will be managed using passive water control structures, such as culverts and/or flashboard weirs with gravity flows driven by the tides, and supplemental pumping as needed.

Eden Landing System E11. This system consists of Ponds E10 and E11. Pond E10 is currently managed under muted tidal conditions and provides year-round open water. Pond E11 is managed as a seasonal pond. In winter both ponds are managed as open water and discharge can occur from either, or both, ponds.

Maintenance Elements. The areas within the SBSP Project require periodic maintenance. Levees and berms need to be maintained for flood protection and habitat protection purposes, water control structures and weirs require maintenance for proper operation, inlet and outlet channels through tidal marsh to these structures require periodic dredging, trash racks and fish screens need to be cleared, islands created for nesting and roosting habitat will need periodic vegetation control and rebuilding with sediment, and the Service and CDFG will need to respond to emergency situations. Each of these activities will require access (by land and/or water), staging areas, and storage areas. These are described below.

Vehicular Access. The majority of the potential actions for on-going O&M, listed below, will require the movement of vehicles on paved and dirt roads with the action area, including levee roads. In some cases, heavy equipment such as excavators will be towed on trailers to work on sites within the SBSP Project area.

Water-based Equipment Access. Access through the Bay, sloughs, and other channels will be required for water-based equipment. This equipment includes boats, floating dredges (e.g. Cargill's *Mallard*), and amphibious equipment (e.g., amphibious dredges or vegetation removal equipment). Areas affected by these actions are described in *O&M Action Area* below.

Routine Inspections. Routine inspection of the water control structures in managed ponds will be necessary to ensure that they are functioning properly. Inspection of water control structures and canals for debris or trash obstructions will be necessary to maintain desired flows. If obstructions are found during inspection, it may be necessary to remove the obstructions either manually or mechanically to maintain flows. Routine inspection of the managed pond levees, trails and internal berms for unintentional breaching and erosion will also be necessary. If unintentional breaching or erosion occurs, the berm or levee will be repaired as needed to maintain pond operations, prevent potential tidal inundation of adjacent managed ponds, and to maintain public access along the trails. Nesting islands will also need to be periodically examined for erosion and growth of vegetation. Viewing platforms, interpretive signs, trails, gates, and fences will be inspected periodically and will be repaired and maintained as necessary to maintain function and appearance.

Dredge Locks. Use and maintenance of existing dredge locks to allow equipment to enter salt ponds for water-based levee maintenance will be required (previously part of Bay Conservation and Development Commission (BCDC) Permit No. 4-93, issued to Cargill). Maintenance of locks involves dredging of and placement of dredged material at 21 existing dredge locks within the SBSP Project area, and at any newly constructed authorized dredge locks, to allow the dredge to access the salt ponds. Advanced notification for these activities will include specific quantities of material to be dredged and placed, and drawings indicating pre-staked, designated areas for stockpiling, side casting and borrowing material will be indicated. Earthen levee material, stockpiled from the last time the lock was accessed atop the main levee will be used to dam the breach following entry. Upon dredge exit, breaching and closing levees will be completed in a similar fashion to that described above. The salt marsh muds that were excavated and sidecast in the access cut will be retrieved and placed back into the access cut and channel, closing the lock once the dredge has exited.

In order to gain access to the ponds for maintenance, there may also need to be dredging within shallow sloughs to provide up to 4 feet of clearance for access. Dredge material that cannot be placed on salt pond levees may be placed on bar mud flats or side-cast following approval in accordance with the notification procedure. Some slough dredging may also be performed near dredge locks for the purpose of obtaining additional mud to bring the access cut fills to the desired elevation following the dredge access.

Channel Maintenance. Periodically, inlet and outlet channels that allow water to flow into or out of water control channels will need to be maintained. This typically will involve dredging of any accumulated sediment that is preventing the free flow of water. Channel maintenance will also involve side-casting dredge material from the inlet/outlet channel of Pond A14 in accordance with regulatory permits. Additionally, periodic inspection and maintenance of restoration internal channels and associated infrastructure such as water control structures, weirs, internal managed pond berms and canals will be required to ensure that the ponds are operating as intended. This could include removal of accumulated sediments, repair of water control structures and weirs and placement of materials on internal levees and berms as needed to maintain ecological functions and values.

Borrow Ditches. Activities may also include dredging in existing and new borrow ditches within the ponds for the purpose of placing the dredged material on existing levees, and dredging in ponds to allow a dredge to cross a pond. This includes the placement of dredge material within the pond. Placement of dredged material within the pond could occur on the pond bottom along the side of the dredged channel. Conversely, fill will also be placed in the borrow ditches themselves in strategic locations to re-direct water flow to enhance ecological functions and minimize low dissolved oxygen conditions.

Levee Fortification and Maintenance. Dredge material will be placed on levee tops and/or levee sides through the placement of material dredged from inside salt ponds or material imported in the minimum amount necessary to repair or protect levees (previously part of BCDC Permit No. 4-93, issued to Cargill). Levees may be serviced by a floating dredge or other methods such as a dragline, barge-mounted dredge, an aquatic excavator, or amphibious construction equipment. Disposed material may be dredged from salt ponds along the inside and top of salt pond levees to maintain levee configuration. This method may require dredge access through pre-approved locations (i.e., dredge locks). In limited instances, levee fortification may be accomplished by importing fill material to place on the top of and on the banks of levees, or by dredging muds from the outside, bay, or slough side of the levee for placement on the salt pond levee. Both alternate methods avoid the need for dredge lock access. Dredged sediment deposition occurs on approximately 5 percent of the salt pond levees a year (10 miles out of 200 total miles). Up to 12 different dredge locks are anticipated to be entered over a 10-year period, fortifying up to 100,000 linear feet of outboard levees and up to 134,000 linear feet of inboard levees. The levee tops are disked and graded prior to maintenance.

Riprap will be placed in the minimum amount necessary to protect existing levees, as approved according to Special Condition 11-C (previously part of BCDC Permit No. 4-93, issued to Cargill). Riprap is required because of continued localized erosion from high wave energy and is maintained on a continuing basis. The amount placed will be the minimum required to provide protection and will be placed from the levee toe upwards onto the levee or to stabilize structures. It is anticipated that riprap will be used to maintain outboard levees of ponds that do not have outboard marsh habitats and that are likely to be restored to tidal circulation in the future. For the purposes of this Phase 1 BO, the maximum length of riprap in the action area is on the order of several thousand feet. If more extensive riprap is necessary to protect levees, effects will be addressed on a project-specific basis. New riprap will be comprised of ¼ ton to ½ ton rock, or may be small pieces of rebar-free demolition rubble (broken concrete slabs), that is compacted in place along outboard and inboard levees as needed to fortify the slopes and prevent erosion, so long as the permittee has adequately demonstrated that the proposed new riprap is placed below the high tide line and/or high pond level at a slope of about 3:1 where needed, taking care to minimize the number of voids between the rubble that might be utilized by red fox (*Vulpes vulpes*) and other nuisance species. Riprap placed on top of non-eroding salt marsh is not authorized.

Dock and Other Structure Maintenance. Docks, boat launches, existing marine crossings, existing bridges, bridge foundations and abutments within the network of levees, intake channels, tide gates, ditches, pumps, piers, trestles, walkways, fences, bulkheads, platforms and other facilities will be used, maintained, and replaced on an in-kind, as needed basis, that does not result in a significant enlargement or increase of square footage (i.e., not more than 100 feet^2) over that of the existing dock (previously part of BCDC Permit No. 4-93, issued to Cargill). If required, maintenance may require the installation and use of new pipes, weirs, berms, culverts, siphons, intake structures, electrical distribution lines for the operation, and pumping facilities, all involving the minimum dredging or fill necessary. Portable pumps, such as diesel-powered pumps, may be used occasionally for O&M activities, such as supplementing gravity flows through the water control structures or dewatering cells or canals for maintenance.

Material Storage. On-going maintenance requires the storage, on a temporary basis, of shoreline protection or levee surface materials in certain previously approved or designated areas approved in writing by for levee protection purposes at specific, dry land locations approved in writing for levee protection purposes (previously part of BCDC Permit No. 4-93). The proposed action includes the continued practice of using existing dredged material stockpile locations, which are used to dry material to create an effective dam after dredge lock and salt pond access, thus ensuring that disturbance occurs generally in the same area. As the material is removed and then replaced with new material on each pass (typically once every 5 to 10 years), the material is new Bay fill each time it is placed. The temporary fill is a necessary part of maintenance activities for shoreline protection surrounding the pond system. Cargill used the same stockpile locations at the dredge locks for many years, where the best locations are for the purpose of maintaining pond levees and preventing unnecessary erosion of the dredge locks themselves.

Island Maintenance. The nesting islands are expected to settle, or erode, over time due to the weak and soft condition of the Bay mud. Maintenance is expected to be required within about 5 to 10 years to raise the nesting islands, unless the lower, subsided nesting island elevations are used successfully by nesting birds. The nesting islands were designed to test the effectiveness of both island shape and spacing. Once the results of that testing are complete, the islands may be recreated in a different configuration.

In locations where the borrow areas for the nesting islands are near historic channels in the cells, the borrow areas will be excavated to connect to these channels. This is expected to facilitate circulation within these borrow areas. In other locations, connections will not be excavated to borrow areas except to facilitate construction access.

Vegetation Management. A number of non-native plant species occur within the project area, some of which have been identified as invasive or potentially invasive. Vegetation management activities will focus on detection and removal of invasive plant species that threaten native habitats and/or alter listed species or migratory bird habitat. This includes vegetation maintenance on created nesting islands (including native wetland vegetation) or shallow water habitat if it is determined that the vegetation is impeding the intended function of providing nesting and foraging habitat for native waterbirds. Also, vegetation management may also be required on levees and berms if they become infested with invasive plants. Preferred vegetation management will involve non-mechanized methods of removal including hand-pulling, saline spray, pond flooding (during non-breeding seasons), and substrate-based controls. Substrate-based controls on plant growth may include adding layers of coarse sand, oyster shell, gravel, and gypsum fragments on nesting islands. If necessary, managers may use gas-powered tools such as weed trimmers and mowers or CDFG-approved herbicides. The conservation measures, as described in the PBO, will be implemented during vegetation removal in order to minimize impacts to nesting birds, other wildlife and fish.

Nuisance Species Management. Predation by a number of both native and non-native predator species impacts populations of special-status and sensitive species in the Bay. The level of impact to a species by a particular predator varies by site, depending largely upon the local predator population level, habitat conditions, and surrounding landscape features. Some of the most common predators include: 1) non-native mammals such as red foxes, Norway rats (*Rattus norvegicus*), roof rats (*Rattus rattus*), and feral cats (*Felis catus*), 2) native mammals such as gray foxes (*Urocyon cinereoargenteus*), striped skunks (*Mephitis mephitis*) and raccoons (*Procyon lotor*), and 3) native birds such as California gulls, northern harriers (*Circus cyaneus*), common ravens (*Corvus corax*), and American crows (*Corvus brachyrhynchos*). Other less common nuisance species (e.g. Canada geese, *Branta canadensis)* may have either localized or larger scale impacts to certain special-status or sensitive species as well as health and human safety.

Predator management will occur on an as-needed basis to protect special-status and sensitive species, such as snowy plovers, clapper rails, harvest mice, and least terns from predators, as well as health and human safety. Predator management will also focus on protection of common nesting species, in order to help the project meet the objective of protection of the breeding birds within the region.

The Service has just begun the Comprehensive Conservation Planning (CCP) process for the Refuge, and the predator management program will be expanded to include both avian and mammalian nuisance species through this process. CDFG will continue predator management under an existing contract with United States Department of Agriculture (USDA), Wildlife Services, which currently includes all species described above, or any newly developed contract.

Operation and Maintenance Schedule

As described in the PBO, conservation measures require abbreviated call-count surveys to confirm the absence of clapper rails prior to any construction or excavation work near tidal marsh habitat during the breeding season (i.e., February 1 to August 31). If these surveys indicate the presence of clapper rails, construction related to O&M activities between February 1 and August 31 will be allowed only at a distance greater than 700 feet from clapper rails in adjacent marsh areas and a distance greater than 200 feet from clapper rails across a major slough channel from the construction site. Otherwise, O&M activities will take place during the non-breeding season.

Construction and excavation activities, related to O&M, in snowy plover nesting areas will occur from September 20 to February 1. Activities between September 20 and February 1 can occur only if pre-construction surveys (and monitoring, if plovers are detected within the pond) determine that no snowy plovers are actively nesting within those areas (i.e., there are no nests with eggs), all young have fledged, or that active nest sites with eggs are located more than 600 feet from the construction site. After the snowy plovers have chicks, work can be performed as long as the chicks are able to move well away from the work area and safely forage. On-going monitoring is expected to ensure that the snowy plovers are not affected by the work area.

Operation and Maintenance Action Area

The on-going O&M activities include a number of actions that may occur throughout the SBSP

Project area. The SBSP action area is described in detail in the PBO and is hereby incorporated by reference.

Proposed Operations and Maintenance Activities for PG&E

PG&E will perform regularly scheduled O&M, as well as unscheduled activities when necessary, within the SBSP Project area. O&M activities will include line patrols, tower inspections, line work, tower maintenance, access road maintenance, boardwalk maintenance, and boardwalk and boat dock construction.

The scope of this Phase 1 BO includes PG&E O&M for all the ponds and the adjoining habitats that are within the SBSP Project area and attempts to capture all future actions that PG&E may have to perform as part of routinely scheduled activities, and unforeseen unscheduled activities. All of these activities will require access (by land, water, or air), staging areas, and temporary storage areas.

Project Location

PG&E O&M activities will occur within the SBSP Project, located in Bay in Northern California within San Mateo, Santa Clara, and Alameda Counties. A detailed description of the SBSP Project area is discussed in the PBO and is hereby incorporated by reference.

PG&E Operation and Maintenance Activities

The PG&E O&M activities include the following:

- Line patrol and tower inspection
- Line work
- Tower and distribution pole maintenance
- Access road maintenance
- Boardwalk and dock maintenance
- Dock and boardwalk construction

These are described in more detail in the following sections.

Line Patrol and Tower Inspection. Scheduled and unscheduled line patrol and tower inspections will occur along PG&E boardwalks and transmission towers. Patrols and inspection access will include walking, driving vehicles, boating, and the use of helicopters. Walking will occur on PG&E boardwalks, levees, and through marsh, and other wetland habitats, when footings are inspected. Driving access will include the use of levees roads and access by boat will include docking of small watercraft at boardwalk docks, which are located at the terminus of boardwalks in slough channels, (e.g. Pond A6 dock in Alviso Slough). Helicopters will be used for inspections, cleanings, repair work, and other maintenance work on towers and lines. Helicopters may hover above, or adjacent to, lines and towers, and landings may occur on designated landing pads (e.g. Pond A6 landing pad).

Line Work. Scheduled and unscheduled line work includes reconductoring (replacing and splicing damaged conductors) and replacing damaged insulators. Reconductoring usually occurs in 2-mile sections, with a tension site and a pull site. Each site requires an area approximately 200 x 300 feet. New conductors are typically installed by temporarily splicing them to the ends of the existing conductors and pulling them through pulleys attached to the arms of the towers or pole cross arms. Boom trucks are used to install the pulleys, unless winches are required in areas where boom trucks cannot access the site. Truck mounted tensioners, small cranes, conductor reel trailers, and conductor reels are used to tension the conductors. Historic pull and tension sites are used whenever possible.

Access includes walking, driving vehicles, boating, and occasionally flying helicopters. Walking will be limited to levees and boardwalks, driving access will include the use of levees roads, and access by boat will involve docking of small watercraft at boardwalk docks, which are located at the terminus of boardwalks in slough channels. Helicopters may hover above lines, or adjacent to lines, and landings may occur on designated landing pads.

Tower and Distribution Pole Maintenance. Scheduled and unscheduled tower maintenance may include replacing damaged steel, towers, and footings, repairing concrete footings, or raising and modifying towers as necessary. Access for tower maintenance will include walking, driving vehicles, boating, and the flying helicopters. Walking will occur on PG&E boardwalks, levees, and through marsh, and other wetland habitats, when footings are inspected. In addition to inspections, construction activities may involve heavy trampling through wetlands adjacent to towers. Driving access will include the use of levees roads and access by boat will include docking of small watercraft at boardwalk docks, which are located at the terminus of boardwalks in slough channels. Tower maintenance will include the use of heavy equipment including jackhammers and impact wrenches, which will produce loud, concussive noises and vibrations. Helicopters may hover above, or adjacent to, towers during maintenance.

Access Road Maintenance. Maintenance to access roads will occur on an as-needed basis. Access road maintenance may include blading (grading) levee tops, mowing vegetation, rut repair, and other activities necessary to maintain vehicular access on levees.

Boardwalk and Dock Maintenance. Boardwalks and docks will periodically require maintenance including replacing broken planks, rebuilding boardwalk sections, raising boardwalk sections, and relocating boardwalks to different areas. Access for boardwalk and dock maintenance will include walking, driving vehicles, boating, and the use of helicopters. Walking will occur on PG&E boardwalks, levees, and through marsh, and other wetland habitats, when boardwalks are inspected. In addition to inspections, boardwalk and dock repair or construction may involve heavy trampling through wetlands. Driving access will include the use of levees roads and access by boat will include docking of small watercraft at boardwalk docks, which are located at the terminus of boardwalks in slough channels. Boardwalk and dock maintenance will include the use of heavy equipment including jackhammers and impact wrenches, which will produce loud, concussive noises and vibrations. Helicopters may hover above, or adjacent to, boardwalks and docks during maintenance.

Dock and Boardwalk Construction. New boat docks and boardwalks may be built to allow boat access to existing boardwalks and spurs may be built off existing boardwalks to allow helicopters to land equipment that is too heavy for boat transport. Access for new dock boardwalk construction will include walking, driving vehicles, boating, and the use of helicopters. Walking will occur on PG&E boardwalks, levees, and through marsh, and other wetland habitats. Boardwalk and dock construction may involve heavy trampling through wetlands. Driving access will include the use of levees roads and access by boat will include docking of small watercraft at boardwalk docks, which are located at the terminus of boardwalks in slough channels. Boardwalk and dock construction will include the use of heavy equipment including jackhammers and impact wrenches, which will produce loud, concussive noises and vibrations. Helicopters may hover above, or adjacent to, boardwalks and docks during construction.

Operation and Maintenance Schedule

- Line patrols (by foot, vehicle, driving, and helicopter) will be scheduled throughout the year as necessary and whenever a power lines go offline due to unplanned events.
- Tower inspections will be scheduled outside of the clapper rail breeding season (February 1 through August 31) unless an emergency requires work within that time frame.
- Line, tower, boardwalk, and access road maintenance will be scheduled outside of the clapper rail breeding season unless an emergency requires work within that time frame. Also, work may be conducted during the clapper rail breeding season if PG&E completes protocol-level surveys that determine there are no clapper rails within 700 feet of the project site and access route.

As noted above in *PG&E Operations and Maintenance Activities*, unscheduled line patrols, tower inspections, line work, tower and distribution pole maintenance, and other activities may occur when equipment is damaged or otherwise in need of immediate maintenance.

Conservation Measures

The conservation measures described below are specific to PG&E O&M actions. PG&E will implement the following conservation measures while conducting O&M activities to reduce or avoid adverse effects to listed species:

- Notify the Service and CDFG each time access is required
- Obey invertebrate season restrictions (dry conditions)
- Use established access routes (roads, levees, boardwalks)
- Avoid walking or driving through artificial mitigation ponds
- Minimize foot traffic in wetland vegetation

- Obey avian breeding season restriction (September 1 through January 31), unless call counts demonstrate nesting clapper rails are at least 700 feet away from PG&E's project area.
- Hover high over marsh and avoid harbor seals when using helicopters
- Avoid inspections within 2 hours of high tide when tides are higher than 6.5 feet as measured at the Golden Gate
- Not conduct work within 2 hours of high tide at construction sites in salt marshes on those days that the tide is higher than 6.5 feet as measured at the Golden Gate Bridge
- Place protective matting on marsh habitat when performing tower footing maintenance
- Conduct worker environmental training before construction begins
- Have a copy of the project description on-site during construction
- Document by brief descriptions and photographs the areas where marsh habitat was impacted immediately before work is started and work is completed. The areas will be revisited after one growing season to make sure the area has recovered
- Use established areas for pull and tension sites, turnarounds and equipment staging areas. If additional work areas are needed, they will be created in upland areas and approved by Service staff before construction
- Use shooflies when absolutely necessary and placed in upland areas approved by Service staff before construction
- Restrict the use of jackhammers to the minimum amount necessary needed to complete the work. Jackhammer usage should not exceed approximately two hours per footing in one day
- Not stage materials on marsh vegetation. Materials should be stored in upland areas, or on boats, barges and boardwalk. If necessary, temporary landing areas (constructed similar to boardwalks) in wetland areas may be used if approved by the Refuge.
- Not grade in or near artificial mitigation ponds. PG&E will place an environmental monitor on-site to monitor and document construction activities.
- Work with the Service on an ongoing basis to develop work practices which can be implemented safely by the field crews which minimize any disturbance to the sensitive species or their habitat.
- Work with the Service to develop a mitigation package for any damage done to the habitat during the emergency work.
- Repair levees as soon as practical under the guidance of Service staff. PG&E should not drive on the levees when the levees are wet.
- Minimize impacts to the hunting public such as avoiding low helicopter flights over hunters, no levee access on ponds open to waterfowl hunting on days ponds are open to hunting, and minimize the disruption of hunters using boats in sloughs. Waterfowl

hunting season will be from October through January and hunters are most numerous on weekends.

- Not conduct engine maintenance or vehicular refueling while on Service property.
- Remove construction materials from the Service's property as soon as possible and nothing will be left on the Service's property after the close of the project period.
- Deposit food and related trash in closed containers and removed from the Service's property at the end of each day.
- Immediately report all sightings of trespassers, feral cats, dogs, or red foxes observed on the Service's property. Fox dens will not be approached or searched.

Operations and Maintenance Action Area

The PG&E O&M activities include a number of actions that may occur throughout the Bay. The action area encompasses:

- Three pond complexes (Eden Landing, Alviso, and Ravenswood) and the neighboring sloughs (Mt. Eden Creek, North Creek, Old Alameda Creek, Alameda Creek Flood Control Channel, Mud Slough, Coyote Creek, Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough, Charleston Slough, and Ravenswood Slough)
- Associated staging areas, parking lots and access points near the three pond complexes
- Portions of the Bay that may be traversed by water-based equipment that may be used for dredging or other actions that require water access
- Any other areas in the vicinity of maintenance and operations that may be directly or indirectly affected by noise, dust, or other factors resulting from associated operations.

Proposed Conservation Measures

The conservation measures described in the PBO will be implemented by the Pond SF2 Restoration Action, Pond A6 Restoration Action, Pond A5, A7 and A8 Restoration Action, Pond A16 and A17 Restoration Action, Pond E8A, E8X, and E9 Restoration Action, Pond E12 and E13 Restoration Action, and O&M Activities for the Service and CDFG within the SBSP Project Area. Each of these Phase 1 actions propose to implement all of the conservation measures in the PBO to further reduce or avoid adverse effects to clapper rails, least terns, harvest mice, and snowy plovers. All of the conservation measures are described in the PBO and are hereby incorporated by reference.

STATUS OF THE SPECIES

The status of the species is described in detail in the PBO for the harvest mouse, clapper rail, least tern, and snowy plover, and is hereby incorporated by reference.

ENVIRONMENTAL BASELINE

Pond SF2 Environmental Baseline

Salt marsh harvest mouse

Small mammal trapping has not been conducted in the salt marsh outboard of Pond SF2, but the harvest mouse is known from the tidal marshes immediately to the south near Cooley Landing. Approximately 14 acres of habitat in the action area is suitable for the species.

California clapper rail

Clapper rails are known from tidal marshes to the south of Pond SF2 in the vicinity of Cooley Landing, and are known to occur in the area north of the Pond SF2, in Ravenswood Slough. The marsh adjoining Pond SF2 is relatively narrow, and could support foraging or dispersing clapper rails. This marsh (approximately 14 acres) may be too narrow to support a breeding pair or population of clapper rails, and no more than one pair likely would nest in this marsh. During one informal site assessment in February 2008, no clapper rails responded to a playback tape (J. Albertson, pers. comm.).

Western snowy plover

Since salt production was abandoned in the Ravenswood pond system, snowy plovers have established several nests each year within Pond SF2 for the past few years. Since that time, Pond SF2 and other ponds to the north of the Dumbarton Bridge have been allowed to seasonally dry and snowy plovers have colonized several of these ponds, albeit in relatively low numbers. Numbers of nests have ranged from 6 in 2004, 2 in each of 2005 and 2006, and none in 2007.

California least tern

There are no records of least terns nesting at Pond SF2, and there is no foraging habitat for the species under current pond conditions. Least terns roost and forage in ponds several miles to the south in the Mountain View and Alviso areas; the nearest nesting site is Hayward Regional Shoreline to the northeast of Pond SF2. Although no habitat currently exists at Pond SF2 for least terns, implementation of the proposed action may create potential nesting habitat that may be used by this species in the future.

Pond E12 and E13 Environmental Baseline

Salt marsh harvest mouse

The harvest mouse is known to occur in the marshes along Mount Eden Creek and there is marginal pickleweed habitat outboard of the eastern side of Ponds E12 and E13. Existing habitat in the immediate overall area is approximately 880 acres. Additionally, there is an on-going tidal restoration project on the north and east sides of this site, and tidal restoration is proposed for ponds south of the site (630 acres). Thus, these ponds may eventually be surrounded by tidal marsh that will likely support harvest mice in the future.

<u>California clapper rail</u>

No clapper rails are known from the marshes adjoining Ponds E12, E13 and E14, or from Mount Eden Creek, however clapper rails may wander into this area for foraging. Additionally, there is an on-going tidal restoration project to the north and east of the project site, and tidal restoration is proposed for the ponds south of the site (630 acres). Thus, these ponds may eventually be surrounded by tidal marsh that will likely support clapper rails in the future.

Western snowy plover

Ponds E12 and E13, especially in the vicinity of the historic salt works, have supported several breeding snowy plovers on a periodic basis over the years. Many of the ponds in the ELER complex periodically support several to moderate numbers of breeding snowy plovers. Depending on site conditions, the concentrations of breeding individuals tends to change from year to year.

Management of pond systems within the ELER complex has recently (2006-2008) focused on early drawdown of certain ponds to provide enhanced foraging and breeding habitat for snowy plovers. In 2006, early drawdown of several ELER ponds (E8, E8A, E6A, E6B) led to early establishment of 41 nests. Later that season, 23 more nests were found in Ponds E12, E13 and E14. The pattern in 2007 and 2008 was similar, with late-season nesting in Ponds E12 and E14, and earlier nesting in Pond E8A and other locations. With the dry winter, more nesting habitat was available early in the season. Additionally, late in the season as many as 150 snowy plovers were observed in the complex (including up to 100 within Pond E14 and 50 in E12 on August 10, 2007), many of which had likely nested in other sites earlier in the season (C. Robinson pers. comm.).

Current potential snowy plover nesting habitat to be impacted by the proposed action includes the dry Ponds E12 and E13 (230 acres). Other existing snowy plover habitat in the vicinity varies depending on rainfall patterns, but includes dry Ponds E8 (242 acres), E6A (322 acres), E6B (291 acres), E11 (125 acres), E14B (30 acres), E15B (45 acres), and E16B (65 acres).

California least tern

Least terns occasionally forage in ELER ponds including Ponds E10, E9, and E8A typically in late summer. The high number of individuals includes 305 birds in August of 2006, although an average of 18 birds may forage in these three ponds in the summer (USGS, prelim. data).

Least terns historically did not nest in the ELER complex of ponds. However, several pairs of least terns attempted to breed in Pond E8A in 2007 and two nests were observed in 2008 (C. Robinson pers. comm.), although the nests were depredated soon after initiation. The depredation of the least tern nests was concurrent with an influx of California gulls, although no direct observations of gull predation has been recorded. ELER ponds have been managed over the last few years to encourage breeding and foraging by snowy plovers; least terns apparently responded to these managed conditions on the site. No least terns currently utilize ponds E12 or E13.

Pond E8A, E8X, and E9 Environmental Baseline

Salt marsh harvest mouse

Little trapping of the outboard marsh adjacent to Ponds E8A, E8X, and E9 for harvest mice has been performed. However, the species is known to occur in the marshes along Mount Eden Creek and it is likely present, and relatively widespread, in high and middle elevation marsh areas in the vicinity. Existing habitat in the immediate overall area is approximately 880 acres. No suitable habitat for harvest mice currently exists within Ponds E8A, E8X, E9, or E10.

California clapper rail

Breeding habitat for clapper rails is present in the marsh south of Pond E8A within the Old Alameda Creek channel and to the west of Ponds E8A and E9 in Whale's Tail Marsh. Whale's Tail Marsh supports only a few nesting clapper rails, but Old Alameda Creek consistently supports a population of 20 to 30 clapper rails (Service, unpubl. data). Existing habitat in the immediate overall area is approximately 149 acres. No suitable habitat for clapper rails currently exists within Ponds E8A, E8X, and E9 or within pond E10.

Western snowy plover

Many of the ponds in the ELER complex periodically support low to moderate numbers of breeding snowy plovers. Concentrations of breeding snowy plovers tend to change location from year to year, depending on site conditions in each pond. Pond E8A has supported breeding snowy plovers in recent years. Twenty-six snowy plover nests were initiated in 2007, and approximately 42 have been recorded as of June 2008, although 21 are known to have been depredated (C. Robinson pers. comm.). Five nests were initiated in Pond E8X in 2007 and none have been initiated as of June 2008. Ponds E12 and E13, especially in the vicinity of the historical salt works, have also regularly supported several breeding snowy plovers (22 nests in 2006 and 14 nests in 2007).

Current potential snowy plover nesting habitat to be impacted by the proposed action includes the dry Pond E8A (282 acres). Other existing snowy plover habitat in the vicinity varies depending on rainfall patterns, but includes dry Ponds E8 (242 acres), E6A (322 acres), E6B (291 acres), E11 (125 acres), E14B (30 acres), E15B (45 acres), and E16B (65 acres).

California least tern

Least terns historically did not nest in the ELER complex of ponds. However, several pairs of least terns attempted to breed in Pond E8A in 2007 and 2 nests were observed in 2008 (C. Robinson pers. comm.), although the nests were depredated soon after initiation. The depredation of the least tern nests was concurrent with an influx of gulls although no direct observations of gull predation have been recorded. ELER ponds have been managed over the last few years to encourage breeding and foraging by snowy plovers and least terns apparently responded to these managed conditions on the site. Current potential least tern nesting habitat is the dry Pond E8A (282 acres), where least terns nest in extremely low density.

Pond A6 Environmental Baseline

Salt marsh harvest mouse

No trapping of the outboard marsh adjacent to Pond A6 for harvest mice has been performed. Although this outboard marsh is narrow, providing little in the way of refugia during extreme high tides, this pickleweed salt marsh provides suitable habitat for harvest mice, and the species is likely present here. Approximately 50 acres of narrow tidal marsh habitat exists on the outboard of Pond A6.

California clapper rail

There is virtually no breeding habitat for clapper rails in the marsh immediately surrounding Pond A6 due to the narrowness of the outboard marsh. Non-breeding clapper rails are expected to forage infrequently in the marsh immediately adjacent to Pond A6, including the areas that will be directly affected by pilot channel creation, due to the paucity of tidal channels. Tidal marsh is somewhat wider in certain areas along Alviso Slough upstream from Pond A6 (where water-based access may occur), and clapper rails have been recorded during the breeding season on both sides of Alviso Slough, along the northeastern side of Pond A5. In 2007, Point Reyes Bird Observatory (PRBO) conducted surveys for clapper rails along the middle and lower reaches of Alviso Slough. A single clapper rail was detected near the mouth of the slough, but none were heard farther upstream. Clapper rails are rarely recorded as far up Alviso Slough as the marina.

Western snowy plover

Snowy plovers historically bred in Pond A6, but since the pond was colonized by nesting California gulls in the 1980s, snowy plovers have not nested there. Within the action area for Pond A6 restoration, snowy plovers occur only within Pond A8, where they nest on exposed salt flats and remnant levees (11 nests found in 2006; 4 nests found in 2007). They occasionally nest and forage in such areas in close proximity to the "Hoxie Highway;" because this area might be used for land-based access to Pond A6, it is within the action area for Pond A6 restoration activities. No nesting habitat currently exists for snowy plovers in Pond A6.

Pond A8 Environmental Baseline

Salt marsh harvest mouse

The habitat along the bayward (i.e., downstream) reaches of Alviso and Guadalupe Sloughs (approximately 246 and 386 acres, respectively), where pickleweed is more widely distributed than in the upper reaches of these sloughs, has the potential to support harvest mice. Recent trapping results discovered this species in brackish marshes along Coyote Creek, indicating that this species could occur in at least small numbers in the brackish marshes along these two sloughs as well. However, the freshwater marshes in the vicinity of the proposed notch are not appropriate habitat for the species.

There are patches of pickleweed on inboard sides of the levees around and within these ponds, especially on the levee between Ponds A5, A7 and A8. These patches are small and isolated, and subject to inundation during high rainfall years and/or when flood flows enter these ponds. As such, it is very unlikely that they support harvest mice on a regular basis.

California clapper rail

Few surveys for clapper rails have been conducted along the middle and upper reaches of Alviso Slough or Guadalupe Slough. Although clapper rails are present in the downstream reaches of these sloughs, where the tidal marsh is dominated by salt-marsh plant species, they are not expected to nest in outboard marsh adjacent to the notch location at Pond A8, which is dominated by freshwater vegetation (e.g., California bulrush (*Scirpus californicus)* and cattail (*Typha latifolia*)). Two clapper rails were detected in a broad patch of alkali bulrush (*Scirpus robustus*) marsh along Guadalupe Slough, north of Pond A4 (approximately 17.6 acres), during surveys conducted in 1990 and 1991. However, clapper rails are not expected to nest farther upstream along Guadalupe Slough. The overall reaches of Alviso and Guadalupe Sloughs consist of approximately 246 and 386 acres, respectively.

In 2007, PRBO conducted surveys for clapper rails along the middle and lower reaches of Guadalupe and Alviso Sloughs. Single clapper rails were detected near the mouths of these sloughs (i.e., along Guadalupe Slough near the A5/A6 levee and along Alviso Slough east of Pond A6), but none were heard farther upstream.

On rare occasions, clapper rails have been recorded in brackish/freshwater transition marshes along upper Alviso Slough as far as the Alviso marina and the Gold Street Bridge, and along Guadalupe Slough as far as the non-tidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of Highway 237. However, such individuals are likely wandering, foraging individuals, and their occurrence in these areas is expected to be sporadic. For example, surveys conducted at the Alviso marina found no clapper rails during early spring 2003 and 2004. Any occurrence by clapper rails in the vicinity of the Pond A8 notch would likely be by occasional non-breeding birds.

Western snowy plover

Low densities of snowy plovers have been recorded during the breeding season, with nests and chicks, at Pond A8. Breeding occurred sporadically during the 1990s and early 2000s, and there was no recorded nesting over a period of several years. Under the ISP management regime, Pond A8 has been managed as a seasonal pond, drying every summer. That management program has attracted snowy plovers to again nest in small numbers on the pond. In 2006, 10 nests were located in Pond A8; and in 2007, 5 nests were located.

Pond A16 Environmental Baseline

Salt marsh harvest mouse

The harvest mouse is known to occur in New Chicago Marsh to the south (approximately 819 acres of marginal habitat) and Triangle Marsh to the west (approximately 85 acres) of the project area. Although no surveys have been conducted in this area, harvest mice likely occur in the marshes immediately north of Pond A17 (approximately 16 acres), and they may also be present in marsh habitat around the pond A20 dredge lock due to the presence of suitable habitat.

California clapper rail

Clapper rails are known to be present in Triangle Marsh west of Pond A17 (approximately 85 acres) and are expected to breed there. They likely use the outboard marsh between Pond A17 and Coyote Creek only for foraging due to the relatively narrow nature of this marsh, although use by breeding clapper rails is possible (approximately 50 acres). Although this marsh is brackish, dominated by alkali bulrush, such brackish marshes have been found to support breeding and wintering clapper rails in the Bay at least some years. Clapper rails may occasionally forage in the freshwater habitat of Artesian Slough (e.g., one was recorded along Artesian Slough near the EEC in January 1999 and January and February 2001; approximately 64 acres), but nesting in this freshwater habitat is not expected.

Western snowy plover

Snowy plovers are not known to occur in Ponds A16 or A17. However, if these ponds are drained prior to construction, the pond bottom could provide potentially suitable nesting habitat. Snowy plovers have been recorded in New Chicago Marsh to the south, though not in close proximity to Pond A16. Snowy plovers have occasionally bred in the impoundment to the southwest of Pond A16, between the UPRR tracks and Pond A12. No nesting habitat for plovers currently exists at Ponds A16 and A17.

California least tern

Least terns forage in nearby ponds, but USGS has recorded no least terns in either Ponds A16 or A17 during their monthly surveys from October 2002 to October 2007. There are no records of least terns breeding on or near the proposed action area. No nesting habitat for least terns currently exists at Ponds A16 and A17.

Operations and Maintenance (USFWS, CDFG and PG&E) Environmental Baseline

The environmental baseline for harvest mice, least terns, clapper rails, and snowy plovers were previously described in the PBO for the SBSP Project area and are hereby incorporated by reference.

EFFECTS OF THE PROPOSED ACTION

Pond SF2 Effects

Salt marsh harvest mouse

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

The proposed excavation of pilot channels and intakes for the new water control structures for Pond SF2 would permanently eliminate 1.19 acres (0.48 hectares) and temporarily affect 2.64 acres (1.07 hectares) of tidal marsh currently available for harvest mice. However, SBSP Project on a programmatic level will compensate for the loss of habitat available for harvest mice on a programmatic basis with the tidal restoration of other ponds (Ponds E8A, E8X, E9, A6, A8, and R1) in the area as part of the long-term SBSP Project.

Construction-related Effects

Construction within the action area could affect individual harvest mice through increased noise and vibrations from equipment and construction activities. Operation of construction equipment could result in displacement of harvest mice from protective cover and their territories (through noise and vibrations). These disturbances likely would disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and likely result in the displacement of harvest mice from their territory in the areas where their habitat is destroyed. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Thus, displaced harvest mice may suffer from increased predation, competition, and mortality.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the bayfront trail and viewing platforms may result in disturbance of harvest mice immediately adjacent to trails. Mammals including rats, cats, skunks, and raccoons which can prey upon harvest mice, are known to use the trails currently in the action area. It is possible that as human use increases after rehabilitation of the existing bayfront trail, predation on harvest mice may increase due to more garbage/food along the trail that may attract predators.

<u>California clapper rail</u>

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

The proposed excavation of pilot channels and intakes for the new water control structures for Pond SF2 would permanently eliminate approximately 1.19 acres (0.48 hectares) of suitable habitat and temporarily impact approximately 2.64 (1.07 hectares) acres of suitable habitat that may occasionally be used for foraging by clapper rails and could possibly be used for nesting by up to one pair of clapper rails. The proposed action would attempt to manage Pond SF2 at optimal water depths for shorebird foraging, which could benefit foraging clapper rails. However, there are no certainties that managing optimal water depths within Pond SF2 would result in actual use by clapper rails. The proposed SBSP Project will attempt to compensate for the loss of habitat available for clapper rails on a programmatic basis with the tidal restoration of other ponds in the area as part of the long-term SBSP Project.

Construction-related Effects

The proposed action is likely to result in disturbance to clapper rails within the tidal marsh habitat adjacent to Pond SF2. These disturbances are most likely to result from work activities associated with creating pilot channels and intakes for the water control structure; and along routes used for construction access into Pond SF2. The proposed action proposes to conduct construction activities within the tidal marshes from September 20 and February 1 to avoid the clapper rail breeding season. Implementation of the conservation measures described in the PBO will minimize construction-related impacts to clapper rails.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the bayfront trail and viewing platforms may result in disturbance of clapper rails foraging in the narrow outboard marsh between Pond SF2 and the Bay. Recreational use of the public access facilities at Pond SF2 could disturb foraging clapper rails, expose clapper rails to predation (especially during extremely high tides) by limiting their use of cover at the marsh edge, and limit use of this section of tidal marsh by this species. Revegetation proposed for the inboard side of the levee in some locations may provide additional temporary refuge for clapper rails foraging in the area. Mammals including cats, which can prey upon clapper rails, are known to use the trails currently in the action area. It is possible that as human use increases after rehabilitation of the existing bayfront trail, predation on clapper rails may increase due to more garbage/food along the trail that may attract predators.

The effects of recreational access on birds will be studied at Pond SF2. This will especially apply to nesting birds on the islands that are created, but any obvious effects of public use on clapper rails will be noted and the Service will identify any additional take that may occur which was not anticipated in this Phase 1 BO.

Western snowy plover

Habitat Loss and Restoration and Associated Loss of Individual Snowy Plovers

Approximately 159 acres (64.3 hectares) of the dry salt pond substrate habitat known to support as many as 6 pairs of nesting snowy plovers will be permanently eliminated. The proposed action would attempt to manage 81 acres (32.8 hectares) of Pond SF2 as seasonal wetland habitat, which could be used by nesting snowy plovers, and would provide suitable habitat for shorebird foraging. In addition, the remaining 159 acres (64.3 hectares) of habitat will be managed as shallow water foraging habitat with approximately 36 nesting islands. However, there are no certainties that successful restoration of these wetland habitats within this area would result in actual use and occupancy by breeding snowy plovers. Therefore, proper design of the seasonal wetlands areas within the action area is critical to optimizing the success of the proposed action. The proposed action will attempt to compensate for the loss of 159 acres (64.3 hectares) of potential snowy plover nesting habitat with the maintenance of shallow-water conditions in the central and eastern cell, the creation of islands within these acres for nesting snowy plovers, and on a programmatic basis under the SBSP Project at other nearby sites, notably with the managed pond habitat at Ponds R3 and R4.

Construction-related Effects

The proposed action is likely to result in disturbance to snowy plovers within the dry salt pond substrate. These disturbances are most likely to result from work activities associated with creating pilot channels and intakes for the water control structure; and construction of other elements of the proposed action within the interior of Pond SF2. Construction activities in the seasonal wetland area will occur between September 20 and February 1, after the breeding season as described above, if nesting snowy plovers are present. Pre-construction surveys will ensure that no snowy plovers are nesting in the construction area. However, construction activities may still disturb snowy plovers that forage in the Pond SF2 action area.

Human Disturbance and Predation Effects Associated with Public Access

The restoration of Pond SF2 has been designed to maintain a 300-foot buffer between the nesting islands to be constructed in the central and eastern cells and the edge of the pond, and between the nesting islands and PG&E boardwalk and towers. Because activities in any one area of the trail or PG&E boardwalk and towers are expected to be of short duration, this 300-foot buffer will limit disturbance of any snowy plovers that might nest or forage on the constructed islands by recreational trail users. Because the two observation platforms are expected to be points of concentration for human activities, the island layout has been designed to maintain a 600-foot buffer between islands and these two platforms to avoid disturbance of nesting snowy plovers. Human activity along Highway 84 and University Avenue could potentially disturb nesting, roosting, or foraging snowy plovers in the seasonal wetland habitat in the southwestern cell of Pond SF2. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult snowy plovers during the breeding season, and loss of foraging opportunities could result from disturbance of foraging snowy plovers. Because human use of these two roadsides will be ongoing during the nest-site selection period, snowy plovers that are intolerant of human activities are likely to nest far enough from the pond's edge so as not to be significantly disturbed by humans along Highway 84 and University Avenue. However, snowy plovers nesting for the first time may have a difficult time with nest site selection.

The proposed action intends to study the effects of trail use on birds at Pond SF2. This will especially apply to nesting birds on the islands that are created. The final design of that study has not been developed, but the general concept of the study has been developed. The public access trail will be open year-round, and the distribution of the nests in relationship to the trails will be analyzed. The study would analyze all nesting species, but nests of snowy plovers would receive special attention in the decisions regarding site management. It is anticipated that the results of the study would be incorporated into the SBSP Adaptive Management Plan (AMP), which may identify additional measures needed to avoid human-related disturbances to snowy plovers.

<u>California least tern</u>

Habitat Loss and Restoration and Associated Loss of Individual Least Terns

Least terns do not currently use Pond SF2, therefore no existing habitat will be impacted or eliminated and no least terns will be lost as a result of the proposed action.

Human Disturbance and Predation Effects Associated with Public Access

If least terns begin to use Pond SF2, the proposed 300-foot buffer between the nesting islands and the pond edge, and the proposed 600-foot buffer between the nesting islands and the viewing platforms, may or likely would minimize disturbance of nesting or roosting terns by human activities around the pond edge. If least terns were to nest in the seasonal wetland habitat in the southwestern cell, they could nest far enough from the pond's edge so as not to be significantly disturbed by human activities along Highway 84 and University Avenue. However, similar to snowy plovers, least terns nesting for the first time may have a difficult time with nest site selection.

The proposed action intends to study the effects of trail use on birds, particularly nesting birds on the islands that are created, will be studied at Pond SF2. Because least terns do not currently use Pond SF2, any use of the pond could be a net benefit to the species, however, it is possible that Pond SF2 may create a nesting "sink" for the species. Therefore, the study would analyze all nesting species, but nests of least terns would receive special attention regarding site management.

Pond E12 and E13 Effects

Salt marsh harvest mouse

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

There will be a permanent loss of tidal marsh habitat (less than 0.1 acre) due to the construction of the intake and outlet pilot channels for the new water control structures at the complex. However, the SBSP Project on a programmatic level will attempt to compensate for the loss of habitat available to harvest mice, particularly at the adjacent tidal marsh restoration of Ponds E8A, E8X, and E9 (discussed in this Phase 1 BO below).

Construction-related Effects

It is possible that individuals will be directly lost due to construction of the intake and outlet pilot channels for the new water control structures between Mount Eden Creek and Ponds E12 and E13. Conservation measures should minimize the possibility of encountering harvest mice during construction, thereby preventing loss of individuals. There is some chance that construction activities will disturb harvest mice in the vicinity of the water control structures or along routes used for access, particularly along routes that are adjacent to Mount Eden Creek outboard marshes. This disturbance is likely to be minimal and implementation of the conservation measures described in the PBO should minimize this disturbance.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the levees around ponds E12 and E13, including the viewing platform at the shoreline viewing area may result in disturbance of harvest mice immediately adjacent to the trail. It is possible that as human use increases on the levees around Ponds E12 and E13, mammals including rats, cats, skunks, and raccoons, which can prey upon harvest mice, may increase due to more garbage/food along the levees that may attract these predators. Therefore, predation on harvest mice may increase.

California clapper rail

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

There will be a permanent loss of tidal marsh habitat (less than 0.1 acre) that may occasionally be used by clapper rails in the non-breeding season due to the excavation of the pilot channel between Mount Eden Creek and ponds E12 and E13. It is anticipated that this loss of habitat for clapper rails will be compensated on a programmatic basis by the SBSP Project at other nearby sites, notably the tidal restoration of Ponds E8A, E8X, and E9.

Construction-related Effects

It is possible that the construction of water control structures and pilot channel excavations through the fringe Mount Eden Creek tidal marsh will affect clapper rails. Although the marsh is newly restored and does not yet provide nesting habitat, the proposed action may adversely affect clapper rails foraging in the action area due to construction-related disturbance. Implementation of the conservation measures described in the PBO should minimize the disturbance to foraging clapper rails and prevent the loss of individual clapper rails during construction.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the levees around ponds E12 and E13, including the viewing platform at the shoreline viewing area may result in disturbance of clapper rails immediately adjacent to the trail. It is possible that as human use increases on the levees around Ponds E12 and E13, mammals including cats, which can prey upon clapper rails, may increase due to more garbage/food along the levees that may attract these predators. Therefore, predation on clapper rails may increase.

Western snowy plover

Habitat Loss and Restoration

The 230 acres of pond that will be flooded in Ponds E12 and E13 will no longer be available for nesting snowy plovers. These ponds were historically part of the salt production system, so until recently were not available snowy plover breeding habitat. However, once the system was taken over by the CDFG, management practices have encouraged nesting in these ponds.

Although potential nesting habitat will be lost in these ponds when they are restored to tidal action, the overall SBSP Project is committed to meeting the recovery plan goal for the snowy plover. While habitat will no longer be available in these ponds, other managed ponds within ELER (including Ponds E6A, E6B, E8, E16B, E15B, E14B, and E14) and Pond SF2, will be managed intensively for the species. Therefore, the proposed action will compensate for this loss of habitat for snowy plovers on a programmatic basis as part of the SBSP Project.

Construction-related Effects

There is some potential for snowy plovers to nest within Ponds E12 and E13 during construction and snowy plovers may forage along access roads used for construction equipment. Therefore, some potential exists for loss of snowy plovers during construction. Pre-construction surveys and other conservation measures described in the PBO should avoid or reduce the possibility of direct loss of individual snowy plovers.

Construction activities have the potential to disturb snowy plovers. These disturbances may be minimized by the flooding ponds such as Ponds E12, E13, and E14. If flooding of work areas does not occur, pre-construction surveys will be implemented and 600-foot buffers will be applied around any active snowy plover nest. Also, conservation measures described in the PBO should minimize this disturbance.

Human Disturbance and Predation Effects Associated with Public Access

The Pond E12-E13 restoration has been designed to maintain a 300-foot buffer between the nesting islands and the pond edge. Because the viewing platforms are expected to be a point of concentration for human activities, the island layout has been designed to maintain a 600-foot buffer between islands and the platform to avoid disturbance of nesting snowy plovers. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult snowy plovers during the breeding season, and loss of foraging opportunities could result from disturbance of foraging snowy plovers. However, because recreational use of the trails and viewing platforms will be ongoing during the nest-site selection period, snowy plovers that are intolerant of human activities are likely to nest far enough from the pond's edge so as not to be significantly disturbed by human disturbance. However, it is possible that first-time nesters may have a difficult time with nest site selection.

<u>California least tern</u>

Habitat Loss and Restoration

Least terns do not currently use Ponds E12 and E13, therefore no existing habitat for this species will be impacted or eliminated as a result of the proposed action.

Construction-related Effects

Some ELER ponds, as well as the Bay and possibly the lower reaches of Mount Eden Creek and Old Alameda Creek, are currently used for foraging by small numbers of least terns. Therefore, some least terns could be present in the vicinity during construction activities. However, it is unlikely that construction at the project site will preclude the least tern's use of adjacent areas for foraging or the islands for nesting, and ample habitat for least terns is available in the Bay. The enhancement of fish habitat resulting from tidal marsh restoration is expected to increase fish populations in the Bay, benefiting least terns in their post-breeding staging areas.

Human Disturbance and Predation Effects Associated with Public Access

Pond E12-E13 restoration has been designed to maintain a 300-foot buffer between the nesting islands and the pond edge. Because the viewing platforms are expected to be a point of concentration for human activities, the island layout has been designed to maintain a 600-foot buffer between islands and the platform to avoid disturbance of nesting least terns. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult least terns during the breeding season, and loss of foraging opportunities could result from disturbance of foraging least terns. However, because recreational use of the trails and viewing platforms will be ongoing during the nest-site selection period, least terns that are intolerant of human activities are likely to nest far enough from the pond's edge so as not to be significantly disturbed by human disturbance. However, it is possible that first-time nesters may have a difficult time with nest site selection.

Pond E8A, E8, and E9 Effects

Salt marsh harvest mouse

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

No harvest mouse habitat currently exists in Ponds E8A, E8X, E9, or E10, however dredging of channels and breaching of levees will result in a temporary loss of 0.30 acres and a permanent loss of 1.1 acres of tidal marsh habitat for this species. In the longer term, the larger tidal prism introduced into the system is predicted to scour approximately 30 acres of additional tidal marsh in the vicinity of Pond E8A along the Old Alameda Creek and in Mount Eden Creek. Since these marshes largely consist of pickleweed, they are likely occupied by the harvest mouse, although surveys to confirm their presence have not been conducted. Although the proposed action will result in short-term loss of harvest mouse habitat, these losses will be offset by larger gains in suitable habitat as marsh is restored. The 630 acres of tidal restoration in Pond E8A, E8X, and E9 will contribute substantially to achieving the goals for recovery of the species.

Construction-related Effects

Levee lowering and levee construction activity, such as driving on outboard levees, will occur in the vicinity of habitat for the harvest mouse. Disturbance will result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance to females during the period of March through November may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success. The benefits of habitat restoration are expected to far exceed any adverse effects of construction disturbance on salt marsh harvest mice. The conservation measures as described in the PBO should minimize disturbance to harvest mice by limiting activities that can occur in marsh habitats.

California clapper rail

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

No clapper rail habitat currently exists in Ponds E8A, E8X, E9 or E10, however, dredging of channels and breaching of levees will result in a temporary loss of 0.30 acres and a permanent loss of 1.1 acres of tidal marsh habitat for this species, although channel habitat produced as a result of dredging will likely support foraging clapper rails. In the longer term, the larger tidal prism introduced into the system is predicted to scour approximately 30 acres of additional tidal marsh in the vicinity of Pond E8A along the Old Alameda Creek and in Mount Eden Creek. This area has historically supported foraging and breeding clapper rails.

Although these activities will result in the short-term loss of clapper rail tidal marsh habitat, these losses will be offset by gains in suitable habitat as marsh is restored in the newly breached ponds. The 630 acres of tidal restoration in this area due to implementation of Pond E8A, E8X, and E9 will contribute substantially to achieving the goals for recovery of the species.

It is unlikely that individuals will be directly lost due to construction activity during dredging of the channel through the marsh into the Old Alameda Creek channel or Mount Eden Creek, or activities adjacent to Whale's Tail Marsh. Nests, eggs, and young are unlikely to be present in areas where excavation will occur within the marsh, and any work performed during the breeding season will be preceded by surveys, as described in the conservation measures in the PBO, to ensure that centers of calling activity are avoided. However, it is possible that up to one pair of clapper rails could be present in the area.

Construction-related Effects

Levee lowering and levee construction activity, such as driving on outboard levees, will occur in the vicinity of foraging and breeding habitat for clapper rails, as described above. The most likely effect of such activities would be to cause harassment of clapper rails as they move farther from these activities to avoid the disturbance. While such an effect would effectively reduce the extent of foraging habitat temporarily, the long-term benefit of tidal marsh and tidal channel restoration will benefit clapper rails. Implementation of the conservation measures described in the PBO should minimize disturbance in the breeding season by avoiding work in clapper rail breeding areas.

Western snowy plover

Habitat Loss and Restoration and Associated Loss of Individual Snowy Plovers

The 630 acres of tidal marsh area that is restored in Ponds E8A, E8X, and E9 will no longer be available for approximately 26 pairs of nesting snowy plovers that are known to occupy this habitat. While habitat will no longer be available in these ponds, other ponds within the ELER and other restoration sites will be managed intensely for this species. Also, other Phase 1 actions will create more than 100 islands that may support nesting snowy plovers in managed systems (Ponds E12, E13, SF2, and A16). It is anticipated that these islands will provide high-quality nesting habitat and may attract nesting snowy plovers.

Construction-related Effects

Ponds E8A, E8X, E9, E10, E13, and E14 will be inundated prior to Pond E8A, E8X, and E9 restoration activities to prevent snowy plovers from nesting in the action area. Pond E12 will be segregated from Pond E13 and drained to provide nesting habitat for snowy plovers during restoration activities. Therefore, snowy plovers should not be nesting in ponds directly adjacent to construction activity for Ponds E8A, E8X, and E9. There is some potential for snowy plovers, including chicks, to forage along access roads for construction equipment, and thus some potential disturbance to snowy plovers during construction. However, conservation measures, including pre-construction surveys should greatly reduce, if not avoid the possibility of direct loss and disturbance of individuals.

California least tern

Habitat Loss and Restoration and Associated Loss of Individual Least Terns

The nesting habitat for least terns in Pond E8A, where least terns established nesting in 2007, will no longer be available for 2 pairs of nesting least terns after tidal marsh habitat is restored. However, tidal marsh restoration will benefit least terns by increasing the prey availability for this species. Also, other Phase 1 actions will create more than 100 islands that may support nesting birds in managed systems (Ponds E12, E13, SF2, and A16). These islands will provide nesting habitat and may attract nesting least terns.

Construction-related Effects

Ponds E8A, E8X, E9, E10, E13, and E14 will be inundated prior to Pond E8A, E8X, and E9 restoration activities to prevent birds, including least terns, from nesting in the action area. Conservation measures should greatly reduce, if not eliminate, the possibility of direct loss and disturbance of individuals.

Some of these ponds, as well as the Bay and possibly the lower reaches of Mount Eden Creek and Old Alameda Creek, are currently used for foraging by small numbers of least terns. Therefore, some individuals could be present in the vicinity during construction activities. However, it is unlikely that construction at the project site would preclude the least tern's use of adjacent areas for foraging, and ample foraging and roosting habitat for least terns is available in the Bay. In addition, restoration of tidal habitat in Ponds E8A, E8X, and E9 may provide foraging habitat for least terns in the short term, as terns may forage within the pond at high tide until sediment accretion raises the pond elevation to the point that it becomes colonized by vegetation. The enhancement of fish habitat resulting from tidal marsh restoration is expected to increase fish populations in the Bay, benefiting least terns in their post-breeding staging areas.

Pond A6 Effects

Salt marsh harvest mouse

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

Breaching of levees and excavation of pilot channels will result in the permanent loss of 1.3 acres of outboard salt marsh habitat available for harvest mice. The lowering of levees and the construction of ditch blocks will result in the permanent loss of approximately 0.1 acre of narrow strips of pickleweed on the interior of the salt pond. Widening of channels through scour resulting from increased tidal prism is expected to cause the loss of up to 20 acres of additional existing marsh. Although no surveys have been conducted, this marsh currently provides suitable habitat for harvest mice.

Construction-related Effects

Construction and excavation activities will result in increased levels of disturbance to harvest mice from noise, vibrations from equipment, and construction activities. Disturbance may result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations). Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance to females during the period of March through November may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

California clapper rail

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

Breaching of levees and excavation of pilot channels will result in the permanent loss of 1.3 acres of outboard salt marsh habitat. Widening of these channels through scour resulting from increased tidal prism is expected to cause the loss of up to 20 acres of additional existing outboard marsh around the new breaches and at the mouth of Alviso and Guadalupe Sloughs. This marsh is currently used as foraging habitat by clapper rails, although use is likely to be infrequent and by small numbers of clapper rails. It is unlikely that the tidal marsh habitat that is lost is used as breeding habitat due to its narrow nature. Channel habitat produced as a result of dredging may support foraging clapper rails.

Although these activities will result in small short-term and larger long-term loss of clapper rail tidal marsh habitat, these losses will be compensated for by the creation of suitable habitat as tidal marsh is restored in the newly breached pond. The tidal marsh that develops within Pond A6 after restoration is expected to provide high-quality breeding and foraging habitat, and the 330 acres of tidal restoration in this area will contribute to achieving the goals for recovery of the species.

Construction-related Effects

There is some potential for disturbance of clapper rails due to the noise and activity of construction equipment during excavation of pilot channels, levee lowering, levee breaching, and PG&E boardwalk construction. The most likely effect of such activities would be to displace clapper rails if they move farther from these activities to avoid the disturbance. While such an effect would temporarily reduce the extent of foraging habitat, the foraging habitat adjacent to Pond A6 is of relatively low quality due to the narrow nature of the marsh and relative scarcity of channels. These marshes would be available to any foraging clapper rails following the completion of the initial restoration activities.

Western snowy plover

Habitat Loss and Restoration and Associated Loss of Individual Snowy Plovers

Snowy plovers do not currently use Pond A6, therefore no existing habitat will be impacted or eliminated as a result of the proposed action.

Construction-related Effects

If the "Hoxie Highway" that separates Ponds A8N and A8S is used by equipment or personnel to access Pond A6 during construction activities, there is potential for disturbance of foraging or nesting snowy plovers in Pond A8N or Pond A8S, leading to the potential loss of eggs or chicks. However, implementation of the conservation measures described in the PBO requires careful monitoring of the locations of active nests and chicks on the levee. Coordination with the Service prior to the use of this levee for Pond A6 access and seasonal restrictions on the use of this access route when nesting snowy plovers are present will avoid and minimize the potential for loss of snowy plovers, including eggs and chicks.

Pond A8 Effects

Salt marsh harvest mouse

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

The 0.8 acre of tidal marsh lost as part of the proposed action is not suitable habitat for the harvest mice, however, the larger tidal prism introduced into the system is predicted to scour additional tidal marsh habitat downstream near the vicinity of Pond A6. Some of those marshes could support harvest mice.

Additionally, some of the isolated habitat within the pond complex will be inundated by the new flood regime. However, the water in the pond complex is expected to be relatively saline, and will facilitate pickleweed colonization in other areas. A band of vegetation is expected to quickly develop above the water level of the ponds under the new management regime. Harvest mice may colonize these areas, or use them occasionally in dispersal or for refugia at high tide.

Construction-related Effects

Construction and excavation activities will result in increased levels of disturbance to harvest mice from noise, vibrations from equipment, and construction activities. Disturbance may result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations). Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Therefore, there is a possibility that individual harvest mice may be harmed during the excavation of the pilot channel through the outboard marsh from the notch to Alviso Slough. However, this is unlikely because the habitat (fresh water marsh) is not suitable for harvest mice, and thus there is a low probability that harvest mice will be present.

<u>California clapper rail</u>

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

The 0.8 acre of tidal marsh lost as part of the proposed action is not suitable nesting habitat for clapper rails and provides only low-quality foraging habitat for the clapper rail. However, the larger tidal prism introduced into the system is predicted to scour additional marsh areas downstream to near the vicinity of Pond A6. Some of those marshes could support nesting or foraging clapper rails.

Construction-related Effects

Clapper rails are not expected to nest in the marsh that will be directly affected by excavation of the pilot channel between the notch and Alviso Slough, and in the event that a foraging individual is present in the impact area when excavation commences, an individual would likely be displaced before it would be killed or injured. Therefore, it is unlikely that individuals will be directly lost due to construction activity. Nevertheless, if construction at the Pond A8 notch is to occur during the breeding season, surveys (e.g., two surveys using tape playbacks during the February to mid-March primary calling period) will be conducted prior to construction to determine whether nesting clapper rails are present in the vicinity, and buffers between clapper rail activity centers and construction will be in place according the conservation measures described in the PBO. There is some potential for disturbance of clapper rails due to the noise and activity of workers and heavy equipment during excavation of the pilot channel and construction of the armored notch. However, this is very unlikely because the habitat (fresh water marsh) is of low quality to clapper rails, and nesting is not expected to occur near the notch.

<u>Western snowy plover</u>

Habitat Loss and Restoration and Associated Loss of Individual Snowy Plovers

All of the habitat in Pond A8 that has been used in the past by nesting snowy plovers will be inundated under the muted tidal management for this complex. Although potential nesting habitat will be lost in this pond when the pond is flooded prior to construction, and lost permanently when muted tidal action is introduced, the overall SBSP Project is committed to meeting the recovery plan goal for the snowy plover. Thus, while snowy plover habitat will no longer be available in Pond A8, other ponds within ELER, Warm Springs, Alviso, and Ravenswood will be managed intensively for the species, compensating for the loss of habitat at Pond A8.

Construction-related Effects

There is some potential for loss or disturbance of snowy plovers (including eggs and chicks) due to construction activities. Staging on the "Hoxie Highway", or vehicular access to or construction activity at the notch location, could potentially disturb nesting snowy plovers. However, because Pond A8 will be flooded prior to the breeding season in which construction will occur, and high water levels will be maintained to discourage snowy plovers from nesting within 600 feet of construction areas, there is a low probability that such impacts will occur. Implementation of the conservation measures described in the PBO requires careful monitoring of the locations of active nests and chicks on the levee. Consultation with Service personnel prior to the use of this levee for ponds A5 and A7 access will further minimize the potential for loss or disturbance to snowy plovers.

Pond A16 Effects

<u>Salt marsh harvest mouse</u>

Habitat Loss and Restoration and Associated Loss of Individual Harvest Mice

There will be a permanent loss of habitat due to the construction of the intake channel for the new water control structures at Pond A17 (0.4 acre), and possibly a temporary loss due to excavation during access to the Pond A20 dredge lock (0.1 acre). This loss is compensated on a programmatic basis as part of the SBSP Project at other nearby sites, notably and concurrently with the tidal restoration of Pond A6.

Construction-related Effects

It is possible that some harvest mice will be harmed due to excavation of pilot channels and levee breaching in the marshes outboard of Pond A17, and possibly during dredge lock access at Pond A20. There is some chance that construction activities will disturb harvest mice in the vicinity of the water control structures and adjacent to routes used for access. These areas may include New Chicago Marsh, Triangle Marsh, and marshes outboard of Pond A17. This disturbance is likely to be temporary and minimal, relative to the railroad traffic that generates noise, vibrations, and dust on a regular, recurring basis in the proposed action area.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the trail may result in disturbance of harvest mice immediately adjacent to the trail. However, dense pickleweed cover occurs in this area, which may provide adequate cover to minimize human-related disturbance. Mammals including rats, cats, skunks, and raccoons which can prey upon harvest mice, are known to use the trails currently in the action area. It is possible that as human use increases on this trail, predation on harvest mice may increase due to more garbage/food along the trail that may attract predators.

California clapper rail

Habitat Loss and Restoration and Associated Loss of Individual Clapper Rails

There will be a permanent loss of habitat that may occasionally be used by clapper rails due to the construction of the intake channel for the new water control structures at Pond A17 (0.4 acre), and possibly a temporary loss of habitat due to excavation during access to the Pond A20 dredge lock (0.1 acre). It is anticipated that this loss of habitat will be compensated for on a programmatic basis as part of the SBSP Project at other nearby sites, notably and concurrently with the tidal restoration of Pond A6.

Construction-related Effects

It is unlikely that individual clapper rails will be directly lost due to construction activity during either excavation of the pilot channels through marshes, levee breaches, or accessing the Pond A20 dredge lock. Nevertheless, if construction in or adjacent to suitable habitat is to occur during the breeding season, surveys (e.g., two surveys using tape playbacks during the February to mid-March primary calling period) will be conducted prior to construction to determine whether nesting clapper rails are present in the vicinity, and buffers between clapper rail activity centers and construction will be in place as described in the PBO, which will minimize the disturbance effects to clapper rails.

Human Disturbance and Predation Effects Associated with Public Access

Human use of the levees around Ponds A16 and A17, including the view platform and interpretive station, may result in disturbance to clapper rails immediately adjacent to the trail. Recreational use of the public access facilities at Pond A16 could disturb foraging clapper rails, expose clapper rails to predation (especially during extremely high tides) by limiting the clapper rails' use of cover at the marsh edge, and limit the use of adjacent tidal marsh by clapper rails. However, given the low density of clapper rails in these areas, and the low probability that nesting is occurring in the outboard marsh north of Pond A17, it is unlikely that clapper rails will be disturbed by activities along the trail.

Western snowy plover

Habitat Loss and Restoration and Associated Loss of Individual Snowy Plovers

Snowy plovers do not currently nest or occur in the proposed action area, therefore no loss of individuals or habitat will occur.

Construction-related Effects

Snowy plovers do not currently occur on the project site. Because snowy plovers may attempt to nest on the pond bottom if it is de-watered prior to construction, pre-construction surveys will ensure that no snowy plovers are nesting in the area prior to construction. Therefore, implementation of Pond A16 restoration is not expected to have adverse effects on snowy plovers.

Human Disturbance and Predation Effects Associated with Public Access

Pond A16 has been designed to maintain a 300-foot buffer between the nesting islands and the pond edge. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult snowy plovers during the breeding season, and loss of foraging opportunities could result from disturbance of foraging snowy plovers. However, because recreational use of the Alviso Slough Trail and viewing platform will be ongoing during the nest-site selection period, snowy plovers that are intolerant of human activities are likely to nest far enough from the pond's edge so as not to be significantly disturbed by human disturbance. However, first-time nesters may have a difficult time with nest site selection

The effects of trail use on nesting birds will be studied at Pond A16. The public access trail will be open year-round and the distribution of the nests in relationship to the trails will be analyzed. The study would analyze all nesting species, but nests of snowy plovers would receive special attention in the decisions regarding site management.

<u>California least tern</u>

Habitat Loss and Restoration and Associated Loss of Individual Least Terns

Least terns do not currently occur on the project site. Therefore, construction will not result in disturbance on roosting or foraging habitat for least terns.

Human Disturbance and Predation Effects Associated with Public Access

Although least terns do not nest in Pond A16, it is possible that this species may establish nests on the islands constructed in the pond and forage in the pond under the new water management regime, and/or roost on islands in the pond. If least terns use the pond, management of water levels and vegetation could potentially result in the disturbance of nesting, roosting, or foraging least terns. If least terns use Pond A16 for roosting and/or nesting, the 300-foot buffer between the nesting islands and the pond edge would minimize disturbance of nesting or roosting least terns by human activities around the pond edge. As noted above, the effects of trail use on birds, particularly nesting birds on the islands will be studied at Pond A16. The study would analyze all nesting species, but nests of least terns would receive special attention in the decisions regarding site management.

Service and CDFG Operations and Maintenance Effects

Salt Marsh Harvest Mouse

Habitat Loss and Associated Loss of Individual Harvest Mice

The proposed project is likely to result in injury or death, and harm to harvest mice through the permanent loss of their habitat and through crushing by equipment and machinery. Harvest mouse habitat may be destroyed or fragmented by dredge lock use, levee maintenance, riprap installation, and other activities that involve the movement of dredge, or other material. Creating dredge lock access channels through fringe tidal marsh may fragment harvest mouse habitat and reduce up to 4.8 acres of available marsh habitat over a 10-year period, particularly when dredge material from channels longer than 70 feet are sidecast into adjacent marshes. The inadvertent spilling of dredge material from the top of salt pond levees or storage areas may also degrade or fragment harvest mouse habitat. Barren areas of land more than 16.4 feet wide, reaches of water more than 42 feet wide, and brackish or freshwater marsh more than 820 feet wide act as barriers to movement of the southern subspecies of the harvest mouse, and hence barriers to gene flow. To reduce potential adverse effects to insignificant levels, the conservation measures described in the PBO (such as the use of temporary or permanent chokers on outboard levees, sloping the levees toward the pond, and removing and revegetating slip-outs) will be implemented.

Since Phase 1 of the SBSP Project will ultimately restore hundreds of acres of salt marsh designed to create new habitat for harvest mice, impacts related to these O&M activities are compensated through the SBSP Project and contribute to meeting the recovery objectives for this species.

Disturbance Due to On-going Operations and Maintenance Activities

On-going O&M activities may disturb harvest mice. Inspections and maintenance of ditch blocks, water control structures, docks, marine crossings, intake channels, tide gates, borrow ditches, pumps, and other routine management practices may temporarily disturb harvest mice in adjacent marsh areas. Noise and vibration created by diesel pumps, excavators, front end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, water trucks, barges, cranes, and other large equipment may also temporarily disturb nearby harvest mice. Noise and vibrations will result in displacement of harvest mice from protective cover and their territories and/or direct injury or mortality. These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of harvest mice from their territory in the areas where their habitat is destroyed. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance to females March to November may cause abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

Effects of Habitat Change

Restoration activities resulting in habitat changes (e.g. pond to tidal marsh) will increase harvest mouse habitat, thereby creating potential unforeseen disturbance issues relating to maintenance activities. For instance, as restored ponds become suitable for harvest mice, they will colonize areas where they previously did not occur. Maintenance activities in, or adjacent to restored ponds, may result in disturbance of harvest mice that will not have occurred in those areas prior to restoration activities.

California Clapper Rail

Habitat Loss and Associated Loss of Individual Clapper Rails

Activities including dredge lock use, levee maintenance, riprap installation, and other forms of maintenance that involve the movement of large equipment, and/or dredge material, may inadvertently crush and kill individual clapper rails, nests, or young. Tidal marsh and high tide refugial habitat for clapper rails could be impacted on the outboard side of the salt pond levees if dredged material were to accidentally fall or flow into the marsh. If levee topping occurred during the clapper rail breeding season, any incidental slippage of material along the salt pond levee also could result in loss of eggs or young if nests were located within the area of incidental slippage in the tidal marsh. Clapper rail habitat may be impacted by dredge lock use, levee maintenance, riprap installation, and other activities that involve the movement of dredge, or other material, that may degrade or fragment adjacent tidal marsh habitat. Creating dredge lock access channels through fringe tidal marsh may fragment clapper rail habitat and reduce up to 4.8 acres of available marsh habitat over a 10-year period, particularly when dredge material from channels longer than 70 feet are sidecast into adjacent marshes. To reduce potential adverse effects to insignificant levels, the conservation measures described in the PBO (such as the use of temporary or permanent chokers on outboard levees, sloping the levees toward the pond, and removing and revegetating slip-outs) will be implemented.

Since Phase 1 of the SBSP Project will ultimately restore hundreds of acres of salt marsh designed to create new habitat for harvest mice, impacts related to these O&M activities are compensated through the SBSP Project and contribute to meeting the recovery objectives for this species.

Disturbance of Foraging Habitat due to On-going Operations and Maintenance Activity

On-going O&M activities may disturb clapper rails. Inspections and maintenance of ditch blocks, water control structures, docks, marine crossings, intake channels, tide gates, borrow ditches, pumps, and other routine management practices may temporarily disturb clapper rails from breeding territories and/or foraging areas. Noise created by diesel pumps, excavators, front end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, water trucks, barges, cranes, and other large equipment may also temporarily disturb individual clapper rails. Clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. In some marshes, clapper rails seem highly tolerant to human activity (e.g. Palo Alto Baylands Nature Preserve), whereas others have demonstrated sensitivity to disturbance (e.g. Laumeister Marsh). This variance in sensitivity is likely correlated with the amount of routine anthropogenic disturbance associated with recreation and maintenance activities. Clapper rail reactions to disturbance may vary with season; however both breeding and non-breeding seasons are critical times.

Disturbance during the nonbreeding season may primarily affect survival of adult and subadult clapper rails. Adult clapper rail mortality is greatest during the winter, primarily due to predation. Disturbance issues may be worsened during winter high tide events, as clapper rails may experience increased vulnerability to predators. The presence of people in the high marsh plain or near upland areas during winter high tides may prevent clapper rails from leaving the lower marsh plain. Clapper rails that remain in the marsh plain during inundation are vulnerable to predation due to minimal vegetative cover available.

Effects of Habitat Change

Restoration activities resulting in habitat changes (e.g., salt pond to tidal marsh) will increase clapper rail habitat, thereby creating potential unforeseen disturbance issues relating to maintenance activities. For instance, as restored ponds become suitable for clapper rails, they will colonize areas where they previously did not occur. Maintenance activities in, or adjacent to restored ponds, may result in disturbance of clapper rails that will not have occurred in those areas prior to restoration activities.

<u>Western Snowy Plover</u>

Habitat Loss and Associated Loss of Individual Snowy Plovers

It is unlikely that on-going O&M activity will cause the loss of snowy plover habitat. Minimal loss of habitat could occur during inadvertent spilling of dredge material from the top of salt pond levees or storage areas into snowy plover breeding or foraging areas. Ponds that are managed as seasonal ponds, which could support snowy plovers, may require flooding in order to perform maintenance of the levees. There could also be minimal, temporary loss of breeding habitat as a floating dredge moves from pond to pond by excavating through the separating levee.

There is some potential for the loss of snowy plover chicks due to on-going O&M activity involving vehicular access on roads that are adjacent to snowy plover breeding habitat. In particular, levee roads adjacent to Ponds A8, A22 and A23, E6A, E6B, SF2, and R1 have the highest risk of snowy plover mortality. However, careful monitoring of the locations of active nests and chicks, a 600-foot buffer around nests and broods, and consultation with the Refuge personnel prior to the use of levee access will minimize the potential for loss of snowy plovers, including eggs and chicks.

Disturbance Due to On-going Operations and Maintenance Activities

There is some potential for disturbance of foraging snowy plovers, and possibly disturbance of nesting adults or chicks leading to the loss of eggs or chicks, due to vehicular access near snowy plover breeding areas as described above. Noise created by diesel pumps, excavators, front end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, water trucks, barges, cranes, and other large equipment may also temporarily disturb individual snowy plovers. These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of snowy plovers from disturbed areas. A minimum buffer of 600 feet around snowy plover nests will be implemented to reduce disturbance to breeding snowy plovers.

Effects of Habitat Change

Habitat changes resulting from future SBSP Phase 1 restoration activities will likely shift snowy plover habitat use from current areas, described above, to newly created managed ponds, such as Pond A16. A shift in snowy plover distribution, particularly in breeding locations, will expose snowy plovers to new disturbances associated with on-going O&M activities. For instance, maintenance activities associated with managed ponds may disturb breeding snowy plovers in those areas.

California Least Tern

Habitat Loss and Associated Loss of Individual Least Terns

There will not likely be a loss of habitat for least terns associated with on-going O&M activities. Minimal loss of foraging habitat may occur, as a result of an increase in turbidity and a reduction in dissolved oxygen, in areas where dredging occurs. However, these losses are expected to be localized and temporary.

There is some potential for the loss of least tern chicks or nests due to on-going O&M activity involving vehicular access on roads that are adjacent to least tern breeding habitat. In particular, levee roads adjacent to Pond E8A, where the most recent least tern nesting has occurred, or other roads near areas where they may breed in the future, have the highest risk of least tern mortality. However, careful monitoring of the locations of active nests and chicks and consultation with the Refuge personnel prior to the use of levee access will minimize the potential for loss of least tern eggs and chicks.

Disturbance due to On-going Operations and Maintenance Activity

On-going O&M activities may disturb least terns. Both adult and juvenile least terns roost on salt pond levees (both outboard levees and interior levees between ponds) and boardwalks. Inspections and maintenance of ditch blocks, water control structures, docks, marine crossings, intake channels, tide gates, borrow ditches, pumps, and other routine management practices may temporarily disturb least terns from roosting and foraging areas. Noise created by diesel pumps, excavators, front end loaders, bulldozers, forklifts, vibratory rollers, dump trucks, water trucks, barges, cranes, and other large equipment may also temporarily disturb individual least terns. However, due to their highly mobile nature, ability to forage in a variety of habitats, and accessibility of a variety of roost sites, it is unlikely that on-going O&M activities will cause substantial disturbance to least terns.

Effects of Habitat Change

Habitat changes resulting from future Phase 1 restoration activities may shift least tern roosting sites from current areas, described above, to newly created managed ponds, such as Ponds A16 and SF2. A shift in least tern distribution could expose least terns to new disturbances associated with on-going O&M activities. For instance, maintenance activities associated with managed ponds may disturb roosting least terns in those areas.

Potential Effects of Mercury Exposure

The listed species addressed are currently exposed to mercury when foraging on mudflats and in sloughs with high levels of mercury contamination. It is possible that certain O&M activities may increase the exposure of these species to mercury by stirring up sediments containing mercury, potentially making mercury more bioavailable to these species. The SBSP Project will be monitoring effects of Phase 1 restoration activities in the Alviso Complex on mercury contamination in sentinel species.

PG&E Operations and Maintenance Effects

Salt Marsh Harvest Mouse

Habitat Loss and Associated Loss of Individual Harvest Mice

Harvest mice habitat may be destroyed or fragmented by boardwalk construction and maintenance, dock construction, and other activities that involve work in tidal marsh. Also, the inadvertent spilling of materials from the top of salt pond levees during access road maintenance may also degrade or fragment harvest mouse habitat. Barren areas of land more than 16.4 feet wide, reaches of water more than 42 feet wide, and brackish or freshwater marsh more than 820 feet wide may act as barriers to movement of the southern subspecies of the harvest mouse, and hence barriers to gene flow.

Activities including line patrol, tower inspection, tower and distribution pole maintenance, access road maintenance, boardwalk construction and maintenance, dock construction, and other forms of maintenance or construction that involves trampling of marsh may inadvertently crush and kill individual harvest mice, nests, or young. Noise and vibration created by helicopters, trucks, jackhammers, impact wrenches, and other large equipment may temporarily disturb harvest mice in adjacent marshes. Disturbance will result in displacement of harvest mice from protective cover and their territories. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predation.

Disturbance Due to On-going Operations and Maintenance Activities

Activities such as line patrol, line work, tower inspection, tower and distribution pole maintenance, access road maintenance, boardwalk construction and maintenance, dock construction, and other O&M activities generating loud noise and vibration may disturb harvest mice. Noise and vibrations will result in displacement of harvest mice from protective cover and their territories and/or direct injury or mortality. These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of harvest mice from their territory in the areas where their habitat is destroyed. Displaced harvest mice may have to compete for resources in occupied habitat, and may be more vulnerable to predators. Disturbance to females during the period of March through November may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success. However, conservation measures will minimize disturbance to salt marsh harvest mouse

Effects of Habitat Change

Restoration activities resulting in habitat changes (e.g. pond to tidal marsh) will increase harvest mouse habitat, thereby creating potential unforeseen disturbance issues relating to PG&E O&M activities. For instance, as restored ponds become suitable for harvest mice, they will colonize areas where they previously did not occur, such as Pond A6. Maintenance activities in, or adjacent to newly restored ponds, may result in disturbance to harvest mice that will not have occurred in those areas prior to restoration activities. However, since the formation of marsh plain in areas like Pond A6 is expected to take many years, perhaps decades, potential future impacts to marsh species will be covered under PG&E's Habitat Conservation Plan (HCP) that is currently under progress.

<u>California Clapper Rail</u>

Habitat Loss and Associated Loss of Individual Clapper Rails

Clapper rail habitat may be destroyed or fragmented by boardwalk construction and maintenance, dock construction, and other activities that involve work in tidal marsh. The inadvertent spilling of materials from the top of salt pond levees during access road maintenance may also reduce or degrade clapper rail habitat.

Activities including line patrol, tower inspection, tower maintenance, access road maintenance, boardwalk construction and maintenance, dock construction, and other forms of maintenance or construction that involves trampling of marsh may inadvertently crush and kill individual clapper rail nests, or young.

Disturbance of Foraging Habitat due to On-going Operations and Maintenance Activities

Activities such as line patrol, line work, tower inspection, tower maintenance, access road maintenance, boardwalk construction and maintenance, dock construction, and other O&M activities generating loud noise and vibration may disturb clapper rails. Noise and vibration created by helicopters, trucks, jackhammers, impact wrenches, and other large equipment may also temporarily disturb individual clapper rails. Clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. In some marshes, clapper rails seem highly tolerant to human activity (e.g. Palo Alto Baylands Nature Preserve), whereas others have demonstrated sensitivity to disturbance (e.g. Laumeister Marsh). This variance in sensitivity is likely correlated with the amount of routine anthropogenic disturbance associated with recreation and maintenance activities. Clapper rail reactions to disturbance may vary with season; however both breeding and non-breeding seasons are critical times. Disturbance during the nonbreeding season may primarily affect survival of adult and subadult clapper rails. Adult clapper rail mortality is greatest during the winter, primarily due to predation. Disturbance issues may be worsened during winter high tide events, as clapper rails may experience increased vulnerability to predators. The presence of people in the high marsh plain or near upland areas during winter high tides may prevent clapper rails from leaving the lower marsh plain. Clapper rails that remain in the marsh plain during inundation are vulnerable to predation due to minimal vegetative cover available. However, conservation measures will minimize disturbance to the clapper rail.

Effects of Habitat Change

Restoration activities resulting in habitat changes (e.g. pond to tidal marsh) will increase clapper rail habitat, thereby creating potential unforeseen disturbance issues relating to PG&E O&M activities. For instance, as restored ponds become suitable for clapper rails, they will colonize areas where they previously did not occur, such as Pond A6. Maintenance activities in, or adjacent to newly restored ponds, may result in disturbance to clapper rails that will not have occurred in those areas prior to restoration activities. However, since the marsh development in areas like Pond A6 is expected to take many years, perhaps decades, potential future impacts to marsh species will be covered under PG&E's HCP that is currently under progress.

Western Snowy Plover

Habitat Loss and Associated Loss of Individual Snowy Plovers

It is unlikely that O&M activity will cause the loss of snowy plover habitat. Minimal loss of habitat could occur during inadvertent spilling of material from the top of salt pond levees during road maintenance.

There is some potential for the loss of snowy plover chicks due to O&M activity involving vehicular access on roads that are adjacent to snowy plover breeding habitat. In particular, levee roads adjacent to Ponds A8N and A8S, A22 and A23, E6A, E6B, SF2, and R1 have the highest risk of snowy plover mortality. However, careful monitoring of the locations of active nests and chicks, a 600-foot buffer around nests and broods, and coordination with the Service prior to the use of levee access will minimize the potential for loss of snowy plovers, including eggs and chicks.

Disturbance Due to On-going Operations and Maintenance Activities

There is some potential for disturbance of foraging snowy plovers, and possibly disturbance of nesting adults or chicks leading to the loss of eggs or chicks, due to vehicular access or helicopter flight near snowy plover breeding areas. Noise and vibration created by trucks, jackhammers, impact wrenches, and other large equipment may also temporarily disturb individual snowy plovers. These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of snowy plovers from disturbed areas. A minimum buffer of 600 feet around plover nests will be implemented to reduce disturbance to breeding snowy plovers.

Effects of Habitat Change

Habitat changes resulting from future Phase 1 restoration activities will likely shift snowy plover habitat use from current areas, described above, to newly created managed ponds, such as Pond A16. A shift in snowy plover distribution, particularly in breeding locations, will expose snowy plovers to new disturbances associated with PG&E O&M activities. For instance, maintenance activities associated with Pond A16 may disturb breeding snowy plovers that colonize the area.

<u>California Least Tern</u>

Habitat Loss and Associated Loss of Individual Least Terns

There will not likely be a loss of habitat for least terns associated with PG&E O&M activities. Minimal loss of foraging habitat may occur, as a result of an increase in turbidity and a reduction in dissolved oxygen, in areas where boat dock construction occurs in the water. However, these losses are expected to be localized and temporary.

There is some potential for the loss of least tern chicks or nests due to O&M activity involving vehicular access on roads that are adjacent to least tern breeding habitat. In particular, levee roads adjacent to Pond E8A, where the most recent least tern nesting has occurred, or other roads near areas where they may breed in the future, have the highest risk of least tern mortality. However, careful monitoring of the locations of active nests and chicks and coordination with the Service prior to the use of levee access will minimize the potential for loss of least tern eggs and chicks.

Disturbance due to On-going Operations and Maintenance Activities

O&M activities may disturb least terns. Both adult and juvenile least terns roost on salt pond levees (both outboard levees and interior levees between ponds) and boardwalks. Activities such as line patrol, line work, tower inspection, tower maintenance, access road maintenance, boardwalk construction and maintenance, dock construction, and other O&M activities generating loud noise and vibration temporarily disturb least terns from roosting and foraging areas. Noise and vibration created by trucks, jackhammers, impact wrenches, and other large equipment may also temporarily disturb individual least terns. However, due to their highly mobile nature, ability to forage in a variety of habitats, and accessibility of a variety of roost sites, it is unlikely that on-going O&M activities will cause substantial disturbance to least terns. However, conservation measures will minimize disturbance to the least tern.

Effects of Habitat Change

Habitat changes resulting from future Phase 1 restoration activities may shift least tern roosting and breeding sites from current areas, described above, to newly created managed ponds, such as Pond SF2. A shift in least tern distribution could expose least terns to new disturbances associated with PG&E O&M activities. For instance, maintenance activities associated with Pond SF2 may disturb roosting or nesting least terns. Also, least terns may forage in areas like

Pond A6 prior to marsh accretion, and therefore may be disturbed by PG&E activities in that area as well.

Cumulative Effects

Cumulative effects of projects in the South Bay on the harvest mouse, clapper rail, snowy plover, and least tern, are discussed in the PBO for the SBSP Project and are hereby incorporated by reference.

CONCLUSION

After reviewing the current status of the clapper rail, harvest mouse, snowy plover, and least tern, the environmental baseline for these species within the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of these species.

We based this determination on the following: (1) successful implementation of the conservation measures described in the PBO to minimize the adverse effects on individual clapper rails, least terns, snowy plovers, and harvest mice, and their habitats; (2) the relatively low number of clapper rails, harvest mice, snowy plovers, and least terns that will be harassed, harmed, or killed; and (3) the restoration actions associated with the programmatic SBSP Project will be implemented and will result in 6,800 to 11,880 acres of tidal habitat restoration and managed ponds that support these species, and is anticipated to more than compensate for the existing habitat lost identified in this biological opinion.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this incidental take statement.

The incidental take statement accompanying this biological opinion exempts take of clapper rails, harvest mice, snowy plovers, and least terns carried out in accordance with the following reasonable and prudent measures and terms and conditions, from the prohibitions contained in section 9 of the Act. It does not address the restrictions or requirements of other applicable laws. The measures described below are non-discretionary, and must be implemented by the Service.

If the Service (1) fails to require to adhere to the terms and conditions of the incidental take statement, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

Conservation measures proposed by the Service and described in the "Description of the Proposed Action" of the PBO will reduce, but do not eliminate, the potential for incidental taking of clapper rails, harvest mice, snowy plovers, and least terns. The Service expects that incidental take of the clapper rail will be difficult to detect or quantify because of the reclusive nature of this species. Similarly, the Service anticipates incidental take of individual harvest mice will be difficult to detect because of the variable, unknown size of any resident population over time, and the difficulty of finding killed or injured small mammals. The Service considers the number of harvest mice, clapper rails, least terns, and snowy plovers subject to harassment from noise and vibrations and human activities to be impracticable to estimate. The Service, therefore, anticipates the following levels of take as a result of implementation of the proposed action.

<u>SBSP Project Phase 1 Restoration Actions</u>

Due to implementation of the Phase 1 restoration actions, incidental take for harvest mice, clapper rails, least terns, and snowy plovers of is expected in the form of:

1. 4.01 acres of tidal marsh habitat available for the harvest mouse and clapper rail will be permanently lost; and 4.34 acres of tidal marsh habitat for these species will be temporarily affected as a result of construction of the proposed Phase 1 action;
2. harm, mortality, or harassment of a maximum of six (6) pairs of clapper rails due to construction of the proposed Phase 1 action within the 2 year construction time
3. harm, mortality, or harassment of up to two (2) pairs of least terns after the permanent loss of 630 acres of salt pond habitat in the Phase 1 action area due to construction of the proposed action;
4. harassment associated with public access of all least terns currently inhabiting 472 acres in Ponds A16, E12 and E13 in the Phase 1 action area; and
5. harassment associated with public access of all least terns which may occupy the newly restored 159 acres of nesting islands and seasonal habitat in Pond SF2 in the Phase 1 action area.
6. harm, mortality, or harassment of a maximum of forty-seven (47) pairs of snowy plovers after the permanent loss of 1,435 acres of salt pond nesting habitat for this species in the Phase 1 action area due to construction of the proposed action;
7. harm or mortality of harvest mice, clapper rails, least terns, and snowy plovers (either directly or by affecting their food sources and habitat availability) in the Phase 1 action area due to predation and invasion of non-native plant species;
8. harassment associated with construction (noise and vibrations) of the proposed action of all harvest mice, clapper rails, least terns, and snowy plovers within the Phase 1 action

area over the 2 year construction time; and

9. harassment associated with public access of all harvest mice, clapper rails, and snowy plovers currently inhabiting the Phase 1 action area.

Operations and Maintenance Activities

Due to implementation of operation and maintenance activities over a 10-year period, incidental take for harvest mice, clapper rails, least terns, and snowy plovers of is expected in the form of:

1. 4.8 acres of tidal marsh habitat available for harvest mice and clapper rails will be temporarily affected due to operation and maintenance activities that will occur over a 10-year period; and
2. harassment associated with operations and maintenance (noise and vibrations) of the proposed action of all harvest mice, clapper rails, least terns, and snowy plovers within the SBSP Project action area over the 10 year period.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of take on the clapper rail, harvest mouse, snowy plover, and least tern:

1. Minimize the potential for harm, harassment, or mortality of harvest mice, clapper rails, snowy plovers, and least terns.

2. Minimize the impacts of permanent loss or degradation of habitat on harvest mice, clapper rails, snowy plovers, and least terns.

Term and Condition

To be exempt from the prohibitions of section 9 of Act, the Service must comply with the following term and condition, which implements the reasonable prudent measures described above. This term and condition is nondiscretionary.

Implement the proposed action as described along with the proposed conservation measures as described in this biological opinion.

Reporting Requirements

The Service must be notified within 24 hours of the finding of any injured or dead harvest mice, clapper rails, least terns, or snowy plovers, or any unanticipated damage to their habitats associated with the proposed action. Injured harvest mice, clapper rails, least terns, or snowy plovers shall be cared by a licensed veterinarian or other qualified person, such as the Service-approved biologist for the proposed action. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. Dead animals should be sealed in a zip lock bag containing a piece of paper indicating the location, date and time when it was found, and the name of the person who found it; and the bag should be frozen in a freezer in a secure location. The Service contact persons are Chris Nagano, Deputy Assistant Field Supervisor (Endangered Species Program) at the Sacramento Fish and Wildlife Office at 916/414-6600 and Resident Agent-in-Charge, Dan Crum of the Service's Law Enforcement Division at telephone 916/414-6660.

Any contractor or employee who during routine operations and maintenance activities inadvertently kills or injures a listed wildlife species must immediately report the incident to their representative. This representative must contact the California Department of Fish and Game immediately in the case of a dead or injured listed species. The California Department of Fish and Game contact for immediate assistance is State Dispatch at (916) 445-0045.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. We make the following conservation recommendations:

1. Assist the Service in implementing other recovery actions identified within most current recovery plans for the clapper rail, harvest mouse, least tern, and snowy plover.
2. Encourage participation of prospective permittees in a program being developed by Federal and State resource agencies to limit and reverse the spread of non-native *Spartina* within the Estuary.
3. Encourage or require the use of appropriate California native species in re-vegetation and habitat enhancement efforts associated with any projects authorized by the Service.
4. Facilitate additional educational programs geared toward the importance and conservation of tidal marsh and seasonal wetlands.
5. Sightings of any listed or sensitive species should be reported to the California Natural Diversity Database of the CDFG. A copy of the reporting form and a topographic map clearly marked with the location where the individuals were observed should also be provided to the Service.

REINITIATION – CLOSING STATEMENT

This concludes formal consultation on the proposed Programmatic South Bay Salt Pond Restoration Project and Phase 1 actions. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Any reinitiation of consultation would be expected to result in supplemental biological opinions, which could be appended to this biological opinion.

If you have any questions regarding this biological opinion on the proposed South Bay Salt Pond Restoration Project Long-term Plan and the Project-level Phase 1 actions, please contact Melisa Helton at (510) 792-0717 (ext. 228) or Ryan Olah at (916) 414-6625.

Sincerely,

Cay C. Goude
Acting Field Supervisor

cc:
Scott Wilson, California Department of Fish and Game, Yountville, California
John Krause, California Department of Fish and Game, Yountville, California
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