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

21 February 2017

Kaylee Allen, Field Supervisor
Bay Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

RE: South Bay Salt Pond Restoration Project, Phase 2, Biological Assessment

Dear Ms. Allen:

On behalf of the U.S. Fish and Wildlife Service (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) and the State Coastal Conservancy (SCC), I am submitting this letter to request formal consultation for Phase 2 of the South Bay Salt Pond (SBSP) Restoration Project under Section 7 of the Endangered Species Act of 1973 (Act) (16 U.S.C. 1531 et seq.) and transmitting the Biological Assessment (BA) herein.

The SBSP Project is the largest wetland restoration project on the West Coast, encompassing 15,100 acres of the former Cargill Inc. (Cargill) salt ponds in South San Francisco Bay, which were acquired by a public-private partnership for restoration and management by the USFWS and the California Department of Fish and Wildlife (CDFW) in 2003. The Refuge and SCC propose to continue implementing the South Bay Salt Pond Restoration Project through the construction, operation, and maintenance of selected ponds as part of Phase 2 project activities that cover approximately 2,200 acres on the Refuge. Phase 2 of the SBSP Restoration Project continues the collaborative efforts among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. These activities will result in the restoration, enhancement or conservation of thousands of acres of tidal marsh, managed pond or open water habitats as well as contribute to the recovery of endangered, threatened, and other special-status terrestrial and aquatic species.

Summary of the Enclosed Biological Assessment

The enclosed BA describes the Phase 2 design elements, conservation measures, environmental setting, Action Area, consultation history with multiple agencies, and presents the determination of effects to federally listed species. Longfin smelt, a candidate species for listing under the federal ESA, is also included in this Biological Assessment per an agreement between the USFWS and the CDFW, even though the species is currently only listed under the California ESA. A separate consultation with the National Marine Fisheries Service for potential effects to federally listed anadromous fishes and Essential Fish Habitat regulated under their jurisdiction is occurring simultaneously.

The Refuge and the SCC have determined that, due to the short-term loss of tidal marsh habitat or breeding habitat, the SBSP Restoration Project *may affect, and is likely to adversely affect* salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*), California Ridgway's rail (*Rallus obsoletus obsoletus*), western snowy plover (*Charadrius nivosus nivosus*), and longfin smelt (*Spirinchus thaleichthys*). The proposed Project *may affect, but is not likely to adversely affect* the California least tern (*Sternula antillarum browni*).

Eligibility for Streamlined Consultation Guidance

We respectfully request that USFWS consider preparing the Biological Opinion for Phase 2 using the expedited consultation process that is described in the USFWS's new *Streamlined Consultation Guidance for Restoration/Recovery Projects* policy (enclosed). We believe that Phase 2 is an excellent example of a restoration and recovery project that furthers the USFWS's conservation mission for which the new guidance was developed. Phase 2 actions meet all the criteria for eligibility as follows:

Criteria A. The project/program must: (1) be developed in consultation with the Service (USFWS) and (2) have the primary purpose of conserving listed species in a manner that is consistent with the recovery needs of the species.

For Phase 2, the Refuge is a project owner and co-applicant and USFWS is the lead federal agency for the SBSP Restoration Project; a programmatic Biological Opinion from USFWS was issued to the Refuge in 2008 (81420-08-F-0621) that also provided coverage for Phase 1 actions that were completed in 2016; and the Refuge will manage, maintain and oversee monitoring for the Phase 2 Action Area. Therefore extensive consultation has occurred between the project with both sides of the USFWS (Refuges and Ecological Services) including a formal Regulatory Work Group meeting that occurs annually, in addition to more frequent informal updates.

One of the project's primary purposes is to restore, enhance, and maintain habitat for federal trust species on federally owned land. Through the restoration of former industrial salt ponds to tidal marsh, open water and managed pond habitat, Phase 2 operations would contribute to the recovery goals for the following listed species: the salt marsh harvest mouse, California Ridgway's rail, western snowy plover, and longfin smelt, as well as meet Refuge purposes.

In addition, the Project is directly implementing the goals set forth in the USFWS's Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California as well as regional planning documents such as the Baylands Ecosystem Habitat Goals Science Update, the San Francisco Bay Conservation and Development Commission's San Francisco Bay Plan, and many others.

Criteria B. Implementation of the proposed project/program must have either a proven track record of successful implementation or a high level of certainty of producing a beneficial impact (i.e., certainty of successful implementation).

Restoration of habitat for listed species was successfully achieved during Phase 1 which converted former commercial salt ponds to 1,600 acres of tidal habitats and 1,440 acres of muted tidal habitats. These tidal habitats will contribute to the recovery of endangered, threatened, and other special-status species; tidal marsh-dependent species; and the recovery of South Bay fisheries and water quality. In fact, the restored tidal marsh habitat in Pond A21 supported salt marsh harvest mice and at least 1 pair of breeding Ridgway's rails within 8 years of breaching. Given the continued positive trajectory of the other restored ponds, we fully expect additional success stories in the coming years.

Additionally, 710 acres of former commercial salt ponds were converted to managed ponds for use by migratory birds at a range of water depths to create a variety of depth, hydrology, and salinity regimes through the use of water flow control structures, grading, and other means. Efforts to enhance nesting success for the western snowy plover through pond management have proven successful, and our monitoring efforts have provided data that will continue to help managers assist in the recovery of this species. Phase 2 operations would continue the programmatic restoration efforts for the SBSP Restoration Project. The initial results of the Phase 1 actions and documentation of the progress for the SBSP Restoration Project are available for review at: http://www.southbayrestoration.org/

In fitting with the SBSP Restoration Project goals, Phase 2 work was designed to increase the net conservation benefits to federally listed species in the Action Area and the estuarine habitats that they rely on. Based on these goals, the results of the project's Initial Stewardship Plan, and Phase 1 action results, we are confident that the SBSP Restoration Project has demonstrated a proven track record of successful implementation of producing a beneficial impact to listed species.

Criteria C. The project/program must produce a beneficial impact to the species.

The SBSP Restoration Project is the largest wetland restoration project on the West Coast, with the ultimate goal of restoring 15,100 acres of habitat for the benefit of listed and special status fish and wildlife species in South San Francisco Bay. Phase 2 actions would result in the restoration, enhancement or conservation of thousands of acres of habitat and contribute to the recovery of endangered, threatened, and other special-status terrestrial and aquatic species. Habitat disturbance from construction activities would be temporary in duration and relatively small when compared to the existing habitat available to the species in and around the Action Area, as well as the extensive areas of new habitat that will be provided by the project. The long-term habitat restoration and enhancements that would be achieved by the SBSP Restoration Project actions would be a large net benefit to federally listed species.

Thank you for your consideration of this request and for the important work you do in our shared goal of recovery for endangered species and their habitats. Please feel free to contact me if you have further questions at John.Bourgeois@scc.ca.gov or 408.314.8859.

Sincerely,

John Bourgeois
Executive Project Manager
South Bay Salt Pond Restoration Project

California State Coastal Conservancy
1515 Clay Street, 10th floor
Oakland, California 94612

cc: Anne Morkill, Chris Barr, and Jared Underwood, USFWS
John Krause, CDFW
Brenda Buxton, SCC
Seth Gentzler, AECOM

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

In Reply Refer To:
FWS/AES/DER/064441

NOV 16 2016

Memorandum

To: Regional Directors, 1-8

From: Deputy Director

Subject: Streamlining Endangered Species Act Consultations for Certain Restoration and Recovery Projects

This memorandum transmits guidance on an approved method for streamlining Endangered Species Act section 7 consultations for certain projects whose primary purpose is the conservation of listed species. Implementing this guidance will facilitate and promote restoration and recovery projects that further our conservation mission. Projects that meet the standards outlined in the guidance will secure restoration and recovery benefits for listed species while avoiding any likelihood of jeopardizing species or adversely modifying or destroying their critical habitat.

If you have questions, please contact Mr. Gary Frazer, Assistant Director – Ecological Services, at (202) 208-4646.

Attachments

Streamlined Consultation Guidance
for
Restoration/Recovery Projects (RRP)

I. Introduction

Conservation planning and implementation by Federal agencies is consistent with the stated policy of Congress declared in section 2(c)(1) of the Endangered Species Act (ESA) "…that all Federal departments and agencies *shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act*." 16 U.S.C. 1531(c)(1). The purposes of the ESA, as stated in section 2(b), are "…to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved…"

Section 7(a)(1) of the ESA directs each Federal agency to carry out programs for the conservation of threatened and endangered species in consultation with the U.S. Fish and Wildlife Service and National Marine Fisheries Service. Accordingly, many Federal agencies are engaged in numerous activities that are designed with the intent of fulfilling the "conservation" policy of the ESA. Even so, because many of these conservation projects may create short-term, low-level, adverse effects to species and critical habitat associated with these activities, formal consultation is required.

Pursuant to section 7(a)(2) of the ESA, all Federal agencies must ensure that actions they authorize, fund, or carry out, including those intended to support recovery of listed species, are not likely to jeopardize listed species or adversely modify or destroy critical habitat. Proposed Federal actions that may affect listed species or critical habitat trigger the formal consultation procedures under section 7 unless they are not likely to adversely affect those species or critical habitat. If formal consultation is required, section 7 of the ESA and the implementing regulations allow 135 days for the issuance of a biological opinion addressing the proposed action following the initiation of formal consultation.

Given the Service's workload and staffing constraints, we have developed, and continue to develop, ways to enhance efficiency while retaining the effectiveness of the consultation process. This guidance document describes an approach that provides for a streamlined consultation process to be completed in less than 135 days for restoration-recovery projects (RRPs) for which there is a high level of certainty associated with expected beneficial effects.

Through this consultation streamlining process, it is our intent to create administrative incentives for Federal agencies to propose such projects as they use their authorities to implement programs for the conservation of listed species in accordance with sections 2(c)(1) and 7(a)(1) of the ESA.

The 7(a)(2) standard to "insure" against jeopardy and adverse modification typically requires a detailed understanding of numerous factors including the species' population status locally and range wide, its ecology, conservation needs, threats and behavior, as well as, behavioral and population reaction to the stressors caused by the agency action. The analysis documenting that response is often customized on a site-specific basis and cannot be approached in a generic fashion because the species' response to those stressors in that particular setting is not always predictable to the same extent.

In the context of RRPs that meet the screening criteria described below, a more generic/streamlined analysis can be applied because the overall beneficial nature of the proposed action and the scope of effects on listed species and critical habitat are more limited and targeted. Thus, a more concise, yet credible analysis can be developed to support the section 7(a)(2) determinations in the biological opinion, which can be prepared and issued in an abbreviated manner compared to the statutory time requirement of 135 days. It is anticipated that these streamlined biological opinions can be completed in a matter of days or weeks rather than over several months.

II. Criteria for RRP Inclusion in the Streamlined Consultation Process

To be eligible for the expedited consultation process, the proposed Federal action must meet the following criteria:

A. *The project/program must: (1) be developed in consultation with the Service and (2) have the primary purpose of conserving listed species in a manner that is consistent with the recovery needs of the species.*

Projects developed in consultation with the Service for the primary purpose of supporting recovery of listed species (e.g., creating, restoring, managing, maintaining, or enhancing habitat) meet this criterion. The degree of consultation necessary will be influenced by the collective experience of the Service and action agency in implementing projects such as the proposed project. While the projects will most typically be developed at the field level, they may also be developed at regional offices or Headquarters with appropriate field office coordination. All such projects should be derived from and consistent with up-to-date conservation plans (e.g., recovery outlines, recovery plans, 5-year reviews, species status assessments) that are based upon the best available scientific information. This two-pronged criterion is meant to clarify that only this subset of Federal actions are eligible for this process, and to clearly distinguish this class of actions from those actions where conservation benefits are the incidental (i.e., not purposeful) result of regulatory requirements to minimize or mitigate impacts to listed species or critical habitat. When the conservation benefits are incidental, the potential for the proposed Federal action to jeopardize listed species or to destroy or adversely modify critical habitat is not necessarily negated. Such projects will typically require more comprehensive analyses to support the section 7(a)(2) determinations.

B. *Implementation of the proposed project/program must have either a proven track record of successful implementation[1] or a high level of certainty[2] of producing a beneficial impact (i.e., certainty of successful implementation).*

To qualify for this expedited consultation process, the proposed action must have a proven track record of successful implementation to insure the required beneficial impact criterion (described below) will be satisfied. If there is not a proven track record of successful implementation for the target species, then there must alternatively be a high level of certainty of producing the intended beneficial impact for the target species (or appropriate surrogate). Proposed activities that are experimental and do not have that high level of certainty of successful implementation do not have the requisite reliability to be eligible for the expedited consultation process at this time. Such experimental projects, however, after showing a track record of successful implementation for a reasonable time period, may later qualify for inclusion.

C. *The project/program must produce a beneficial impact to the species.*

To use the expedited consultation process, the proposed action must be likely to produce a beneficial impact to the species or critical habitat that must be consistent with the recovery of the species by improving the species' habitat conditions or conservation status to an extent that will substantially outweigh any adverse effects caused by its implementation. Such projects must over an agreed-upon duration, create a demonstrable, quantifiable, beneficial impact to listed species or critical habitat, and have only short-term, temporary, small magnitude adverse effects and limited, if any, incidental take in order to meet this beneficial impact standard.

The beneficial impact standard can be achieved in many ways. For example, existing threats to a listed species or critical habitat (e.g., human disturbance, predation, habitat loss and degradation, disease, etc.) can be reduced, remediated, or eliminated by the proposed conservation activity. Habitat can be improved, restored, or managed. Conservation benefits can be accrued either directly through means such as predator removal, or indirectly by improving conditions such that aspects of the species' reproductive and survival rates are improved. Beneficial management could include actions to enhance, restore, or maintain habitat (e.g., restoring fire by prescribed burning, restoring hydrological conditions) or could reduce habitat fragmentation impacts, increase habitat connectivity, reduce the effects of catastrophic events, or establish buffers for protected areas.

---

[1] "Track record" means that the proposed activity/procedure has been successfully implemented on multiple occasions for the target species.

[2] "High level of certainty" means using known, accepted practices, procedures and techniques that are highly certain to produce the intended response or result. In the case of habitat management, there must be high level of certainty both of the intended response of habitat to the management actions, and the intended response of the species to the habitat changes. Use of similar species or habitat as surrogates is appropriate and consistent with the ESA, its implementing regulations and Service policy.

Inherent in the concept of beneficial impact is the requirement that any initial adverse effects or incidental take of listed species be small in magnitude, temporary, short-term with respect to local populations of listed species and/or units of critical habitat. Conversely, activities that may ultimately produce a beneficial impact, but have adverse effects that are not small in magnitude compared to the benefits to the affected population and are not temporary, do not qualify for the expedited consultation process.

To ensure that each program and/or project implemented is likely to produce a beneficial impact, each of the following factors must be affirmatively addressed in an effects analysis to qualify for the expedited consultation process:

- Adverse impacts (including those that conform to incidental take) are likely to be small in magnitude, temporary (meaning not continuous, recurring, or chronic), short-term and geographically local with respect to each local population being addressed? [*Note: this standard does not preclude those activities that require periodic management actions that may involve limited adverse effects.*]
- The amount or extent of incidental take of listed species is likely to be low, and is not likely to have adverse population-level impacts to the affected listed species.
- The project cannot be likely to cause a permanent net loss of habitat, net loss of habitat function, or net loss of functional value of critical habitat.

Proposed Federal actions to establish mitigation and conservation banks in response to a specific section 7(a)(2) regulatory requirement to minimize and mitigate impacts to listed species (e.g., establishing a mitigation framework or a bank related to specific projects) are not eligible for the expedited consultation process. However, proposed Federal actions to implement discrete habitat restoration and management activities (e.g., controlled burning or vegetation planting) associated with a mitigation or conservation bank may be included if they meet all of the above criteria.

South Bay Salt Ponds Restoration Project, Phase 2, U.S. Fish and Wildlife Service Biological Assessment

January 2017

60423372

This page intentionally left blank

Table of Contents

List of Appendices

List of Tables

List of Figures

List of Acronyms

AAC	All-American Canal
ABA	Architectural Barriers Act
ABAG	Association of Bay Area Governments
ADA	Americans with Disabilities Act
AMP	Adaptive Management Plan
BMP	Best Management Practice
BA	Biological Assessment
BCDC	San Francisco Bay Conservation and Development Commission
BO	Biological Opinion
Cargill	Cargill Inc.
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife (formerly CDFG)
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
Delta	San Francisco Bay Delta
EIS/R	Environmental Impact Statement/Environmental Impact Report
ESA	(Federal) Endangered Species Act
FACU	facultative upland species
FEMA	Federal Emergency Management Agency
h:v	horizontal to vertical
HDPE	high density polyethylene
HTL	high-tide line
ISP	Initial Stewardship Plan
MHHW	mean higher high water
MHW	mean high water
NASA	National Aeronautics and Space Administration

NAVD88	North American Vertical Datum, 1988
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOD	Notice of Determination
PBO	Programmatic Biological Opinion
PG&E	Pacific Gas and Electric Company
Project	South Bay Salt Pond Restoration Project
QAPP	Quality Assurance Program Plan
Refuge	Don Edwards San Francisco Bay National Wildlife Refuge
ROD	Record of Decision
ROW	right-of-way
RWQCB	San Francisco Regional Water Quality Control Board
SBSP	South Bay Salt Pond
SCC	(California) State Coastal Conservancy
SFBNWR	San Francisco Bay National Wildlife Refuge
SCVWD	Santa Clara Valley Water District
SR	State Route
SSC	suspended sediment concentration
South Bay	South San Francisco Bay
SWPPP	Storm water pollution prevention plan
UPRR	Union Pacific Railroad
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

Executive Summary

Phase 2 of the South Bay Salt Pond (SBSP) Restoration Project (Phase 2) is a collaborative effort among federal, state, and local agencies working with scientists and the public to develop and implement project-level plans and designs for habitat restoration, flood management, and wildlife-oriented public access. The Phase 2 project is located within portions of the former Cargill Inc. (Cargill) salt ponds in South San Francisco Bay (South Bay), which were acquired by the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW) in 2003. The former salt ponds included in this Biological Assessment (BA) cover nearly 2,400 acres and are part of the USFWS-owned and managed Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), which includes approximately 9,600 acres in the South Bay (Figure 1).

Phase 2 actions discussed in this BA will occur in four groups of ponds (referred to as "pond clusters" in this document: the Alviso-Island Ponds (Ponds A19, A20, and A21); the Alviso-A8 Ponds (Ponds A8 and A8S); the Alviso-Mountain View Ponds (Ponds A1 and A2W); and the Ravenswood Ponds (Ponds R3, R4, R5, and S5; Figure 2). This BA describes potential effects of the proposed Phase 2 Actions on fish and wildlife species under the jurisdiction of the USFWS, pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 United States Code [U.S.C.] §§ 1531 et seq.). Longfin smelt, a candidate species for listing under the federal ESA, is also included in this BA per an agreement between the USFWS and the CDFW, even though the species is currently only listed under the California ESA (see Section 1.3 Consultation History). The Action Area for the Phase 2 project includes all areas that are directly or indirectly affected by the federal action, as well as interrelated and interdependent actions and thus extends beyond the boundaries of the pond clusters.

Historically and recently collected data on species occurrences, research related to species distribution, and habitat assessments in the vicinity of the Action Area indicate the following threatened or endangered species may be affected by Phase 2 Actions:

- Salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*),
- California Ridgway's rail (*Rallus obsoletus obsoletus*) – formerly called the California clapper rail (*R. longirostris obsoletus*),
- Western snowy plover (*Charadrius nivosus nivosus*),
- California least tern (*Sternula antillarum browni*), and
- Longfin smelt (*Spirinchus thaleichthys*).

Table ES-1 lists the species that may be affected by the proposed Phase 2 activities and summarizes the proposed determination and rationale from the Effects of the Proposed Action (Section 6 of this BA).

Adverse effects to species may include direct take of individuals, habitat loss (through conversion) or degradation, construction disturbance, and long-term or periodic disturbance from expanded recreation or operations and maintenance activities. Though it is unlikely, a small number of individual listed species may be incidentally harmed, harassed, or killed during construction or long-term operation and use of the project. Indirect effects resulting from construction activities are limited to increases in ambient and underwater noise, increases in turbidity, and changes in water quality. Any effects from future operations, maintenance activities, and public access/recreation use of the restoration areas are expected to be discountable. Habitat conversion is identified as the major source of adverse effects, as discussed below.

Conservation measures (see Section 2.6) are provided to avoid or minimize effects from construction and operation of the project. These measures include avoiding construction during listed species breeding seasons to the maximum extent practicable, preventing the release of toxic materials, sampling and monitoring for contaminated sediments, minimization of disturbance to marsh vegetation, working at low tide whenever practicable, completing preconstruction surveys for federally listed species, and conducting biological monitoring. Additionally, the Action Area is relatively small and the construction impacts are temporary in duration compared with the extent of similar habitats in the San Francisco Bay estuary and relative to the long-term habitat enhancements and additions that would be achieved by the Phase 2 actions.

With the careful implementation of the conservation measures, only relatively small areas of mostly low quality habitat would be lost for some species. Habitat conversion losses would include the following:

1. Channels would be excavated through fringing marsh outside of breached levees to connect the ponds to the Bay; these marshes are potentially used by California Ridgway's rails and salt marsh harvest mouse.
2. Sections of internal levee slopes and adjacent pond bottoms and aquatic habitat would be filled by the placement of fill for levee improvements, the creation of habitat transition zones and habitat islands.
3. A portion of western snowy plover nesting habitat in what is currently a seasonally dry salt panne would be converted to tidal marsh.

In the long term, there would be large habitat benefits to most threatened or endangered species at the Phase 2 ponds. The proposed actions would result in considerable increases in the quantity, quality, and connectivity of tidal marsh and other estuarine habitats in the South Bay, and enhance several managed ponds. These positive outcomes would far outweigh the small areas of lost, converted or degraded habitat from filling in existing habitats. Minimal and temporary adverse effects on habitat would be expected during construction, operation, and maintenance activities.

Table ES-1. Listing Status and Effects Determinations for Federally Listed Species in Phase 2 of the SBSP Restoration Project.

SCIENTIFIC NAME	COMMON NAME	LISTING STATUS[1]	EFFECTS DETERMINATION*	RATIONALE	POTENTIAL TO OCCUR IN ACTION AREA
Mammals					
Reithrodontomys raviventris raviventris	Salt marsh harvest mouse	FE, SE, FP	Likely to adversely affect	Short-term habitat disturbance. Potential for direct take. Short-term habitat loss and degradation of habitat. Long-term net habitat gain.	Island Ponds, A8, Mountain View, Ravenswood
Birds					
Rallus obsoletus obsoletus	California Ridgway's rail	FE, SE, FP	Likely to adversely affect	Short-term habitat disturbance. Potential for direct take. Short-term habitat loss and degradation of habitat. Long-term net habitat gain.	Island Ponds, A8, Mountain View, Ravenswood
Charadrius nivosus nivosus	Western snowy plover (coastal population)	FT	Likely to adversely affect	Permanent loss of nesting habitat. Short-term habitat disturbance, potential for direct take. Short-term habitat degradation. Long-term net habitat enhancement.	Ravenswood
Sternula antillarum browni	California least tern	FE, SE, FP	Not likely to adversely affect	Short-term reduction in foraging habitat, habitat disturbance. Extremely low potential for direct take. Potential for long term foraging habitat enhancement.	Island Ponds, A8, Mountain View
Fish					
Spirinchus thaleichthys	Longfin smelt	FC, ST	Likely to adversely affect	Short-term habitat disturbance. Low potential for direct take. Potential for long term habitat enhancement.	Island Ponds, A8, Mountain View, Ravenswood

FE – Federally Endangered
FT – Federally Threatened
FC – Candidate for Federal Listing
SE – State Endangered
ST – State Threatened
FP – State Fully Protected
Source: CNDDB 2016

This page intentionally left blank

1 Introduction

1.1 Project Overview and Background

The South Bay Salt Pond (SBSP) Restoration Project is a multi-agency 50-year effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill Incorporated (Cargill) in 2003. The former salt-production areas are no longer used for that purpose, and, in many cases, they are no more saline than San Francisco Bay (Bay) itself. Immediately after the March 2003 acquisition and subsequent transfer of those ponds from Cargill, the landowners, the U.S. Fish and Wildlife Service (USWFS) and California Department of Fish and Wildlife (CDFW), began implementation of the Initial Stewardship Plan (ISP) (USFWS and CDFG 2003), which was designed to maintain open water and unvegetated pond habitats with enough water circulation to preclude salt production and maintain habitat values and conditions until the long-term restoration actions of the SBSP Restoration Project could be implemented. The longer-term planning effort involves a 50-year programmatic-level plan for restoration, flood protection, and public access. This effort has already seen the implementation of Phase 1 projects, which are described in the SBSP Restoration Project's 2007 Environmental Impact Statement/Report (hereafter, "2007 EIS/R") and the associated Biological Assessments and Biological Opinions for the project's Phase 1 actions (USFWS 2008). Long-term planning was facilitated by the California State Coastal Conservancy (SCC) and was completed in January 2009. The planning phase of the SBSP Restoration Project was completed in January 2009 with the publication of the 2007 EIS/R. Phase 1 implementation in the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) began in 2010 and was completed in December 2014. Phase 1 involved the construction of 3,040 acres of tidal or muted tidal wetlands, 710 acres of enhanced managed ponds, 7 miles of new public access trails, and habitat islands and improved levees. The selection of and planning for the Phase 2 projects started in 2010 and the Final EIS/R was released in April 2016.

Phase 2 of the SBSP Restoration Project builds on previous efforts to develop and implement plans and designs for habitat restoration, flood risk management, and wildlife-oriented public access. The former salt ponds are part of the USFWS-owned and managed Refuge, and cover approximately 9,600 acres in the South Bay (**Figure 1**). The Refuge ponds included in the Phase 2 project are collectively nearly 2,400 acres in size. Those ponds are in groups referred to as "pond clusters" in four different locations of the Refuge, as shown in **Figure 2**.

The Final EIS/R for the Phase 2 actions was adopted by the SCC (the state lead agency under the California Environmental Quality Act [CEQA]). The federal lead agency under the National Environmental Policy Act (NEPA) will file a Record of Decision (ROD) for the Final EIS/R for the Phase 2 project following the completion of this Section 7 consultation.

The ponds that were neither part of Phase 1 nor part of Phase 2 will continue to be actively managed according to the goals set forth in the ISP and the Refuge's Pond Management Plan until further implementation planning and the appropriate adaptive management studies are completed. They may be included in future project phases as well.

1.1.1 Project History

The SBSP Restoration Project is intended to tier from the analysis conducted for the 2007 EIS/R by advancing additional restoration activities within the SBSP project area. The 2007 EIS/R assessed the environmental consequences associated with two long-term restoration alternatives. In consideration of the environmental consequences discussed in the 2007 EIS/R, the USFWS ROD and the CDFW Notice of Determination (NOD) state that the USFWS and CDFW will implement Programmatic Alternative C, which would eventually convert up to 90 percent of the former salt ponds to tidal marsh, while at least 10 percent would remain as enhanced managed ponds. Phase 2, as the second project component of this long term restoration project, would incrementally advance the project toward achieving the 90/10 goal.

The 2007 EIS/R was not just a planning document but also included project-level analysis of several restoration, enhancement, recreation, and flood protection projects that would help fulfill the SBSP Restoration Project's goals and objectives. The selection of the Phase 1 projects considered a variety of factors. The criteria, as listed in the 2007 EIS/R, were available funding, likelihood of success, ease of implementation, visibility and accessibility, opportunities for adaptive management and applied studies, value in building support for the project, and certainty of investment.

Phase 1's restoration actions were successfully completed in December 2010; the last of the public access and recreation features were completed in April 2016. At the end of Phase 1, 1,600 acres of tidal habitats and 1,440 acres of muted tidal habitats were opened to tidal inundation. The tidal areas already show signs of estuarine sedimentation and natural vegetative colonization. These tidal habitats will contribute to the recovery of endangered, threatened, and other special-status species; tidal-marsh-dependent species; and the recovery of South Bay fisheries and water quality. Also, 710 acres of managed ponds were constructed for use by migratory birds at a range of water depths to create a variety of depth, hydrology, and salinity regimes through the use of flow control structures, grading, and other means. In addition, approximately 7 miles of new trail were built, providing new recreational opportunities. Small habitat transition zones were constructed in Eden Landing Pond E14 and vegetated with native upland species by volunteers. Islands were constructed in Ponds SF2, A16, and E12 and E13.

Phase 2 of the SBSP Restoration Project is a direct outgrowth of the acquisition of the Alviso and Ravenswood pond complexes (either in fee ownership or the salt-making rights) from Cargill in 2003 and the continued implementation of the larger SBSP Restoration Project laid out in the 2007 EIS/R. The project has focused on how best to manage and restore these lands.

In 2010, the Phase 2 planning was initiated. The initial project elements included restoration, public access, and flood protection[1] actions in all three pond complexes: Alviso, Ravenswood, and Eden Landing. In April 2016 the Final EIS/R for Phase 2 at the Refuge (i.e., Alviso and Ravenswood) was completed. Phase 2 at Eden Landing is proceeding separately and is not included in this consultation.

---

[1] The terminology used by the SBSP Restoration Project to describe its goals has changed from "flood protection" to "flood risk management". Not only can this distinguish improvements to existing berm-like salt pond levees from engineered levees specifically designed for flood protection, but it also reflects a general shift in terminology used by the partner organizations. This document generally uses the former term to refer to overall Project goals that were established prior to this terminology change but uses the latter term for forward-looking statements and actions that would be taken in the future.

1.1.2 Project Location

The SBSP Restoration Project is in South San Francisco Bay (South Bay) in Northern California (see **Figure 1**). Phase 2 of the SBSP Restoration Project includes parts from two complexes of former salt ponds and adjacent habitats in the South Bay that the USFWS acquired from Cargill in 2003. The salt pond complexes consist of the 8,000-acre Alviso pond complex and the 1,600-acre Ravenswood pond complex, both of which are owned and managed by USFWS as part of the Refuge (see **Figure 2**). Within these two pond complexes, there are four groups of ponds (or "pond clusters") that are included in the proposed Phase 2 actions. They are as follows:

- Alviso–Island Ponds (Island Ponds)
- Alviso–A8 Ponds (A8 Ponds)
- Alviso–Mountain View Ponds (Mountain View Ponds)
- Ravenswood Ponds

The Alviso pond complex consists of 25 ponds on the shores of the South Bay in the cities of Fremont, San Jose, Sunnyvale, and Mountain View, within Santa Clara and Alameda Counties. The pond complex is bordered on the west by the Palo Alto Baylands Park and Nature Preserve and the City of Mountain View's Charleston Slough; on the south by commercial and industrial land uses, Mountain View's Shoreline Park, the National Aeronautics and Space Administration (NASA) Ames Research Center, and Sunnyvale Baylands Park; and on the east by Coyote Creek in San Jose and Cushing Parkway in Fremont.

The Phase 2 project actions in the Alviso pond complex focus on three clusters of ponds. The first cluster, the Island Ponds, containing Ponds A19, A20, and A21 is between Coyote Creek and Mud Slough near the eastern end of the Alviso pond complex. The Island Ponds were breached in 2006 as part of tidal marsh restoration actions covered by the ISP. The second cluster, the A8 Ponds, containing Ponds A8, and A8S is in the southern and central portion of the Alviso pond complex. The A8 Ponds are west of the town of Alviso, north of Sunnyvale and State Route (SR) 237, and east of other parts of the Alviso pond complex. Ponds A8 and A8S were also included in the Phase 1 work; they were made reversibly tidal through the installation of a variable-size and reversible "notched" gate that opened in July 2010. Ponds A5 and A7 were also connected to Pond A8 and Pond A8S as part of Phase 1 actions. There would be no Phase 2 actions at that end of this group of ponds. The third cluster, the Mountain View Ponds, containing Ponds A1 and A2W is on the western edge of the Alviso pond complex. The City of Mountain View lies immediately to the south, and the Charleston Slough and the Palo Alto Flood Control Basin lie to the west.

The Ravenswood pond complex consists of seven ponds on the Bay side of the Peninsula, both north and south of SR 84, west of the Dumbarton Bridge, and on the Bay side of the developed areas of the City of Menlo Park in San Mateo County. Bayfront Park in Menlo Park is directly west of the Ravenswood pond complex, and SR 84 is along its southern border. The Phase 2 project actions in the Ravenswood pond complex are focused on the western half of the pond complex, which contains Ponds R3, R4, R5, and S5, here referred to as the Ravenswood Ponds.

Table 1 lists each pond, the cluster it is part of, and its area, center point, and latitude and longitude coordinates in decimal degrees. Pond areas in the following table are sourced from the 2007 SBSP Program Final EIS/R and provide general estimates for each pond. Areas calculated for Phase 2 operations have been updated and may slightly differ from those estimated in that 2007 Final EIS/R. Other estimates of individual ponds may appear in various documents, and these may differ because they may include the external levees instead of the internal levees, or they may have been sampled during different seasons or tidal cycles. Total areas of pond complexes or pond clusters might include uplands adjacent to them or to waterways or marshes between them.

Table 1. SBSP Phase 2 Approximate Pond Area and Location

POND CLUSTER	POND	AREA (ACRES)	LATITUDE	LONGITUDE
ALVISO-ISLAND PONDS	A19	265	37.467092	-121.957692
	A20	65	37.464876	-121.970986
	A21	150	37.465142	-121.979427
ALVISO - A8 PONDS	A8	410	37.428778	-121.991558
	A8S	160	37.420860	-121.989553
ALVISO - MOUTAIN VIEW PONDS	A1	275	37.442525	-122.086577
	A2W	435	37.441989	-122.074607
RAVENSWOOD PONDS	R3	270	37.486675	-122.155291
	R4	295	37.493048	-122.161933
	R5	30	37.488054	-122.170371
	S5	30	37.485913	-122.170712

Note: Pond areas excerpted from the 2007 SBSP Final EIS/R.
AECOM 2016

1.2 Phase 2 USFWS Biological Assessment

The purpose of this Biological Assessment (BA) is to assess the impacts of the proposed Phase 2 actions (proposed action) on federally protected species for consultation with the USFWS under Section 7 of the Endangered Species Act.

Based upon an understanding of existing environmental conditions at the project site, the analysis of potential project effects identified five species under the regulatory authority of the USFWS with potential to be affected by project activities:

- Salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*),
- California Ridgway's rail (*Rallus obsoletus obsoletus*) – formerly called the California clapper rail (*R. obsoletus*),
- Western snowy plover (*Charadrius nivosus nivosus*),
- California least tern (*Sternula antillarum browni*), and
- Longfin smelt (*Spirinchus thaleichthys*).

The remainder of this document explains how these species were identified, summarizes their potentially suitable habitats and presence or absence of individuals in the Phase 2 project areas, and how the proposed action would affect them. Greater detail describing the methods and documents used to determine the federally listed species addressed in this BA is included in Section 5.1 and Section 5.2.

The Refuge is the project proponent for Phase 2. USFWS is also the NEPA lead federal agency for implementing the Phase 2 actions. The Refuge has also opened Section 7 consultation with the National Marine Fisheries Service (NMFS) on potential effects of the proposed action on federally listed anadromous fishes and Essential Fish Habitat through a separate BA.

1.3 Consultation History

Coordination between the National Wildlife Refuge section of the USFWS and the Endangered Species section of the USFWS regarding the SBSP Restoration Project has occurred regularly since 2004. The following is a list of the major steps and events in the consultation history, including that for Phase 2 actions, though there are individual emails and telephone conversations that may not be captured here.

Programmatic and Phase 1

- Multi-agency biennial (every other year) SBSP Restoration Project meetings, as follows:
    - 2004-2007. The Refuge and other Project partners coordinated 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 Refuge and other project partners continued coordination with other federal and state and agencies regarding the development of the proposed action's programmatic and project-level biological assessments.
- Written correspondence between Refuge and USFWS between the period of 2007 and 2010.
    - The Refuge requested formal consultation on implementation of the SBSP Restoration Project (including Phase 1 actions) from the USFWS via the U.S. Army Corps of Engineers (USACE) in December 2007.
- The Refuge and CDFW released the *South Bay Salt Pond Restoration Project Final Environmental Impact Statement / Report* for the Program in December 2007; it was certified early in 2008.
- The Refuge submitted a draft Programmatic BA to USFWS for review in July 2007.
- The Refuge submitted draft Phase 1 BAs to USFWS for review in November 2008.
- USFWS issued a single biological opinion (BO) for the programmatic SBSP Restoration Project as a whole and for the Phase 1 actions in August 2008.
- Biennial regulatory agency work group meetings continued throughout the planning process for Phase 2 actions. Those meetings occurred in 2010, 2012, 2014, and 2016. Details are in the Phase 2 sub-section below.
- Annual Stakeholder Forum meetings, to which the USFWS, NMFS, and other regulatory agencies were invited, have taken place since 2010

Phase 2

- A 2010 charrette specific to the Phase 2 actions, including which ponds to include in consideration for a Phase 2 project, was conducted. The USFWS was a participant.
- Alviso Working Group meetings occurred in August 2011 and June 2012; the USFWS and NMFS were invited participants.
- The biennial regulatory agency work group was convened in November 2012, at which the earliest Phase 2 ponds and restoration concepts were presented. Design sufficient for inclusion in an EIS/R proceeded thereafter.
- A public scoping meeting on the Phase 2 actions took place in September of 2013 to present the conceptual alternatives and the plans for developing and analyzing the Phase 2 alternatives.
- The 2014 regulatory agency work group was convened in May of 2014. The refined conceptual alternatives for Phase 2 actions were presented. Work on the Draft EIS/R was in progress at that point and was completed in the summer of 2015.
- SBSP Restoration Project Executive Project Manager John Bourgeois held several meetings with San Francisco Bay Conservation and Development Commission (BCDC) between 2013 and 2016 to discuss upland transition zones and Bay fill, including participation in a BCDC Bay fill subcommittee and its "Policies for a Rising Bay" project.
- SBSP Restoration Project Executive Project Manager John Bourgeois met to discuss the Phase 2 project with regulatory staff from the U.S. Environmental Protection Agency.
- SBSP Restoration Project Executive Project Manager John Bourgeois conducted a 2015 site tour and project orientation meeting with the USFWS' Endangered Species staff.
- The Phase 2 SBSP Draft EIS/R was released in August of 2015. Following a public comment period, responses to comments, the Phase 2 SBSP Final EIS/R was prepared and released in April of 2016.
- The biennial regulatory agency work group was convened in July 2016. A strategy for permitting, including Section 7 consultation with the USFWS and the NMFS, was included. The USFWS attended and participated. By agreement between the CDFW and the USFWS, longfin smelt – a candidate species for federal listing under the ESA but is already listed under the California ESA – will be covered under Section 7 consultation for any project in which the USFWS is the federal lead agency.
- SBSP Restoration Project Executive Project Manager John Bourgeois conducted an August 2016 site visit with Frances Malamud-Roam of the USACE to field-verify some of their Jurisdictional Delineation details.

1.4 Project Purpose and Proposed Action

The overall SBSP Restoration Project purpose is to:

1. Restore and enhance a mix of wetland habitats.
2. Provide wildlife-oriented public access and recreation.
3. Provide for flood risk management in the South Bay.

The purpose of Phase 2 of the SBSP Restoration Project is to meet the needs described above by implementing the proposed work to restore tidal marsh habitat, reconfigure and enhance managed pond habitat, maintain or improve current levels of flood protection, and provide recreation opportunities and public access.

Phase 2 addresses multiple needs that include:

- Historic losses of tidal marsh ecosystems and habitats in San Francisco Bay and concomitant declines in populations of endangered species (e.g., California Ridgway's rail and salt marsh harvest mouse);
- Increasing salinity and declining ecological value in several of the ponds within the project area;
- Long-term deterioration of non-certifiable levees (for Federal Emergency Management Agency [FEMA] purposes) within the project area, which could lead to levee breaches and flooding;
- Long-term tidal flood risk management and sea level rise adaptation; and
- Limited opportunities in South San Francisco Bay for wildlife-oriented recreation.

1.4.1 Overview of Phase 2 Actions

A brief overview list of Phase 2 actions is provided below. Detailed descriptions of these actions and their location are provided in **Section 2**.

Tidal Marsh Restoration. Construction activities involved in tidal habitat restoration include the following, not all of which are planned to be implemented at all Phase 2 ponds:

- Breaching sections of outboard levees or widening existing breaches
- Lowering and removing sections of outboard levees
- Breaching or removing internal levees
- Raising and improving internal and external levees to maintain current levels of flood protection
- Armoring and bridging certain breaches to retain vehicle access
- Excavating pilot channels to sloughs through the existing fringing marsh outboard of levee breaches
- Excavating pilot channels inside of ponds to improve filling and draining
- Constructing ditch blocks in the internal borrow ditches with material excavated from the levee breaches and lowered levees, or from other clean sediment
- Importing and placing fill material from offsite upland excavation projects
- Building habitat islands
- Building habitat transition zones between pond bottoms and adjacent uplands or levees
- Removing or abandoning existing water control structures or other derelict salt works infrastructure

Managed Pond Enhancement. Construction activities involved in establishing or enhancing the habitat in managed ponds include the following, not all of which may be used at a given pond:

- Building habitat transition zones between pond bottoms and adjacent uplands or levees
- Building habitat islands
- Excavating and grading pond bottoms to achieve desired grades and elevations
- Addition of oyster shell or other nest enhancing material on habitat islands
- Installing water control structures to allow management of water depths, salinity, and other elements of water quality
- Raising and improving internal and external levees to maintain current levels of flood protection

Public Access and Recreation. Construction activities involved in installing or upgrading public access and recreation components include the following, not all of which may be used at a given pond:

- Construct several miles of new trail, most of which would be spur trails off of the Bay Trail spine
- Construct three viewing platforms with benches and interpretive panels and signage
- Reconstruct existing portions of the existing Bay Trail and other existing public access features that would be disturbed by construction
- New trails and platforms would be compliant with requirements of the ADA and ABA

1.5 Organization of the Biological Assessment

This BA is organized as follows:

- **Section 2 – Description of the Proposed Phase 2 Actions –** Describes the proposed location of Phase 2 actions, history design elements, access, construction process, schedule, and conservation measures.
- **Section 3 – Environmental Baseline –** Describes the current environmental conditions at the Phase 2 project sites, including information on climate, hydrology, and biology.
- **Section 4 – Action Area –** Describes the Action Area for the proposed action.
- **Section 5 – Species and Critical Habitats Considered –** Discusses the existing biological resources and natural environment including descriptions of federally listed species and critical habitat that may be present in the Action Area.
- **Section 6 – Effects of the Proposed Action –** Provides an analysis of proposed actions, describes modifications to the proposed Phase 2 Actions to reduce potential adverse effects on covered species, and estimates the unavoidable effects associated with the proposed Phase 2 Actions.
- **Section 7 – Determination –** Summarizes the potential adverse effects on these species and provides a final determination for each of them.
- Section 8 **–** Maps
- Section 9 **–** References

2 Description of the Proposed Action

2.1 General Features and Operations

The Phase 2 sites include several common restoration features and operations that are proposed to meet project goals. These features include levee breaching, levee raising/improvement, levee lowering or removal, habitat transition zones, habitat islands, ditch blocks, and water control structures, as well as public access and recreation features. In addition, there would be an initial overbuild for some of the features described below to compensate for the expected subsidence and settlement following material placement. All of these features are illustrated by pond cluster on **Figure 3**, sheets a-d. Detailed information proposed actions and operations at each site is provided in Section 2.3, Section 2.4, and Section 2.5. A general summary of these operations and features follows.

2.1.1 Levee Breaching

Levee breaches are proposed at specific pond locations to open the ponds to full tidal flows and/or to establish hydraulic connections between ponds. Levees would be breached after all internal pond activities are completed. Levees would be breached mechanically using earth moving equipment. Most breaches would not be reinforced and would be allowed to scour and widen naturally. Select locations would have armored breaches to support bridges where access by levee roads would be maintained. Material from breaches would be used for levee enhancements, placed into the ponds and used to create ditch blocks or pond bottom to create topographic variation and speed the return to marsh plain elevation. In one instance, an existing levee breach would be widened to increase flows through it.

2.1.2 Levee Raising/Improvement

Levee improvements are proposed at some locations to maintain or improve flood control, improve levee conditions for public access features and promote the establishment of wildlife habitat and native plant composition. These activities involve raising, widening, compacting, and otherwise improving existing levees where it is necessary to do.

2.1.3 Levee Lowering

At select locations, levees would be lowered by scraping their tops down to the local mean higher high water (MHHW) elevation. Levee lowering would enhance habitat connectivity and provide transition of some locations to tidal marsh. Levee material would be used for levee enhancements, placed into the ponds to create ditch blocks or pond bottom to establish topographic variation and speed the return to marsh plain elevation.

2.1.4 Levee Removal

Levee removal is proposed at specific ponds to restore managed ponds to tidal wetland and to enhance hydraulic connections between ponds. Levee removal would bring certain sections of levees down to the elevation of the adjoining marsh plain and would thereby help connect aquatic habitat at high tides and speed the overall restoration of tidal marsh. Levee material would be used for levee enhancement, placed into the ponds, and used to create ditch blocks or pond bottom to speed the return to marsh plain elevation.

2.1.5 Habitat Transition Zones

As an adaptation to future sea level rise, the 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 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"; this document uses the term "habitat transition zones" for these constructed features. Habitat transition zones are specifically called out in documents such as the USFWS Tidal Marsh Recovery Plan (USFWS 2013) and the recent Science Update to the Baylands Ecosystem Habitat Goals Project Report (Goals Project 2015). 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:

- Establish areas in which terrestrial marsh species can take refuge during high tides and storm events, thereby reducing their vulnerability.
- Expand habitat for a variety of special status plant species that occupy this specific elevation zone.
- 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 were 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 (generally 15:1 to 30:1 but potentially larger). 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 new levees are built to protect that area from tidal flooding, the only area remaining to build the transition zones is in the former 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 former ponds.

For these reasons, the project plans to construct the habitat transition zones inside the former salt ponds. The transition zones would improve the habitat quality of the restored marsh, particularly for endangered and threatened species, and improve resiliency of the shoreline over time as sea levels rise.

2.1.6 Habitat Islands

Within specific ponds, habitat islands would be constructed from fill and existing levees to provide isolated roosting or nesting areas for birds. These islands would increase the quality, complexity, and availability of bird habitat in the Phase 2 areas and in the Refuge in general. As the ponds transition to marsh, the island habitat would eventually become marsh mounds (possibly requiring active vegetation management), which have various ecological benefits as high-tide refugia and as focal points for further sediment aggregation and vegetation formation.

2.1.7 Ditch Blocks

To create the existing salt production evaporation ponds, earth was piled in a mound around each pond's perimeter to establish a levee that separated the pond from communicating with the waters of the Bay. The material for these levees was sourced from digging ditches around the inside perimeter of the pond, leaving a borrow ditch around the raised levees. Operations and maintenance of the levee maintained this process during salt production. Phase 2 proposes the use of ditch blocks within the borrow ditches as a means of enhancing tidal flow as select ponds are restored to tidal marshes.

Ditch blocks would be built by placing fill material inside of the historic borrow ditches to direct tidal flows into the center of the ponds instead of allowing them to flow around the interior perimeter. Fill material would be sourced from levee lowering, removal and breaching operations at each pond as well as from off-site sources.

2.1.8 Water Control Structures

Within the Ravenswood Ponds, four water control structures would be installed. Water control structures are proposed to allow management of water levels and quality in managed ponds. They would give Refuge staff more ability to avoid water quality problems, algal blooms, or other adverse impacts. The water control structures would be pipe culverts with gates at each end to provide directional control.

2.1.9 Public Access and Recreation Features

At two of the four Project locations, there would be trails and viewing platforms placed to add or improve public access and recreational opportunities in these areas. None of these features would require fill or excavation or other construction activities solely for their placement; all of these public access features would be placed on existing developed uplands or on levees that would be improved for flood risk management or other purposes.

2.1.10 Initial Overbuild

To achieve final design goals, many fill operations would require that construction elevations are built at a higher elevation than the final design. This planned overbuild is to allow for compaction, address wind and water erosion, and compensate for settling that will occur after fill is placed. Constructions elevations for levee improvements, habitat transition zones, and habitat islands would typically be constructed 2 to 4 feet above design goals.

2.2 Site Descriptions

2.2.1 Island Ponds

As shown in **Figure 3a**, the Island Ponds consists of Ponds A19, A20, and A21, the levees surrounding each pond, and some of the fringe marsh outside of these levees, including the narrow marsh between Ponds A19 and A20. Ponds A19, A20, and A21 are in the eastern portion of the Alviso pond complex. These ponds are oriented east to west between Mud Slough to the north and west and Coyote Creek to the south. Mud Slough and Coyote Creek converge at the western edge of this pond cluster. The community of Alviso and the city of Milpitas are to the south and to the east of this cluster, respectively. The ponds are geographically isolated from urbanized and built-out areas by other waterbodies, other ponds, and a landfill. The former community of Drawbridge is on a strip of land between Pond A21 and Pond A20. That strip of land also holds an active Union Pacific Railroad (UPRR) track.

All three of these ponds were breached on their southern sides in 2006 as part of the SBSP Restoration Project's ISP, which preceded the 2007 Programmatic EIS/R for the project and the subsequent Phase 1 actions. Two breaches were made into Pond A19, the easternmost of the three, and into Pond A21, the westernmost. Pond A20 is smaller and was only breached at one location. These breaches connected these ponds with Coyote Creek and began their transition to tidal marsh.

Breaches allowed sediment to accrete and vegetation to establish in Pond A21 and, to a somewhat lesser extent, in Pond A20. However, Pond A19 has been slower in its transition, and most of its accretion and vegetation has been limited in its spatial distribution to the areas nearest to the breaches.

2.2.2 A8 Ponds

As shown in **Figure 3b**, the A8 Ponds include Ponds A8 and A8S and the levees surrounding them. This pond cluster is in the south-central portion of the Alviso pond complex, between the Guadalupe Slough and Alviso Ponds A5 and A7 to the west; Sunnyvale Baylands County Park, Guadalupe Slough, Calabazas Creek, and San Tomas Aquino Creek to the south; Alviso Slough to the east and northeast; and San Francisco Bay to the north. The cities of Sunnyvale and Santa Clara are inland of the pond cluster to the south; a capped landfill lies to the southeast.

The SBSP Restoration Project set the initial goals for this pond cluster to be reversibly tidal habitat to address mercury concerns and later to possibly become fully tidal habitat, maintain or improve current levels of flood risk management, and improve recreation and public access. Ponds A8 and A8S were physically connected in the Phase 1 actions and were made "reversibly muted tidal habitat" by removing parts of the levees (and associated vehicle access) between them and between Pond A8 and the adjacent Ponds A5/A7 to the west. A reversible, armored notch (smaller than a full breach that can be closed seasonally) was made in the eastern levee of Pond A8 to allow some muted tidal exchange and to allow the Refuge to vary the size of the notched opening.

Ambient levels of mercury are elevated in Pond A8 due to sediment inputs from the upstream, long-closed New Almaden Quicksilver Mine. Therefore, there are concerns about mercury exposure in the A8 pond complex. Prior to any restoration actions, bioavailability and bioaccumulation of mercury were found to be greater in Pond A8 than in either Alviso Slough or its fringing tidal marsh.

Methylmercury concentrations in water and sediment were greater in Pond A8 than in Alviso Slough or its fringing tidal marsh channels, and biosentinels representing benthic and shoreline habitats indicated more mercury bioaccumulation in Pond A8 than in the tidal marshes along Alviso Slough (Grenier et al. 2010).

As a result, a Phase 1 action was undertaken to better understand the level of the risk and any implications of taking actions to restore tidal flows to the pond. A variable crest weir with numerous gates (also referred to as the 'notch') was installed to incrementally allow tidal waters and to study the resulting effects. Adaptive management measures have been and will continue to be used to monitor effects from the A8 Ponds. Adaptive management monitoring has included methylmercury concentrations in water and sediments; special studies of sediment scour and transport; and changes in food web indicators and sentinel species. Adaptive management actions would be triggered when mercury concentrations of sentinel species increase substantially, compared to the reference site, regardless of whether they are over or under desirable levels. If triggers are exceeded, then adaptive management actions would be implemented. Examples of such actions include changing hydraulic residence times or manipulating other factors.

Findings to date include that the initial Phase 1 construction activities temporarily increased mercury levels that were observed in Forster's tern (a piscavore) eggs in this pond immediately following Phase 1 construction activities and opening of the notch at A8. However, these levels reduced and stabilized to those found at nearby reference sites by the next nesting season (Ackerman et al. 2014). A similar trend was observed in fish, but the return to ambient levels was much quicker (~3 months) and has been consistent with reference sites ever since (Bourgeois, pers. comm.). Construction at this location for Phase 2 will not include excavation of pond bottom, only the addition of clean fill material on top of existing pond bottom, therefore re-suspension of existing mercury at this location is believed to be a minimal risk. Additionally, the approved QAPP for upland fill material will ensure that any fill used in the creation of habitat transition zones or habitat islands is free of contaminants that may enter the water.

Ponds A8 and A8S are configured and managed such that they can also be used as flood storage basins during high-rainfall events. Pond A8 contains an overflow weir. During flood events greater than a 10-year flood in the lower Guadalupe River and Alviso Slough, water can overflow into Pond A8 for initial flood storage. Recreation and public access features at these ponds themselves are limited to a hunter check-in station and a hunter-use small boat launch area along the northwestern edge of A8S.

2.2.3 Mountain View Ponds

The Mountain View Ponds are in the western portion of the Alviso pond complex, between Charleston Slough and the Palo Alto Flood Basin to the west; City of Mountain View's Shoreline Park, Mountain View Mitigation Marsh, and Stevens Creek Mitigation Marsh to the south; Stevens Creek and Whisman Slough to the east; and the open Bay to the north. Permanente Creek, which flows into Mountain View Slough, is between Ponds A1 and A2W. The cities of Mountain View and Palo Alto are immediately inland of the pond cluster to the south and west, respectively. As shown in **Figure 3c**, for the purposes of this document, the Mountain View Ponds consists of Pond A1, Pond A2W, the levees surrounding each pond, some of the fringe marsh outside of the pond and slough levees, Permanente Creek, and Mountain View Slough. Charleston Slough, which is owned by the City of

Mountain View is not part of the Refuge, is not included in the proposed project itself, but one of the levees around it – the Coast Casey Forebay levee – is included because it also borders Pond A1. The improvements proposed for the Coast Casey Forebay levee extend beyond the border of Pond A1 and would provide a greater level of increased flood risk management than the improvements to other levees. These differences are discussed in more detail below.

Unlike the Island Ponds or the A8 Ponds, the Mountain View Ponds have not been subject to previous restoration actions under the SBSP Restoration Project. The ponds themselves are somewhat subsided and have water depths of approximately 2 to 4 feet above pond bottom elevations that are at approximately 0-1 feet elevation North American Vertical Datum of 1988 (NAVD88). As illustrated in Chapter 3 of the SBSP Restoration Project Final Environmental Impact Statement/Report (AECOM 2016), the ponds have limited hydrologic exchange with the Bay, as there is one small culverted inlet into Pond A1, a siphon to connect it to Pond A2W, and an outflow connection from Pond A2W back to the Bay.

2.2.4 Ravenswood Ponds

As shown in **Figure 3d**, the Phase 2 Ravenswood pond cluster consists of Ponds R3, R4, R5, and S5; the levees surrounding each pond; some of the fringe marsh outside of these levees; and the All-American Canal (AAC). The pond cluster is bordered by Menlo Park's Bedwell Bayfront Park to the west, SR 84 and the city of Menlo Park to the south, Ravenswood Slough to the east, and Greco Island and open Bay water to the north. A small triangular pond is to the immediate west of Pond S5. This pond is unnamed and is labeled or described in various documents in three different ways: part of Pond S5, a separate but unnamed pond, or as the forebay of Pond S5. This document refers to it as the Pond S5 forebay.

There are a number of complicated easements as well as several different landowners in the area where Flood Slough, the Pond S5 forebay, SR 84, Marsh Road, Bedwell Bayfront Park, and the driveway into the park, all come together. This area includes various parcels and their owners, as well as easements for utilities or access. Cargill holds fee title on much of Flood Slough and has a 10-foot wide pipeline strip of property along the entire southern border of Ponds S5 and R3. Cargill's coordination and approval would be required for any proposed activities that would take place on, cross, or otherwise affect lands or properties it owns or to which it holds fee title. This includes proposed additions of fencing, building a trail that would cross Cargill's pipeline easement, and connecting Flood Slough to the S5 forebay. Similar statements would apply to the City of Menlo Park and the West Bay Sanitary District, which are also landowners, and to the California Department of Transportation and other holders of utility easements.

2.3 Proposed Action

The SBSP Restoration Project's proposed actions for Phase 2 provide a variety of habitat enhancements at all four pond clusters and include maintained or increased flood risk management, and additional public access and recreation features at two of the pond clusters. **Figures 3a-3d** illustrate the proposed construction as it would be implemented at each of the Phase 2 pond clusters. More detailed engineering drawings of these features are presented in Appendix A. The pond-cluster specific operations are discussed in detail in the following sections.

2.3.1 Island Ponds

The proposed project would increase habitat connectivity, tidal flow and expedite the transition of these ponds to tidal marsh.

Proposed project activities at the Island Ponds include the following actions, all of which are illustrated in **Figure 3a.**

2.3.1.1 Lower Portions of Pond A19 Northern Levee

Lower much of Pond A19's northern levee to MHHW elevation (approximately 7 feet NAVD88), but leave portions of that levee at existing elevations to provide more high-tide refugia and roosting or nesting areas. Levee lowering locations would be grubbed and cleared before constructions and would be hydroseeded with native plan seed mix after lowering is complete. The levee lowering would further increase habitat complexity and connectivity, while unchanged sections of this levee would become island-like high-tide refugia. Cut volumes and areas for levee lowering at Island Ponds are provided in **Table 2**.

2.3.1.2 Widen the Westernmost of the Two Existing Breaches on the Southern Levee of Pond A19

Widening the existing western breach along Pond A19's southern levee would improve the circulation and flow of sediment into the pond, speed the breakdown of the remaining levee, and increase the rate of transition to marsh habitat. Following the widening, the breach would have a bottom width of approximately 150 feet, an invert elevation near 3.5 feet NAVD88 and 3:1 (h:v) side slopes. The length of the cut would be approximately 90 feet. Cut volumes and areas for breach widening are provided in **Table 2**.

2.3.1.3 Remove Most of the Western Levee of Pond A19 and the Eastern Levee of Pond A20

Removing most of the levees between Ponds A19 and A20 would add more habitat connectivity by connecting the two former ponds. Removal of these levees would be to the elevation of the strip of existing marsh between the two ponds, to an approximate elevation of 6.6 feet NAVD88. Sections of these two levees would be left at their existing elevations to provide high-tide refugia for birds and other wildlife species. Their removal would create a larger area of connected marsh and aquatic habitat. Cut volumes and areas for levee removal are provided in **Table 2**.

2.3.1.4 Construct Two Breaches on the North Side Levee of Pond A19 to Connect the Pond with Mud Slough

By adding north side breaches, the habitat connectivity at the Island Ponds would increase, and the distribution of sediment and vegetation would improve. This action would include excavating a channel through the adjacent fringing tidal marsh. Both breaches would be roughly 50 feet wide at the bottom with an invert elevation of 3.5 feet NAVD88 with 3:1 (horizontal to vertical [h:v]) side slopes. The length of channels cut to connect Pond A19 with Mud Slough through the levees would be approximately 150 feet at the Pond A19 northwest breach and approximately 90 feet at the Pond A19 northeast breach. Cut volumes and areas for levee breaches and associated channels are provided in **Table 2**.

2.3.1.5 Install Ditch Blocks and Fill Existing Borrow Ditches

Placement of material from levee breaching and other modifications would be used to establish ditch blocks or placed into the ponds' borrow ditches. Placing fill into borrow ditches and constructing ditch blocks would speed the transition to tidal marsh. Phase 2 operations would build approximately 6 ditch blocks in Pond A19. Ditch blocks would be established in the existing borrow ditches to direct tidal flows into the interior of the ponds. The material for the ditch blocks would be sourced on-site from levee lowering or breaches. All fill for ditch blocks and material placed on pond bottoms to enhance topographic variation would be below MHHW elevation. The fill for the ditch blocks would be from the levee modifications done at the site as part of the project. Therefore, there would be no imported fill at the Island Ponds. Estimated fill volumes for ditch blocks and re-used levee material placed in ponds is provided in **Table 3**.

Table 2. Island Ponds - Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	FOOTPRINT AREA (ACRES)	AREA BELOW MHHW (ACRES)
Pond A19	Northwest Levee Lowering	5,000	1,000	1.4	0.4
Pond A19	North Levee Lowering (Middle)	1,800	450	0.5	0.1
Pond A19	Northeast Levee Lowering	2,600	520	0.6	0.2
Pond A19	Southwest Levee Lowering	1,400	280	0.5	0.2
Pond A19	Southeast Levee Lowering	1,900	380	0.5	0.2
Subtotal	***Levee Lowering***	***12,700***	***2,630***	***3.3***	***1.0***
Pond A19	Southwest Levee Removal	1,400	467	0.4	0.2
Pond A19	Northwest Levee Removal	3,200	1,067	0.8	0.2
Pond A20	Northeast Levee Removal	1,400	467	0.4	0.2
Pond A20	Southeast Levee Removal	2,900	967	0.9	0.4
Subtotal	***Levee Removal***	***8,900***	***2,967***	***2.5***	***1.0***
Pond A19	Northwest Breach	1,400	800	0.2	0.2
Pond A19	Northeast Breach	1,000	230	0.1	0.1
Pond A19	South Breach Widening	1,500	560	0.2	0.2
Subtotal	***Levee Breaches***	***3,900***	***1,590***	***0.6***	***0.4***
Totals	**Existing Levee Fill Removed**	**25,500**	**7,187**	**6.4**	**2.4**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 3. Island Ponds - Estimated Fill Volumes and Areas

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Pond A19 - Northwest Breach - Ditch Block 1	1,800	1,800	0.3	0.3
Pond A19 - Northwest Breach - Ditch Block 2	1,900	1,900	0.3	0.3
Pond A19 - Northeast Breach - Ditch Block 1	1,500	1,500	0.3	0.3
Pond A19 - Northeast Breach - Ditch Block 2	1,400	1,400	0.3	0.3
Pond A19 - South Breach Widening - Ditch Block 1	2,200	2,200	0.3	0.3
Pond A19 - South Breach Widening - Ditch Block 2	2,200	2,200	0.4	0.4
Other placed Levee Material	14,500	14,500	4.7	4.7
Total	**25,500**	**25,500**	**6.6**	**6.6**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

2.3.2 A8 Ponds

2.3.2.1 Construct and Vegetate Habitat Transition Zones

The proposed project activities at the A8 Ponds, illustrated in **Figure 3b**, would build habitat transition zones at the southwest and southeast corners of Pond A8S to provide a range of benefits. The benefits of this operation include establishment of habitat complexity and diversity, erosion protection for the landfill and adjacent levees, and preparation for long-term sea-level rise adaptation. These benefits would provide critical components to the potential long-term restoration plan for the A8 Ponds – to restore them to full tidal action. The operations would include building the tops of the proposed habitat transition zones to approximately 9 feet elevation NAVD88. The lengths of the transition zones along the MHHW line at the southwest and southeast corners would be approximately 2,075 feet each. The habitat transition zones would be separated in the middle so that potential future connections with San Tomas Aquino Creek to the south are not be precluded.

Establishing these habitat transition zones would require import and placement of submerged fill above and below MHHW elevation as shown in **Table 4**. The habitat transition zones would be constructed of fill material from upland construction projects and would extend into the center of the pond at a typical slope of 30:1 (h:v). Fill placed to build transition zones below MHHW tidal elevation would convert ponds to tidal wetlands, but fill placed above that elevation would convert waters to uplands. The areas and volumes above and below MHHW elevation are presented because that elevation represents an ecologically relevant boundary for many plant and wildlife species in tidal areas. In the permitting documents for the USACE, BCDC, and the San Francisco Regional Water Quality Control Board (RWQCB), the Mean Higher High Water (MHHW) and High-Tide Lines (HTL) are provided because these are the jurisdictional boundaries established under the Clean Water Act and the Porter-Cologne Act. At this time, no further actions (levee removal, habitat islands, or public access) are proposed for the A8 Ponds.

Table 4. A8 Ponds - Estimated Fill Volumes and Areas

FILL PURPOSE	TOTAL VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Western Habitat Transition Zone	94,100	91,500	12.1	11.7
Eastern Habitat Transition Zone	84,900	82,500	12.5	12.2
Total	**179,000**	**174,000**	**24.6**	**23.9**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

2.3.3 Mountain View Ponds

The restoration goals for the Mountain View Ponds are to restore them to tidal marsh by connecting them to the Bay, adjacent streams, and sloughs through proposed breaches. After breaching, the ponds would accrete sediment until they reached marsh plain elevation and then begin to develop marsh vegetation. The proposed project includes those breaches as well as a number of other habitat enhancements, flood risk management components, and additional public access and recreation features.

Proposed project activities at the Mountain View Ponds include the following, all of which are illustrated in **Figure 3c**.

2.3.3.1 Raise and Improve the Western Levee of Pond A1

Most of the western levee of Pond A1 would be raised to provide flood risk management to inland areas west and south of the Mountain View pond cluster. The levee breaches in Pond A1 would remove some of the de facto flood protection currently provided by the outboard levees of Pond A1, but raising the western levee of Pond A1 would offset that loss and maintain the current levels of flood risk management in the communities and infrastructure to the southwest of Pond A1. Much of the material for raising the levee would come from off-site, upland sources, though some would come from on-site breaching. The length of levee that would be raised is approximately 4,400 feet. The improved levee would have a 12-foot wide crest north of the proposed viewing platform (where no trail would be present) and a 14-foot wide crest from the viewing platform southward (where a trail would be added). Levee side slopes would be 3.5:1 (h:v). For levee height, the crest of the levee north of the proposed viewing platform would be constructed to an elevation of 11 feet NAVD88 along its length north of the viewing platform. The crest of the Pond A1 western levee at the viewing platform and southward would be raised to an elevation of approximately 14.7 NAVD88 to match that of the raised Coast Casey Forebay levee (described in the next bullet) that it connects to on its southern terminus. Estimated fill volumes and areas for A1 levee improvements are provided in **Table 5**.

2.3.3.2 Raise and Improve the Coast Casey Forebay Levee and Associated Structures

Improvements to the Coast Casey Forebay are shown in **Figure 3c**. To offset the loss of de facto protection provided by Pond A1, the Coast Casey Forebay levee that is along the western end of the southern border of Pond A1 would be improved between the Palo Alto Flood Control Basin levee and the high ground in Shoreline Park. In accordance with that necessity, the City of Mountain View, which owns that levee, seeks to raise the entire length of that levee even beyond its intersection with the Pond A1 levee. To incorporate the highest sea-level rise prediction from the City of Mountain View's Sea Level Rise Study, Feasibility Report, and Capital Improvement Program (ESA PWA 2012), this levee improvement would build a levee base and foundation support sufficient to support a 16-foot NAVD88 cross section but to a crest elevation of 14.7 feet NAVD88. This design levee height satisfies the FEMA design criteria for 100-year flood level plus 3 feet and gives the City of Mountain View the option of future improvements to address sea-level rise. Further, the Santa Clara Valley Water District (SCVWD), which is the flood protection agency in Santa Clara County, has recommended that a levee-top elevation of 14.7 feet NAVD88 be used for long-term sea-level rise planning. This design levee height would also improve flood risk management along the southern end of Charleston Slough and the communities and infrastructure behind it. The length of the levee improvements would be approximately 1,440 feet. The top width of the improved levee would be approximately 24 feet. In and around this levee are a pump station, a valve vault, and several utility access ports, and all would remain. An existing pump station control building to the southwest would remain in place and the raised levee would be built around it. The existing wooden platform and viewing station that extend into the slough from the trail near the water intake would remain in place, and an ADA-compliant sloped path would be installed to connect it to the raised Coast Casey Forebay levee. A similar path would connect the top of the Coast Casey Forebay levee to the existing trail from the parking area to the south. Estimated fill volumes and areas for all of these levee improvements and associated structural improvements at the Coast Casey Forebay are provided in **Table 5**.

Finally, an excavation is required to place the shear key that is necessary to complete the improvements on the Coast Casey Forebay levee. A shear key is a volume of strengthened material that extends into the existing material and helps stabilize the improved levee from sliding to increase the stability and resistance to sliding for the improved levee. The volume and area for this ground excavation-and-replacement activity are included as part of the Coast Casey Forebay improvement estimates in **Table 5**. The cut volume and area for this portion of work are shown in **Table 6**. All cut and fill work for the shear key excavation would occur below MHHW, though the forebay itself is not tidally connected. The shear key excavation would remove and replace an equal volume of fill over the same area and would improve material and stability to existing conditions.

2.3.3.3 Add Recreation and Public Access

Three recreation and public access features would be added. Estimated dimensions for these features are provided in **Table 7** and **Table 8**.

- In the first, a viewing area including a platform, informational signage, and benches would be constructed within the City of Mountain View's Shoreline Park or near the existing trail on the southern border of Pond A1 near the eastern end of the pond. The viewing platform area would be graded and its surface would be improved, but no elevated structures would be built.
- In the second, a spur trail would be constructed along the improved western levee of Pond A1 to a viewing platform similar to the one described above. It would be placed near the point where the habitat transition zone meets the Pond A1 west levee. The viewing platform would be established on a somewhat widened section of the existing levee where the benches and interpretive panels can be placed. The height of the levee-top trail from its split with the Bay Trail atop the Coast Casey Forebay levee would be at 14.7 feet elevation NAVD88 to match the elevation of the Bay Trail spine. (Beyond the viewing platform area, the levee top elevation would be at approximately 11 feet NAVD88, as discussed above.) This would provide viewing access to Charleston Slough and Pond A1. Benches and interpretive signage are proposed on both sides of the trail at the A1 western levee viewing platform.
- In the third, a trail along the levee on the eastern and northeastern side of Pond A2W. The trail on the eastern and north-eastern levees of Pond A2W would be approximately 6,440 feet (1.2 miles) long. The surfaces and side slopes of those levees would be maintained for PG&E access and would also open that route for public recreational access, add signage, and include more-frequent maintenance for safety. A viewing platform, similar to the ones described above, would be added at the end of the trail. This area would provide access to views of Pond A2W and the Bay.

2.3.3.4 Construct and Vegetate Habitat Transition Zones in Ponds A1 and A2W

Habitat transition zones would be constructed in Ponds A1 and A2W inside the southern edges of Ponds A1 and A2W to create transitional habitat between the lower elevation of the pond bottoms and the uplands and levees behind them. Once vegetated, the habitat transition zones would provide habitat for salt marsh harvest mouse and other terrestrial species. They would also provide a gentle slope for dissipation of wave energy and reduction of erosion potential, thereby protecting the closed landfill below Shoreline Park. The transition zone in Pond A1 would extend all the way across the southern border of the pond. In Pond A2W the transition zone would only cross the central portion of the pond's southern border, so that potential future connections with the existing mitigation marshes to the south (the Mountain View mitigation marsh and the Stevens Creek mitigation marsh) would not be precluded. The habitat transition zones would be constructed primarily of upland fill material from off-site projects. Roughly 3,700 linear feet and 3,200 linear feet of transition zone would be established along the inside slope of Ponds A1 and A2W, respectively. The habitat transition zones would have a top elevation of approximately 9 feet NAVD88. The slope of these features in Pond A1 would be varied to provide a range of different slopes including slopes at 10:1, 20:1, 30:1 and 40:1 (h:v). The intent of this variation is to execute a pilot project that would provide observational data about the habitat values, erosion protection, and sea-level rise adaptation that would result from these varying slopes. This approach is proposed as part of the SBSP Restoration Project's commitment to developing and sharing scientific insights to inform not only future phases of this project, but also to develop insights and test hypotheses that have broader application to other projects. In Pond A2W, the slope would be approximately 30:1 (h:v). Estimated fill volumes and areas for the habitat transition zones at the Mountain View Ponds are provided in **Table 5**.

2.3.3.5 Construct Habitat Islands in Ponds A1 and A2W for Birds

Nesting and roosting habitat for shorebirds, terns, and dabbling ducks would be created through the construction of islands in Ponds A1 and A2W. This would include building up to ten islands, with 3 to 5 islands per pond. The islands would be constructed largely of upland fill material from off-site projects. Each island would have a top area of roughly 10,100 square feet , a top elevation of 12.5 feet NAVD88 (roughly 3 feet above MHHW) and side slopes would be approximately 3:1 (h:v). As the ponds transition to marsh, the island habitat would eventually become marsh mounds (possibly requiring active revegetation), which have various ecological benefits as high-tide refugia and as focal points for further sediment aggregation and vegetation formation. Estimated fill volumes and areas for habitat islands at Mountain View Ponds are provided in **Table 5**.

2.3.3.6 Breach Pond A1 at Two Locations and Pond A2W at Four Locations

These breaches and the associated channels that would be excavated to connect them to the surrounding sloughs would allow tidal flows to enter, sediment to accrete, and vegetation to become established. The two Pond A1 breaches would be at the northwest corner of the pond on the western levee and along the eastern levee into Permanente Creek/Mountain View Slough. Two of the four Pond A2W breaches would be on the western levee into Permanente Creek/Mountain View Slough. The other two breaches would be on the eastern levee into Stevens Creek/Whisman Slough. The specific locations of these breaches would be determined during advanced construction design, but their locations would generally follow the locations of historical slough traces and are also being chosen to minimize the amount of existing fringing marsh through which the channel to connect the breaches to the sloughs must be excavated. The breaches would all have an invert elevation of approximately 2 feet NAVD88 and have approximately 2:1 (h:v) side slopes. The bottom widths would be approximately 60 feet. The length of the channel cut connecting Pond A1 to adjacent Mountain View Slough would be approximately 110 feet. At Pond A2W's western levee, the channel cut through the south breach connecting Pond A2W to Permanente Creek/Mountain View Slough would be approximately 230 feet and through the north breach the channel cut would be approximately 200 feet. On Pond A2W's east levee, the channel cut through the south breach connecting A2W to Stevens Creek/Whisman Slough would be approximately 210 feet long and through the north breach it would be approximately 200 feet long. The two breaches on the eastern levee would be designed such that the top width would be wide enough to span access bridges (described below). Both of the breaches on the eastern side of Pond A2W would be armored on both sides to protect the bridge abutments from future erosion or scour. Estimated cut volumes and areas of breaches and the associated channels are provided in **Table 6**.

2.3.3.7 Armor the Two Eastern Breaches of Pond A2W and Add Bridges over the Two Breaches

Two single-span precast/prestressed I-girder bridges would be installed to extend over the armored breaches on the eastern levee of Pond A2W and would provide access to existing PG&E utilities. To accommodate the load of maintenance vehicles, bridges would be designed to accommodate a vehicle load of 4,000 pounds. The bridges would consist of pile supported abutments and wing walls at each end that would provide a foundation for the superstructure and would also serve to armor the breaches and prevent further scour and widening. Foundations and wing walls would be cast-in-place concrete footings supported on top of piles driven into the existing levee and its edges, where it meets the fringing marsh and the pond interior. Each foundation's abutment is estimated to require 8 supporting piles. The total pile count for both bridges is estimated to be 32 piles. The superstructure would be cast-in-place concrete bridge deck on precast/prestressed 2.5 feet deep I-girders. Concrete barriers (Type 732 or similar) would be placed on each side of the bridge. Each bridge would be approximately 60 feet long and 19 feet wide. This length would allow for a minimum of 40 feet channel bottom width through the bridge opening. The bridge deck elevation would be 12.25 feet NAVD88 and the soffit would be at 9 feet NAVD 88 elevation. The dimensions of the fill for abutments and piles are presented in **Table 9**. A trail approximately 15 feet wide with 2-foot wide shoulders on each side with would traverse the top of the bridges.

2.3.3.8 PG&E Infrastructure Improvement

Sixteen (16) transmission towers are within Pond A2W. Conversion of this pond to tidal marsh habitat would require PG&E to upgrade the tower foundations to account for the introduced tidal flux and to raise the maintenance/service boardwalks that run under the power lines and provide PG&E access to the towers. The concrete pedestals on which the towers sit would be reinforced with additional concrete placed higher on the tower legs to protect the metal portions of the towers from the corrosive action of saltwater from the highest tides.

The tidal marsh restoration would also require elevating the existing PG&E access boardwalks in Pond A2W and constructing a new section of boardwalk outside of Pond A1 to connect Pond A2W's outboard levee with the existing boardwalk outside of the Palo Alto Flood Control Basin. All existing boardwalks would be raised a maximum of 4 feet, utilizing the existing boardwalk pillars. The existing boardwalks in Pond A2W are made of wooden planks on a wooden frame that rests on concrete foundations set into the pond bottom. The decking is intermittently used by PG&E for pedestrian access to the towers. This boardwalk would be removed and replaced with a higher one to retain PG&E access to the towers. In addition to raising the boardwalk within the pond, a new section of boardwalk would be added to connect the end of the Pond A2W boardwalk with the end of an existing one that lies northwest of Pond A1. The access points to the boardwalks would be gated to protect against unauthorized human entry and would be designed to exclude terrestrial predators that may use them. Construction details for PG&E operations can be found in Appendix B.

The combined areas and volumes of these improvements are small and are presented in the summary tables in the following subsection.

Table 5. Mountain View Ponds - Estimated Fill Volumes and Areas by Purpose

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Coast Casey Forebay Levee Improvement	27,400	12,050	2.3	1.5
Pond A1 West Levee Improvement	89,100	40,320	12.7	8.3
10 Habitat Islands	53,500	40,600	5.1	5.1
Bridge Piles, Abutments	540	100	0.1	0.0
Pond A1 Habitat Transition Zone	77,100	73,480	16.9	15.9
Pond A2W Habitat Transition Zone	80,000	77,120	15.7	15.7
Totals	**327,640**	**243,670**	**52.8**	**46.4**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 6. Mountain View Ponds - Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	FOOTPRINT AREA (ACRES)	AREA BELOW MHHW (ACRES)
Pond A1	Northwest Breach	1,700	990	0.2	0.1
Pond A1	Southeast Breach	1,700	660	0.2	0.1
Pond A2W	Northwest Breach	2,400	660	0.3	0.1
Pond A2W	Southwest Breach	3,000	880	0.4	0.1
Pond A2W	Northeast Breach	1,100	330	0.1	<0.1
Pond A2W	Southeast Breach	2,200	1650	0.3	0.2
Subtotal	*Mountain View Pond Breaches*	*12,100*	*5,170*	*1.5*	*0.7*
Pond A1 (Coast Casey Forebay)	Shear Key Excavation	3,100	3,100	0.7	0.7
Totals		**15,200**	**8,270**	**2.2**	**1.3**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 7. Mountain View Ponds - Recreational Features: Viewing Platform Footprints

FEATURE	AREA (SQUARE FEET)
A1 West Levee Viewing platform	830
Shoreline Park Viewing platform	440
Pond A2W Northeast Viewing platform	1,900
Total	**3,170**

AECOM 2016

Table 8. Mountain View Ponds - Recreational Features: Trail Lengths and Areas

FEATURE	LENGTH (FEET)	WIDTH (FEET)	AREA (SQUARE FEET)
Pond A1 West Levee Trail	480	14	6,720
Pond A2W East Trail	6,440	16	103,040
New Trails: Subtotal	***6,920***	***NA***	***109,760***
Coast Casey Levee Trail Replacement	1,460	16	23,360
Total	**8,380**	**NA**	**133,120**

Notes: All trail widths include 2 feet of shoulder space on each side of the trail.

AECOM 2016

Table 9. Mountain View Ponds - A2W Bridge Details

LOCATION	BRIDGE SUPERSTRUCTURE FOOTPRINT (SQUARE FEET)	NUMBER OF PILES	PILE LENGTH (FEET)	PILE DIAMETER (INCHES)
Pond A2W Northeast Breach	1,131	16	45	14
Pond A2W Southeast Breach	1,131	16	45	14

AECOM 2016

2.3.4 Ravenswood Ponds

The restoration goals for the Ravenswood Ponds are to restore Pond R4 to tidal marsh by connecting it to the Bay through a breach into Ravenswood Slough, to improve Pond R3 as an enhanced managed pond for small shorebirds, including western snowy plover, and to convert Ponds R5 and S5 to enhanced managed ponds for dabbling ducks and other bird guilds. The proposed project includes the breach, four water control structures, a number of other habitat enhancements and flood risk management components, and additional public access and recreation features.

Proposed project activities at the Ravenswood Ponds include the following, all of which are illustrated in **Figure 3d**. Estimated cut volumes and areas are summarized in **Table 10**. Estimated fill volumes and areas are summarized in **Table 11**.

2.3.4.1 Convert Ponds R3, R5 and S5 to Enhanced Managed Ponds and Install Water Control Structures

There would be four water control structures installed within and between these ponds to allow them to be managed to achieve different habitat goals. First, a water control structure would be installed into the eastern levee of Pond R3 where the historical slough trace intersects with Ravenswood Slough. This water control structure would allow direct control and management of the water levels in the pond to provide for better water quality, better control over water levels, and improvement of the existing western snowy plover forage habitat in Pond R3. There would also be a channel excavated through the external fringing marsh to connect the water control structure with Ravenswood Slough.

Ponds R5 and S5, which are currently seasonal ponds, would be converted into a single enhanced managed pond through removal or modification of levees within and between the ponds. There would be four water control structures (pipe culverts through levees) installed. One would be installed at the levee between Ponds R4 and R5. Another would be installed between Pond S5 and Flood Slough. A third would be installed between Ponds S5 and R3. The fourth would be installed between Pond R3 and Ravenswood Slough. By providing the means for year-round control of water levels and some control of the salinities and other aspects of water quality in the ponds, these structures would allow for separate control of different types of managed pond habitat for various guilds of birds with different bottom depths and elevations.

The water control structures would be circular high density polyethylene (HDPE) pipes (culverts). The number of pipes, pipe size, and invert elevations of the water control structures that would be installed at proposed locations around the project site, are listed in **Table 12**. The water control structures would be gated at both ends to allow two-way control over flows in or out of each pond.

To support loads from the control structure gates and access to gate controls by Refuge personnel, bridges would be constructed above each pipe culvert from the proposed or existing levee grade to the end of each pipe. The bridge decks would be pre-cast/pre-stressed concrete voided slab decks on pile caps supported by concrete piles. Bridge decks would include cable railing on each side of the deck as a safety measure.

2.3.4.2 Improve Levees and Fill in the All-American Canal

Approximately 4,700 feet of improved levee would be constructed on existing levees and would fill in the All-American Canal (AAC). The berm-like levees along both sides of the AAC would be raised and strengthened, and the AAC would be filled in, creating a single levee. Constructing this improved levee would replace the de facto flood protection currently provided by the outboard levees on Pond R4. Improvements at the western end of the AAC would extend north along the Ponds R4/R5 border and south along the R3/S5 border to isolate Ponds R5 and S5 from the others so that they can be managed separately. Most of the material for the improvements would come from off-site sources, though some may be from local cut activities. The improved levee would consist of a 60-foot-wide crest with side slopes at approximately 3.5:1 (h:v) on the north side and 4.5:1 (h:v) on the south side. The crest of the levee would be at elevation 11 feet NAVD88. The improved levee would become wider as it transitions to meet the sections of improved levee that would form the eastern borders of Ponds R5 and S5 and would also be the basis of a public access trail and viewing platform. The AAC would not have a trail on top, but would allow access by vehicles for maintenance and monitoring activities. A gate would be placed at the viewing platform area to restrict access.

2.3.4.3 Construct and Vegetate Two Habitat Transition Zones in Pond R4

Construct and vegetate habitat transition zones in the western side of Pond R4, up against the Bedwell Bayfront Park (a closed landfill) border. This habitat transition zone would be approximately 2,500 feet long. Construct and vegetate the second habitat transition zone to extend northward into Pond R4 from the improved AAC levees. This second habitat transition zone would be approximately 5,100 linear feet long. The habitat transition zones would be at an elevation of 9 feet NAVD88 along the levees or the high ground of the park and have side slopes of 30:1 (h:v) with varying steeper slopes at end transitions. The transition zones would be constructed primarily of upland fill material brought in from off-site locations.

2.3.4.4 Remove Internal Levees in Ponds R5 and S5

As part of converting Ponds R5 and S5 to managed ponds, four water control structures (discussed above) would be installed within and between these ponds. To further enhance the habitat, most of the levee between Ponds R5 and S5 would be removed, and the levee within Pond S5 (i.e., between the forebay and the main part of Pond S5) would be removed to an elevation of 4.5 feet NAVD88 to match the surrounding pond bottoms. This would increase the area available for aquatic habitat within the ponds. As discussed below, a portion of the existing internal levee between Ponds R5 and S5 would be left in place and resurfaced to improve its suitability for use as a habitat island for bird roosting and nesting (below).

2.3.4.5 Establish a Habitat Island between Ponds R5 and S5

A habitat island would be created between Ponds R5 and S5 from the remnants of the internal levee currently between those ponds. The island would be modified to optimize its usefulness as upland wildlife habitat. The habitat island surface would be approximately 1.77 acres with a relatively flat top at elevation 9 feet NAVD88 (above the MHHW elevation) with side slopes of 2:1 (h:v) down to the adjacent pond bottom. Sand, shell, or other suitable topping would be added to the island to enhance its usefulness for the birds that would use it and to help control invasive vegetation.

2.3.4.6 Excavate a Pilot Channel in Pond R4

Portions of the bottom of Pond R4 would be modified to direct the new tidal flows (introduced by the levee breach) into the interior of the pond by creating and extending pilot channels from portions of former slough traces. The proposed pilot channels would together be roughly 2,890 feet long and would be excavated through the existing pond bed. The invert elevation would be at 2 feet NAVD88 to roughly match the invert elevation of the existing channels within Pond R4. The bottom width of the channel cut would be roughly 50 feet wide with side slopes of 2:1 (h:v). The moved material would be used to enhance levees, and construct habitat transition zones and ditch blocks.

2.3.4.7 Build Ditch Blocks in Pond R4

Build ditch blocks in the existing borrow ditches west of the R4 breach to direct tidal flows into the interior of the ponds. The material for the ditch blocks would be from a combination of imported fill material and local material from levee lowering or breaches.

2.3.4.8 Lower Levee in the Northwest Corner of Pond R4

Approximately 960 linear feet of the northwestern levee on the edge of Pond R4 would be lowered to MHHW. This modification would improve habitat connectivity between Pond R4 and Greco Island/West Point Slough, and it would also provide high-tide refugia for salt marsh harvest mouse and other species. The new top elevation would be at approximately 8 feet NAVD88 and side slopes would be approximately 2:1 (h:v). Material from the lowered levee would be used to raise levees or construct habitat transition zones.

2.3.4.9 Add Recreation and Public Access Features

A trail along the improved eastern levees of Ponds R5 and S5 would be constructed and linked to the existing trails outside of these ponds. As shown in **Figure 3d** the northern end would connect to the existing trail in Bedwell Bayfront Park; the southern end would connect to the Bay Trail spine. This trail would be approximately 2,750 feet long and 10 feet wide with 2 feet of shoulder on each side. Surfacing materials would be decomposed granite with timber or concrete edging. The proposed water control structures between Ponds R4 and R5 and between Ponds R3 and S5 would be set low enough to allow trail construction over them. This trail would necessitate a break in the new fence that borders the northern side of the Bay Trail, a gate, and appropriate signage along the southern border of Ponds R5 and S5 where it leaves the Refuge and connects to the Bay Trail. The trail would be bordered on both sides with low symbolic deterrent fencing (2- or 3-foot high posts connected by chains, cables, or rails) to provide a visual reminder to trail users to stay on the trail and not enter the restoration areas. Total length of fencing to be installed would be approximately 5,160 feet.

A viewing platform would be constructed near the central point of this trail, at the junction with the improved AAC levee. The viewing platform would have benches and interpretive signage on pedestals and/or information panels. This would improve public access and supplement the visual benefits the trail and the restoration project would make available. Benches would be located near the exhibit's signage. This action would allow the public to enhance the recreational experiences at the relatively high-use Bedwell Bayfront Park in Menlo Park by incorporating the interpretive opportunities and providing a view of all three of the Refuge's restoration pond types at these ponds. Fencing and a gate at the AAC would prevent public access into the closed area between R3 and R4.

2.3.4.10 Lower Levee in the Northwest Corner of Pond R4

Approximately 960 linear feet of the northwestern levee on the edge of Pond R4 would be lowered to MHHW. This modification would improve habitat connectivity between Pond R4 and Greco Island/West Point Slough, and it would also provide high-tide refugia for salt marsh harvest mouse and other species. The new top elevation would be at approximately 8 feet NAVD88 and side slopes would be approximately 2:1 (h:v). Material from the lowered levee would be used to raise levees or construct habitat transition zones.

2.3.4.11 Breach Pond R4

Breach the northeastern corner of Pond R4 to open the pond to tidal flows from Ravenswood Slough. Material from the breached levee would be used to build ditch blocks to direct flows through the borrow ditch to the historic slough trace and into the pond's center; material could also be used to improve levees or construct habitat transition zones. The bottom width of this breach would be approximately 200 feet, with an invert elevation of 2 feet NAVD88 and with side slopes of 3:1 (h:v). The length of the excavated channel to connect the breach to Ravenswood Slough through existing fringe tidal marsh would be approximately 470 feet.

2.3.4.12 Fence the Southern Border of Ponds R3 and S5

A low (3-foot-high) chain-link fence approximately 8,000 feet in length would be installed inside the Refuge property and adjacent to the existing Cargill pipeline property, north of the Bay Trail. The purpose of the fence is to deter people and their pets from leaving the trail and entering the restored habitat there. The fence would also help keep trash from blowing into the ponds and keep chicks from straying from Pond R3 onto the paved trail and roadway to the south.

Table 10. Ravenswood Ponds - Estimated Cut Volumes and Areas

CUT LOCATION	CUT PURPOSE	CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW MHHW (ACRES)
Pond S5	Internal Levee Removal	2,500	1,000	0.5	0.2
Ponds R5/S5	North Internal Levee Removal	4,100	3,900	1.5	0.9
Ponds R5/S5	South Internal Levee Removal	4,100	2,800	1.2	0.6
Subtotal	***Levee Removal***	***10,700***	**7,700**	***3.2***	***1.7***
Pond R4	Northwest Levee lowering	2,100	0	0.9	0.3
Pond R4	Northeast Breach	13,300	10,600	2.1	2.0
Pond R4	Pilot Channel	16,000	16,000	4.1	4.1
Pond R3	Water Control Structure	1,000	1,000	0.2	0.2
Totals		**43,100**	**35,300**	**10.4**	**8.2**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 11. Ravenswood Ponds - Estimated Fill Volumes and Areas by Purpose

FILL PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
R5/S5 East Levee and All American Canal Levee Improvement	182,400	46,090	17.5	7.0
All American Canal HTZ	76,300	69,460	14.9	12.0
Bedwell Bayfront Park HTZ	50,200	47,240	9.1	8.3
Ditch Block west of R4 Breach	1,000	1,000	0.3	0.3
Water Control Structures	400	400	0.2	0.2
Total	**310,300**	**164,190**	**41.9**	**27.8**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 12. Ravenswood Ponds - Water Control Structures

LOCATION	NUMBER OF PIPES	INSIDE DIAMETER (INCHES)	PIPE LENGTH (FEET)	INVERT ELEVATION NAVD88 (FEET)	PILE QUANTITY*	TOTAL AREA** (SQUARE FEET)
Pond R5/S5 to Flood Slough	2	48	183	2	8	3,790
Pond R5/S5 to Pond R4	2	48	78	3.5	8	1,650
Pond R5/S5 to Pond R3	1	48	67	4.5	8	690
Pond R3 to Ravenswood Slough	1	48	62	2	8	640
Total	**6**	**N/a**	**390**	**n/a**	**32**	**6,770**

Notes:

*All piles are 16-inch diameter and approximately 20 feet long.

**Total Area includes pipe-culvert, gates and bridges at each control structure

AECOM 2016

2.3.5 South Bay Salt Pond Restoration Project Phase 2 Summary Tables

Tables 13-18 summarize the lengths, areas, and volumes of the proposed actions for the SBSP Phase 2 project. For ease of reference, the fill and cut estimates are provided by location (i.e., pond cluster) in one set of tables and by purpose in another set of tables. The cut information in **Table 13** and **Table 14** represent the same volumes and areas presented two different ways, likewise for the fill volumes and areas summarized in **Table 15** and **Table 16**. Additionally, each of these tables contains the total areas and volumes at each location, or for each purpose, and then parses those areas or volumes into the amounts above and below MHHW. This split of the totals is intended to help the regulatory agencies understand the portion of these totals that would be placed into intertidal or subtidal habitat versus that placed into uplands. As noted above, MHHW is not the regulatory boundary of waters of the United States or of the State of California, but they are ecologically appropriate boundaries.

In addition **Table 17** and **Table 18** present the lengths and areas of new public access features by pond cluster location. As all of these features would be placed onto existing ground or onto levees that would be enhanced regardless; these features add negligible amounts of new cut or fill areas or volumes. The areas and volumes of fill from PG&E infrastructure activities are shown in **Table 19**.

Table 13. SBSP Phase 2 - Total Cut Volumes and Areas by Location

LOCATION	NET CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW MHHW (ACRES)
Island Ponds	25,500	7,187	6.4	2.7
A8 Ponds	0	0	0	0
Mountain View Ponds	15,200	8,270	2.2	1.3
Ravenswood Ponds	43,100	35,300	10.4	8.2
Total	**83,800**	**50,757**	**19.0**	**12.0**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 14. SBSP Phase 2 - Total Cut Volumes and Areas by Purpose

PURPOSE	NET CUT (CUBIC YARDS)	CUT BELOW MHHW (CUBIC YARDS)	AREA (ACRES)	AREA BELOW MHHW (ACRES)
Levee Removal	19,600	10,667	5.7	2.7
Levee Lowering	14,800	2,630	4.2	1.3
Levee Breaches, Excavations and Pilot Channels	49,400	37,460	9.1	8.0
Total	**83,800**	**50,757**	**19.0**	**12.0**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 15. SBSP Phase 2 - Total Fill Volumes and Areas by Location

LOCATION	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Island Ponds	25,500	25,500	6.6	6.6
A8 Ponds	179,000	174,000	24.6	23.9
Mountain View Ponds	327,640	243,670	52.8	46.4
Ravenswood Ponds	310,300	164,190	41.9	27.8
Total	**842,440**	**608,360**	**125.9**	**104.8**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 16. SBSP Phase 2 - Total Fill Volumes and Areas by Purpose

PURPOSE	VOLUME (CUBIC YARDS)	VOLUME BELOW MHHW (CUBIC YARDS)	TOTAL FOOTPRINT AREA (ACRES)	FOOTPRINT AREA BELOW MHHW (ACRES)
Levee Improvement	298,900	98,460	32.5	16.8
Habitat Island	53,500	40,600	5.1	5.1
Habitat Transition Zone	462,600	441,300	81.1	75.9
Ditch Blocks & Placement of Re-used Levee Material	26,500	26,500	6.9	6.9
Structures (Water Control and Bridges)	940	500	0.2	0.2
Total	**842,440**	**607,360**	**125.9**	**104.9**

Note: Some individually listed values may not sum to the listed total because of rounding. Totals presented are sums of unrounded values, which are then rounded.

AECOM 2016

Table 17. SBSP Phase 2 - Recreational Features: Trails

LOCATION	LENGTH (FEET)	AREA (SQUARE FEET)
Island Ponds	NA	NA
A8 Ponds	NA	NA
Mountain View Ponds*	8,380	133,120
Ravenswood Ponds	2,750	38,500
Total	**11,130**	**171,620**

*Note: Mountain View Pond totals include installing new trails and replacing existing trails
AECOM 2016

Table 18. SBSP Phase 2 - Recreational Features: Viewing Platform Footprints

LOCATION	AREA (SQUARE FEET)
Island Ponds	NA
A8 Ponds	NA
Mountain View Ponds	3,170
Ravenswood Ponds	9,960
Total	**13,130**

AECOM 2016

Table 19. Areas and Volumes of PG&E Infrastructure Actions

ITEM	AREA (ACRES)	VOLUME (CUBIC YARDS)
Replace boardwalks in Pond A2W (new fill in water)	0	0
Wider deck on replaced boardwalk in Pond A2W (shade over water)	0.31	280
Add new boardwalk outside of Pond A1	0.16	93
Enlarge concrete tower footings	0.02	80
Total	**0.17**	**173**

AECOM 2016

2.3.6 Means, Methods, and Equipment

This section discusses the construction approach at each of the Phase 2 pond clusters. It describes the means and methods of how each component listed above would be implemented, and lists the equipment that would be used to do so. Subsequent sections address details of construction schedules and of the planned operations and maintenance.

A San Francisco RWQCB accepted Storm Water Pollution Prevention Plan for the project would be implemented for all project-related activities; appropriate Best Management Practices (BMPs) would be used for all activities with potential impact on water quality. Water quality monitoring would be undertaken in compliance with a SBSP Restoration Project 401 Certification and Waste Discharge Requirements, once issued by the RWQCB, and the San Francisco Bay RWQCB Basin Plan.

Prior to performing construction activities, areas to be disturbed by construction equipment would be cleared of existing vegetation and disposed off-site.

2.3.6.1 Island Ponds

At the Island Ponds, the construction approach would include the following details.

Construction Access

Primary land access to the Island Ponds would be from the adjacent levees at Ponds A22 and A23. Vehicle and heavy equipment access to these ponds is available from levee roads. An amphibious excavator would be offloaded and floated across Mud Slough. Daily access for crews would be from the Fremont Boulevard exit off of Interstate 880, onto Landing Road, and then onto Coyote Creek Lagoon Trail that connects to the northeast corner of Pond A19 via a small footbridge. Construction crews would typically consist of fewer than a dozen people.

Construction Staging Areas

No staging areas are necessary for stockpiling at the Island Ponds. Most equipment used for construction would stay within the project footprint, and no fill material would be brought into the Island Ponds. However, a small staging area northeast of Pond A19 would be provided during construction for vehicles and equipment.

Levee Breach and Channel Excavation

All levee modifications – including adding new breaches, widening an existing breach, and lowering and removing levees – would be accomplished by using amphibious excavators, and other conventional construction equipment. Movement of the excavator between the perimeter levees of Ponds A19 and A20 would occur at low tide utilizing mats. The excavators would work from the existing levees.

Ditch Blocks

Ditch blocks would be formed by placing material from other onsite activities into the existing internal borrow ditches and compacting it. Excavators would be used for placement and initial compaction, and a vibratory hand tamper or a roller would be used for compaction.

Construction Equipment

Construction equipment would include excavators (amphibious and/or terrestrial, fitted with long-reach attachments), a barge (for fueling and possibly for access to the project site), low-bed truck, other common construction equipment, skiff, and pickup vehicles for transportation in and out of the project site.

2.3.6.2 A8 Ponds

At the A8 Ponds, the construction approach would include the following details.

Construction Access

Access to the A8 Ponds would be from Gold Street or America Center Road near the southeast corner of Pond A8S and the levee crests along the perimeter levees. The ponds would be accessed by haul trucks using existing roadways and levee roads. No work would occur on the internal pond levees. Construction crews would typically consist of fewer than a dozen people. The existing levees are known to be capable of handling heavy construction equipment and trucks carrying dirt because the SCVWD uses these access roads to import material dredged from creek channels in Santa Clara County.

Construction Staging Areas

A staging area would be established for equipment and material stockpiling. The location would be within the hard-pack access and turnaround areas that exist within the construction area along the southern border of Pond A8S.

Habitat Transition Zones

The habitat transition zones would be constructed by placing fill material along the slopes and into the pond bottom. The work would proceed from the existing levee roads outward into the pond. Material would be placed and compacted to approximately 70 percent density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

Construction Equipment

Construction equipment would include haul trucks, bulldozers, water trucks, compaction rollers, other construction equipment, and vehicles for transportation in and out of the project site.

2.3.6.3 Mountain View Ponds

At the Mountain View Ponds, the construction approach would include the following details.

Construction Access

Primary access to the project site would be from U.S. 101 via exits for major arterials. The first of those would be to the Pond A1 portion of the project using the North San Antonio Road exit, continuing north to Terminal Boulevard and then heading east onto the levee road between the Shoreline Park sailing lake and the Coast Casey Forebay. From there, the work areas along the Coast Casey Forebay, Charleston Slough, and Pond A1 would be accessible. A secondary route is available along the levee road that forms the western boundary of the Coast Casey Forebay. To reach the work areas at Pond A2W, the Rengstorff Avenue North exit would be used to leave U.S. 101 and head north, after which, Amphitheater Parkway, North Shoreline Boulevard, and Crittenden Lane would be used to reach the large levees and existing access roads around west of Stevens Creek and the northeastern corner of Shoreline Park.

The exact route(s) and timing used for material delivery are subject to modification due to City of Mountain View requirements for traffic control, Shoreline Park activities, and burrowing owl protection. The SBSP Restoration Project will develop the final haul routes in consultation with the City of Mountain View's traffic engineers to minimize potential traffic impacts.

Construction crews would typically consist of five to ten people. The pond cluster would likely be accessed by construction crews from U.S. 101, after which various arterial, collectors, and local streets provide access to Mountain View Shoreline Park and the ponds beyond it. Heavy vehicles would avoid crossing structures in the levees if the vehicle exceeds the weight-bearing capacity. If this is not possible, engineer-approved precautions would be taken to avoid damaging the structure.

Construction Staging Areas

Construction staging areas will be established within Mountain View Shoreline Park in coordination with City of Mountain View. The staging areas will be adjacent to the southern border of Pond A1 north of the sailing lake and east of the Coast Casey Forebay and adjacent to the southern border of Pond A2W west of Stevens Creek Marsh in upland areas alongside existing roads and trails, as shown on project plan sheets (Appendix A).Levee Improvement

Levee improvements along the western side of Pond A1, the eastern side of Pond A2W, and the Coast Casey Forebay levee would require clearing of vegetation, debris, and grooving. Fill would be placed in approximately 6-inch-thick lifts and compacted either through a vibratory hand tamper or a roller to achieve approximately 90 percent compaction for the A1 west levee and 95 percent compaction for the Coast Casey Forebay levee. Some material would be largely sourced from off-site excavation projects. On-site sources would include excavated material from levee lowering, channel excavation, and breaching activities. After levee improvement operations, the A1 levee north of the viewing platform would be hydroseeded with a native plant mix.

Levee crests destined for trail access would be finished with an approximately 12-inch-thick layer of aggregate base to provide all weather access and to be compliant with the Architectural Barriers Act (ABA) on federal lands and the Americans with Disabilities Act (ADA) where the trails are part of the Bay Trail system or where project partners (e.g., city, county, or state agency) have compliance obligations.

Habitat Islands

The material for the habitat islands would be placed by long-reach excavators working from the existing levees or from construction barges that would be assembled in the ponds. Material would be delivered by haul trucks to the working locations. A water truck will be used for dust control of delivered material, if necessary. An excavator would place and moderately compact material in the pond. The material would be piled in layers and compacted by a vibratory tamper or a roller. The top surface of the proposed habitat islands would be treated with a combination of rock, shell, and sand; current designs include a 12-inch-thick sand layer underlain by 6-inch-thick crushed rock to cover any surficial cracks and prevent weed establishment. The sand layer would be covered with a 4-inch-thick layer of oyster shells, or similar appropriate material, to provide a barren land sight that is typically preferred by some nesting birds.

Habitat Transition Zones

Pond A1's habitat transition zone would be constructed by placing fill material along the existing levee side slopes and into the pond bottoms at a range of different side slopes including 10:1, 20:1, 30:1 and 40:1 (h:v). Pond A2W habitat transition zone would be constructed with 30:1 (h:v) a side slope. The work would proceed from the existing levee roads outward into the pond. These features would be compacted to approximately 70 percent dry density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

PG&E Boardwalk and Tower Footing Improvements and Additions

The new boardwalks would be placed within the existing PG&E right-of-way (ROW), adjacent to the towers. All new sections of boardwalk would be built approximately 4 feet above the height of the existing boardwalk. The boardwalk spans would be 3-foot-wide sections and would include a double handrail. The boardwalk spans would be built in 20-foot-long sections supported by 4-inch by 4-inch vertical plastic lumber posts, known as support footings, which would be spaced 10 feet apart along the boardwalk spans. The boardwalks would parallel the transmission line towers and would include additional lateral boardwalks, which would be used to access each tower from the main boardwalk. Boardwalk work would be completed first for worker safety and to more efficiently transport materials and tools to the towers. Following the completion of boardwalk replacement and construction, work would be performed on the footings of the towers in Pond A2W. Multiple towers will be worked at the same time from each side of the boardwalks. All structures would require adding additional concrete to existing concrete foundations to a greater height of up to 4 feet above existing structure footing. Construction details for this work are provided in Appendix B

Levee Breach and Channel Excavation

Breaching would be accomplished from the levee crests using excavators and hauling material to locations receiving fill for beneficial re-use in the project area. The breach at the northwest corner of Pond A1 would be at the location of the current water intake gate, which would be removed as part of this breach activity.

Levee Bridges

The two breaches in the east levee of Pond A2W would be bridged to provide continued PG&E maintenance access and to support a public access trail. Existing levees at connection points would be raised from approximately 10 feet NAVD88 to approximately 12.5 feet NAVD88. These bridges would include prefabricated I-girder superstructure with a cast-in-place concrete bridge deck on precast 2.5 feet deep concrete I-girders set on seat-type abutments with wing walls that would be cast on top of driven concrete piles. Installation of the abutment foundations would require vibratory and/or impact driving to install concrete piles, installing and dewatering cofferdams at each abutment location, setting foundation forms, and pouring concrete. Support piles at each abutment would be 14 inch pre-cast concrete piles approximately 45 feet in length. Eight piles at each of four abutment footings would be driven. The total count for piles driven to support both bridges would be 32. Piles would be driven using an impact hammer.

Dewatering

Armoring and bridging of breaches on the east levee of Pond A2W would require dry conditions. Therefore, installation of cofferdams at the breach and bridge locations would facilitate the construction of concrete abutments and wing walls. During cofferdam dewatering, pumped water would be managed in accordance with the 2007 SBSP Program Final EIS/R and 2016 SBSP Phase 2 Mitigation Measure 3.4-5a. The language from this Mitigation Measure follows.

SBSP Mitigation Measure 3.4-5a: Stormwater Pollution Prevention Plan.

This mitigates potential impacts due to construction related-activities and maintenance activities. The Project sponsors will obtain authorization from the RWQCB prior to beginning construction. As part of this application, the Project sponsors will prepare a Stormwater Pollution Prevention Plan (SWPPP) and require all construction contractors to implement BMPs identified in the SWPPP for controlling soil erosion and discharges of other construction-related contaminants. Routine monitoring and inspection of BMPs will be conducted to ensure that the quality of stormwater discharges is in compliance with the permit.

BMPs that will appear in the SWPPP include:

- Soil stabilization measures, such as preservation of existing vegetation and use of mulch or temporary plantings to minimize soil disturbance;
- Sediment control measures to prevent disturbed soils from entering waterways;
- Tracking control measures to reduce sediments that leave the construction site on vehicle or equipment tires;
- Non-stormwater discharge control measures, such as monitoring water quality of dewatering operations and hazardous material delivery, storage, and emergency spill response requirements, and measures by the Project sponsors to ensure that soil-excavation and movement activities are conducted in accordance with standard BMPs regarding excavation and dredging of bay muds as outlined in San Francisco Bay Conservation and Development Commission's bay dredge guidance documents. These include excavating channels during low tide; using dredge equipment, such as sealing clamshell buckets, designed to minimize escape of the fine grained materials; and testing dredge materials for contaminants.

The contractor will select specific BMPs from each area, with Project sponsor approval, on a site-specific basis. The construction general contractor will ensure that the BMPs are implemented as appropriate throughout the duration of construction and will be responsible for subcontractor compliance with the SWPPP requirements.

Other impacts due to construction-related and maintenance activities can be mitigated by appropriate additions to stormwater pollution prevention plans, including a plan for safe refueling of vehicles and spill containment plans. An appropriate hazardous materials management plan will be developed for any activity that involves handling, transport or removal of hazardous materials.

Trails, Viewing Platforms, Signs, and Benches

All rebuilt trails on existing levees that would be raised or modified as part of this project would be resurfaced with decomposed granite.

A new trail would be built on a portion of the raised and improved Pond A1 west levee. A new trail would also be built on the eastern levee of Pond A2W, which would not be raised but which would be graded and filled in places as needed to make the levee top suitable for a trail. Eroded or uneven surfaces on these levees would be regraded for ADA and ABA compliance. Surfacing materials would be decomposed granite with timber or concrete edging. These materials would be placed with dump trucks and bulldozers.

The new viewing platforms would not be elevated above the levees or existing land on which they would be placed, though the A1 west levee platform would involve local levee widening to accommodate the added space required. The viewing platforms would be graded and surfaced to meet ABD and ADA standards and would have a visual appearance matching nearby conditions. The main features at the platforms would be benches and signs or panels that provide site information to the public. These features would be constructed of metal and wood and placed on cast-in-place concrete footings. The footings would be dug with an auger attachment on a bobcat. Concrete would be imported by concrete truck and the footings would be cast-in-place. The signage at the platforms would be mounted on pedestals, and one or more benches would be located near each sign or panel.

Construction Equipment

Construction would be accomplished using conventional construction equipment including excavators, bulldozers, dump trucks, compaction rollers, water tankers, refueling tanks, pile-driving equipment, pumps, sheet piles, cranes, barges, skiffs, paving equipment, and pickup vehicles for transportation in and out of the project site. Helicopters may be needed in areas where new PG&E boardwalks are constructed. Temporary fill would also be used at staging locations if required. Fill material would be transported to the project area by haul trucks.

2.3.6.4 Ravenswood Ponds

At the Ravenswood Ponds, the construction approach would include the following details.

Construction Access

Ravenswood Ponds would be primarily accessed from the Marsh Road exit on U.S. 101 via the entrance to the City of Menlo Park's Bedwell Bayfront Park. The USFWS has an access easement with the city for this purpose. Alternate access to the southern edge of Pond R3 is possible from the paved bicycle path/hiking trail just north of SR 84. The details of this access would be developed in coordination with the City of Menlo Park.

The construction areas in and around the ponds themselves would be accessed via existing trails in Bedwell Bayfront Park and on the Refuge levee crests. The USFWS Refuge staff drive on the levees for maintenance, cleanup, and other management purposes, and it is assumed that the existing levees are capable of handling heavy construction equipment. Ponds R4, R5, and S5 can be accessed via existing trails on the edge of Bayfront Park and the outboard perimeter levee in Ponds R3 and R4. The crests of the berms on either side of the AAC or the levee around the perimeter of Pond R4 would be used to access various construction areas in Ponds R3 and R4.

If conditions warrant, levee improvements, including the widening of the crest to provide adequate pathway for construction equipment, would be undertaken. Heavy vehicles would avoid crossing structures in the levees if the vehicle exceeds the weight-bearing capacity of a structure. If this is not possible, engineer-approved precautions would be taken to avoid damaging the structure.

Construction Staging Areas

Staging areas would be established for equipment and material storage within the Refuge boundaries. These areas may be on existing levees or in areas that would be filled as part of the Phase 2 actions later in the project. The Pond S5 forebay would be used for stockpiling before Pond S5 is hydraulically connected to Flood Slough. Material staging areas would not be located within the City of Menlo Park's Bedwell Bayfront Park.

Dewatering

Construction could occur in the wet or the dry. If the contractor decides to perform construction in the dry, some localized dewatering would be required. Dewatering of pond bottom would be accomplished by evaporating the pond beds to provide access to excavate pilot channels. Limited, local dewatering using portable, generator-powered pumps would likely take place during the installation of water control structures. Pumped water would be discharged per the 2007 EIS/R and the 2016 SBSP Phase 2 Final EIS/R Mitigation Measure 3.4-5a.

Demolition of Existing Water Control Structures

Six existing water control structures in the Ravenswood Ponds would be removed. These remnant features of the former salt production infrastructure would be removed during construction. All associated support structures would be demolished and disposed off-site or recycled as appropriate.

Water Control Structures

The four water control structures would be placed into trenches cut by excavators and/or backhoes. To reduce the corrosion concerns typically expected in brackish water and to allow for management of pond habitat, solid-wall HDPE pipes would be used. Pipe bridges would be built over both ends of each structure to allow maintenance and operations access. The pipe bridges would be built pre-cast/pre-stressed concrete voided slab decks on pile caps, supported on concrete piles. Pile installation methods would include auguring, casting in place, and vibratory or impact driving, depending on seasonality of sensitive wildlife species nearby.

The water control structure connecting Flood Slough to the Pond S5 forebay would be the most involved installment because a portion of the existing roadway entrance into Bedwell Bayfront Park would have to be removed to allow access to the ground below it.

Habitat Transition Zones

The habitat transition zones would be constructed by placing fill material along the existing levee side slopes and into the pond bottoms. The work would proceed from the existing levees outward into the pond. These features would be compacted to approximately 70 percent density to enable vegetation establishment. Slope protection would be maintained by establishment of native vegetation. Hydroseeding or other seeding method with a native plant mix, development of a planting scheme, and invasive plant control would aid in establishing desirable vegetative habitat.

Levee Improvements

Levee improvements at the AAC would consist of preparing the subgrade to receive additional fill material by clearing vegetation, debris, and grooving. Fill would be placed in approximately 6 inch-thick lifts and compacted either through a vibratory hand tamper or a roller to achieve approximately 90 percent compaction. Borrow material would be sourced on-site from levee lowering at Pond R4, internal levee removal at Ponds R5 and S5, and pilot channel excavation, but most would be from off-site upland excavation projects.

Levee Removal

Earth moving machinery including an excavator and loader would be used to remove most of the levees within and between Ponds R5 and S5. Removed material would be used on site to improve levees, fill borrow ditches in Pond R4, construct ditch blocks, or to construct habitat transition zones.

Portions of the internal levees between and within Ponds R5 and S5, with lengths of approximately 880 feet at the northern segment of the levee separating R5 from S5, 530 feet at the southern segment of that same levee, and at the S5 internal levee approximately 370 feet, would be removed (i.e., lowered to match the existing pond bottom elevation of about 4.5 feet NAVD88). This activity would also use an excavator and loader. Removed material would be re-used to on site to improve levees, fill borrow ditches in Pond R4, or to construct habitat transition zones.

Pilot Channel Excavation

Existing soil conditions at the R4 pond bottom are likely to be too soft to support vehicles or heavy equipment. Temporary mats with gravel cover would be deployed at the pond bottom to create a firm surface that can handle heavy equipment such as an excavator, loader, or mini-dozer to access locations where pilot channels are to be established. Alternatively, amphibious equipment such as an aquatic excavator would be used to excavate in the wet to designed depths. It is likely that removed material would be unsuitable to be used as levee fill material and would instead be used to fill borrow ditches within Pond R4 or as fill for habitat transition zones.

Levee Lowering

Levee lowering at the northwest corner of Pond R4 would be accomplished by using an excavator and loader and hauling the removed material to fill borrow ditches in Pond R4 or to construct habitat transition zones. Levee lowering at Pond R4 would remain at elevations above the MHHW until construction activities within the pond that need to be performed in the dry are complete. After construction operations within the ponds are complete, these levees would be lowered to approximately 8 feet NAVD88. This would cause levee overtopping, levee erosion and allow for improved hydraulic and habitat connectivity.

Ditch Blocks

Ditch blocks would be formed by placing material from other onsite activities into the existing internal borrow ditches and compacting it. Excavators would be used for placement and initial compaction of material, and a vibratory hand tamper or a roller would be used for compaction.

Habitat Island

Habitat islands would be cleared, grubbed and fine graded before surface enhancements are installed. The expected treatment for the top surface of the island is a 12-inch-thick sand layer underlain by a 6-inch-thick crushed rock to minimize weed establishment. The sand layer would be mixed with Bay mud to prevent formation of cracks. The sand layer would be covered with 4-inch-thick layer of oyster shells, or similar appropriate material, to provide a barren land site that is typically preferred by nesting birds. Other combinations of rock, sand, dirt, or other materials may be used as available. These materials would be brought in and placed prior to removal of the portions of the levee to be breached.

Levee Breach and Channel Excavation

The levee breaching and associated excavation of a channel to connect to Ravenswood Slough would be accomplished from levee crests using long-reach excavators and hauling material using trucks to on-site locations receiving fill for beneficial re-use.

Trail, Viewing Platform, Signs, and Benches

The 2,750-foot trail on the eastern border of Ponds R5 and S5 would be at least 10 feet wide with 2-foot shoulders on each side and would be built on the improved levees described above. Erosion or uneven surfaces on existing levees would be regraded for compliance with the ABA on federal lands and the ADA elsewhere. Levees would be graded and compacted. Geotextile fabric would be laid out and gravel imported and compacted in place. Quarry fines would then be compacted over the gravel with a smooth drum compactor to create an accessible surface.

The new viewing platform would not be elevated above the levee or existing land on which it would be placed. There would be local levee widening to accommodate the added space required. The viewing platforms would be graded and surfaced to meet ABA and ADA standards and would have a visual appearance matching nearby conditions. The main features at the platforms would be benches and signs or panels that provide site information to the public. These features would be constructed of metal and wood and placed on cast-in-place concrete footings. The footings would be dug with an auger attachment on a bobcat. Concrete would be imported by concrete truck and the footings would be cast-in-place. The signage at the platforms would be mounted on pedestals, and one or more benches would be located near each sign or panel.

Construction Equipment

Excavators, bulldozers, amphibious equipment (e.g., an aquatic excavator), dump trucks, compaction rollers or vibratory plates, a water tanker, pumps, sheet piles, refueling tanks, and pickup vehicles for transportation in and out of the project site would be used during construction. Depending on the soil conditions within the ponds, temporary heavy equipment mats or wooden mats with gravel cover would be employed to provide access and establish working conditions to excavate pilot channels at the pond bottom. Temporary fill would also be used at staging locations if required. Upland fill material would be transported to the project area by trucks.

2.4 Construction Schedule and Sequence

The following section describes the general sequence, timing, and duration of activities at each of the pond clusters. First, however, it is useful to provide a brief discussion of the construction timing as it would be affected by species-specific work windows.

2.4.1 Species-specific Construction Timing Considerations

At all four pond clusters, there are certain special-status species, regulated by USFWS, NMFS, or CDFW that may be affected by construction activities. The presence of these species may limit construction activities or require certain avoidance and minimization measures. The pond-cluster-specific special-status species, as well as the limits and requirements for each species and their habitats, are addressed in the Conservation Measures of the SBSP Restoration Project's Programmatic and Phase 1 EIS/R and permitting documents. These include the BOs from NMFS and USFWS, the Clean Water Act Section 404 and 401 permits from the USACE and the RWQCB respectively, the BCDC permit, and others. This overview information is provided here as part of the project designs to help frame the construction sequences that follow. The timing considerations below will be incorporated into detailed designs and project planning to reduce the overall potential for adverse impacts and the need for mitigation.

- Bird nesting: Regulatory work windows for bird nesting typically run from February 1 through September 15. Work occurring within this window would implement approved avoidance and minimization measures including the presence of an approved biological monitor and preconstruction surveys.
- Steelhead migration: Activities that may affect upstream migration of adults or downstream migration of juveniles would be avoided to the maximum extent practicable. In-water work that has potential to impact steelhead from December through February (adult upstream migration period) and from April through June (juvenile downstream migration period) would be avoided to the maximum extent practicable. If in-channel work were to be performed during these periods, fish exclusion methods may be implemented, including timing work during low tide cycles to avoid or minimize potential in-water impacts. If the use of work windows is applicable, the NMFS acceptable work windows for steelhead are June through November.
- Longfin smelt and green sturgeon: There is potential for these species to be present year-round in the San Francisco Bay, therefore seasonal avoidance is not possible.

2.4.2 Island Ponds

In each pond, the construction scenario would likely initiate levee removal from the farthest end of the construction access point along the perimeter levees and proceed toward the starting point of the access. The likely order of construction at the Island Ponds would be as follows:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.
2. Lower Pond A19 south perimeter levee and widen the existing western breach.
3. Remove Pond A20 east perimeter levee, leaving some high portions.
4. Remove Pond A19 west perimeter levee, leaving some high portions.
5. Lower and make two breaches in Pond A19's north perimeter levee, leaving some high portions.

The construction schedule would be affected by species windows, weather conditions, earthwork quantities, and land disturbance. Construction is expected to begin in the second half of 2017. A preliminary estimate shows that construction would likely be completed in approximately 4 months over a single construction season. This estimate assumes that USFWS would permit heavy construction activities to occur during the bird-nesting window using avoidance and minimization measures including the presence and direction of a biological monitor.

2.4.3 A8 Ponds

This part of the project would include:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.

2. Placement of imported fill material into the southern corners of the A8 Ponds (Figure 4). This placement may involve brief stockpiling of material along the existing levee roads and bare ground prior to placement and subsequent compaction.

3. Hydroseeding habitat transition zones to establish native vegetation.

The project is anticipated to begin in the second half of 2017, depending on the material available for use in the Alviso-A8 Ponds or in other Phase 2 project ponds. If sufficient quantities of material are available, construction of habitat transition zones would take approximately 12 months in 2 construction seasons.

2.4.4 Mountain View Ponds

Construction operations would occur either simultaneously at both ponds, or would proceed in tandem. Earthwork activities would be sequenced such that operations which are more efficient and feasible to perform during the dry season, such as working on levee tops, would be completed first. Levee lowering and breaching along the outer bounds of the ponds that are designed to establish hydraulic connection with adjacent sloughs would be performed after all the internal pond activities are completed. Construction of habitat islands and habitat transition zones would be performed prior to breaching the perimeter levees. Breaching would not occur until all necessary flood control components and in-water habitat enhancement features are completed.

The likely order of construction at the Mountain View Ponds would be as follows, though availability of upland material for various actions could alter the sequence:

1. Site preparation including clearing and grubbing of debris and vegetation from construction areas.
2. Raise and improve Pond A1 western levee.
3. Construct trail on Pond A1 western levee to viewing platform.
4. Raise the Coast Casey Forebay levee to 17 feet; make other required improvements to existing Mountain View infrastructure (pump station access, etc.).
5. Rebuild the portion of trail (part of the Bay Trail spine) that is currently on top of the Coast Casey Forebay levee.
6. Modify the access to the existing viewing platform at the southern end of Charleston Slough.
7. Construct PG&E tower and boardwalk improvements around Pond A2W (must be completed prior to levee breaching).

8. Construct and vegetate habitat transition zones and construct and amend habitat islands (must be completed prior to levee breaching).
9. Install cofferdams and construct bridges on eastern levee of Pond A2W.
10. Breach perimeter levees at Ponds A1 and A2W.
11. Construct public access trail and viewing platform on eastern levee of Pond A2W.
12. Install viewing platform in Mountain View Shoreline Park and viewing platform on Pond A1 west levee.
13. Install gates at necessary locations along levees.

The construction schedule would be affected by seasonal work restrictions to avoid impacts to protected species, weather conditions, earthwork quantities, and land disturbance. Construction is expected to begin in the summer or fall of 2017.

Construction would likely be completed in approximately 29 months over 4 construction seasons. This estimate is based on the assumption that some heavy construction activities would be permitted to occur during the restricted work window for nesting bird habitat under implemented avoidance and minimization measures including the presence of a biological monitor.

2.4.5 Ravenswood Ponds

Earthwork activities would be sequenced such that activities which would be efficient to perform in dry conditions would be completed first. These activities include levee improvements, installation of hydraulic controls, pilot channel excavation, and internal levee lowering. Levee lowering and breaching along the outer bounds of the ponds designed to establish hydraulic connection with adjacent sloughs would be performed after the internal pond activities are completed. Once sufficient upland fill material to complete initial construction plans for habitat transition zones and levee improvements is in place, additional material would be accepted as available to expand the habitat transition zones or to raise or improve flood risk management further. Breaching would not occur until all necessary flood control components and in-water habitat enhancement features are completed.

The likely order of construction at the Ravenswood Ponds would be as follows, though availability of upland material for various actions could alter the sequence:

1. Mobilize to site, conduct clearing and grubbing (vegetation removal), and demolish existing derelict water control structures.
2. Import material and improve levees along the AAC and along the eastern levees of Ponds R5 and S5.
3. Construct and hydroseed habitat transition zones along (1) the western edge of Pond R4 levee; and (2) the northern side of the AAC.
4. Modify central portion of levee between Ponds R5 and S5 with gravel, sand, and shells in preparation for its use as a habitat island.
5. Remove unmodified parts of internal levees between Ponds R5 and S5 and within Pond S5, as described above.
6. Install external water control structures (i.e., between R3 and Ravenswood Slough; between S5 forebay and Flood Slough).
7. Excavate pilot channels in Pond R4.

8. Build ditch blocks in Pond R4's borrow ditches.
9. Install internal water control structures (i.e., between Pond R3 and Pond S5; between Pond R4 and Pond R5).
10. Build public access trail along improved R5/S5 eastern levees.
11. Install viewing platform on new public access trail.
12. Lower Pond R4 levee near Greco Island.
13. Breach Pond R4 levee at its northeastern corner.
14. Install fencing along southern border of pond cluster and gates at necessary locations.

The construction schedule would be affected by seasonal work restrictions to avoid impacts to protected species, weather conditions, and volume of earthwork quantities to be moved. Several hundred thousand cubic yards of material would need to be imported and either placed immediately or stockpiled at the site.

Although it is assumed that the ponds would be sufficiently dry during the beginning of the construction season and that active draining or dewatering of pond bottoms would be unnecessary, limited installation of cofferdams and dewatering of small portions of the pond would be necessary for installing water control structures.

Construction is expected to begin in the summer or fall of 2017. Some of the construction activities could take place concurrently or in tandem, with multiple crews to achieve project goals. A preliminary estimate shows that construction would be completed over approximately a 16-month period over 2 construction seasons, assuming all upland fill material would be available. This estimate is based on the assumption that some heavy construction activities would be permitted to occur during the restricted work window for nesting bird habitat under implemented avoidance and minimization measures including the presence of a biological monitor.

2.5 Operations and Maintenance

2.5.1 Island Ponds

Aside from the monitoring and management activities of the SBSP Restoration Project Adaptive Management Plan (AMP) (Appendix C) (also available as Appendix D of the 2007 Final EIS/R) and continued maintenance of the existing UPRR track, no other operations and maintenance activities would occur at the Island Ponds. The existing and newly proposed breaches would scour from hydraulic action and would gradually widen until equilibrium with the tidal flux is reached. Most levees would be allowed to degrade naturally; however, the levee containing the existing railroad track would be maintained by the UPRR to allow the continued use of the tracks. Ongoing monitoring and studies to track the progress of these ponds toward restoration as tidal marsh would be a component of the continued implementation of the AMP.

2.5.2 A8 Ponds

The USFWS would continue to operate and maintain the ponds in accordance with various Refuge operations and maintenance permits, the AMP and other ongoing management practices that have been in place since the implementation of Phase 1 actions. Phase 2 would not involve changing these ongoing management practices during or after the construction activities described above. The habitat transition zones that would be placed in Phase 2 may occasionally need maintenance such as removing invasive plant species and native plant revegetation, which would be performed in accordance with existing Refuge policies and practices for doing so.

2.5.3 Mountain View Ponds

Operations and maintenance activities would continue to follow and be determined by various Refuge operations and maintenance permits, applicable county operations, and the AMP. PG&E would continue to operate and maintain its infrastructure, which would occur in coordination with the Refuge staff to ensure consistency with the operations and maintenance of the pond cluster. The City of Mountain View would continue to operate and maintain its properties that are adjacent to the pond cluster, and these activities would also occur in coordination with the Refuge staff.

Periodic maintenance of the pond infrastructure would be required following construction. Maintenance activities would require a staff person to travel to the pond cluster regularly to perform activities such as mowing, invasive plant control, and vandalism repairs. Predator management activities may occur throughout the year. AMP monitoring activities would also occur, which would require additional workers (e.g., staff, consultants) to access the pond clusters. The frequency of visits to the pond cluster to conduct AMP monitoring activities would depend on the actual activities and would vary by season (e.g., during the bird breeding season there may be more trips to the site than during the non-breeding season).

The improved western levee of Pond A1 would require ongoing levee maintenance because it would provide flood risk management, and the north and east levees of Pond A2W would be maintained for PG&E and trail access. This ongoing levee maintenance would continue in consistency with USACE permit #2008-00103S. These levee maintenance activities could include occasional placement of additional earth on top of, or on the sides of, the levees as the levees erode or subside, with the level of settlement dependent on geotechnical considerations. In general, pond levees that are improved to provide flood risk management would likely exhibit the greatest degree of settlement. Levees that require erosion control measures would also require routine inspections and maintenance.

The northern perimeter levee, eastern levee, northern portion of the western perimeter levee at Pond A1, and the western levee of Pond A2W would not be maintained and would be allowed to degrade naturally. The eastern and northern levees of Pond A2W would be maintained for PG&E access. The eastern levee of Pond A2W would also be maintained for recreational public access on the trail atop it.

Improved levees would be inspected and maintained for slope stability, erosion control, seepage, slides, and settlement on an annual basis. Maintenance is expected to occur every 5 years to add additional fill material in areas where settlement occurs. Most of the maintenance would be accomplished during low tides and from the levee crest.

Maintenance of the habitat islands may require weed/vegetation removal as often as quarterly and the placing of fill material (sand, gravel, and/or oyster shells) before the onset of the nesting period in some years. Habitat islands would also be periodically examined for erosion.

Maintenance of habitat transition zones would include inspections and maintenance for slope stability, erosion control, seepage, slides, and settlement on an annual basis. As necessary, vegetation removal would occur to prevent colonization by invasive species. Fill material would be placed, when needed, to respond to areas where erosion is observed. Additional maintenance activities may also be a need to address an AMP-specified management trigger.

Public access and recreation features would be maintained as needed to keep trail surfaces safe and accessible. There would be a need for trash removal along trails and more intensely at staging areas and trailheads. The viewing areas would be designed to minimize maintenance by utilizing durable and sustainable materials as much as possible to prevent degradation and the need for repeated maintenance. These would need to be checked periodically for defacement of interpretive boards and other forms of vandalism.

The proposed bridges and the concrete abutments with wing walls at both ends of the bridge would be basically maintenance free for the design life cycle of 50 to 75 years. The bridges' superstructures include main span girders, a lateral bracing system, deck slab systems, and a safety railing would need basic erosion protection maintenance work every few years. These activities may include sanding, cleaning, and re-painting as needed, which are common activities for all steel structures permanently exposed to weather.

The PG&E towers, boardwalks, and power lines would be maintained in accordance with PG&E's current practices, which are described in Appendix D of the April 2016 SBSP Restoration Project Phase 2 Final EIS/R (AECOM 2016). The maintenance of Pond A2W's eastern and northern levees and the construction of new and improved boardwalks for PG&E's use would continue to provide the necessary access at the current levels.

2.5.4 Ravenswood Ponds

Operations and maintenance activities for the components of the pond clusters within the Refuge would continue and be determined by various Refuge operations and maintenance permits, applicable county operations, and the AMP. The City of Menlo Park would continue to operate and maintain its properties that are adjacent to the pond cluster, in coordination with the Refuge managers.

Periodic maintenance of the pond infrastructure would be required following construction. Maintenance would require a staff person to travel to the pond cluster one or two times a week to perform activities such as water structure control operation, mowing, invasive plant control, and vandalism repairs. In addition, AMP monitoring activities would occur, which would require additional workers (e.g., staff, consultants) to access the pond clusters. The frequency of visits to the pond clusters to conduct AMP monitoring activities would depend on the actual activities and would vary by season (e.g., during the bird-breeding season, there would be more trips to the site than during the non-breeding season).

Ongoing levee maintenance would continue for existing levees that provide flood risk management (as part of the operations and maintenance activities described above and in consistency with USACE permit #2008-00103S). Levee maintenance activities would include the placement of additional earth on top of or on the pond side of the levees as the levees subside, with the level of settlement dependent on geotechnical considerations. In general, pond levees that are improved to provide flood risk management would likely exhibit the greatest degree of settlement. Levees that require erosion control measures would also require routine inspections and maintenance. The northern perimeter levee at Pond R4 would not be maintained and would be allowed to degrade naturally.

Improved levees would be inspected and maintained for slope stability, erosion control, seepage, slides and settlement on an annual basis. Maintenance is expected every 5 years to add additional fill material in areas where settlement occurs. Most of the maintenance work can be accomplished during low tides and from the levee crests.

Water control structures would require inspection for structural integrity of gates, pipes, and approach way; obstruction to flow passage and preventative maintenance such as visual functionality of gates, seals; and removal of debris. Inspection would be required every month through the first year and semi-annually thereafter. Maintenance would be required on an annual basis. Operations and maintenance activities would be conducted during low tides in Pond R4 and sloughs and by maintaining low storage conditions in the managed ponds.

Maintenance of habitat transition zones would include inspections and maintenance for slope stability, erosion control, seepage, slides, and settlement on an annual basis. Native plant revegetation would occur, including annual weed removal to prevent colonization of invasive species. Fill material would be placed, when needed, to respond to areas where erosion has been observed. Maintenance activities would also be dictated by the AMP if an AMP management trigger is reached, especially a trigger related to a biological resource (e.g., salt marsh harvest mouse) that would utilize habitat transition zones as habitat.

Maintenance of public access and recreation features would address both viewing platforms and trail maintenance. The viewing areas would be designed to minimize maintenance utilizing durable and sustainable materials as much as possible to prevent degradation and the need for repeated maintenance. All features would be checked periodically for defacement of interpretive boards and other forms of vandalism. The eastern levees of Ponds R5 and S5 would also be maintained for recreational public access on the trail atop it. Trash removal would take place as needed along trails and at staging areas and trailheads.

Operations and maintenance of water levels in Ponds R3, R5, and S5 would be managed as follows:

- The water levels in Ponds R5 and S5 would be actively managed year-round by opening and closing the water control structures as needed to maintain desired surface elevations, flows, and water quality. The salinity of these ponds would also be somewhat controlled through the use of the water control structures. USFWS Refuge staff would operate the water control structures and provide maintenance and cleaning as needed.
- The water levels of Pond R3 would be actively managed using the new water control structures to provide for the improvement of the existing western snowy plover habitat in Pond R3. USFWS Refuge staff would operate all of the water control structures and provide maintenance and cleaning as needed.

2.6 Conservation Measures

This section presents general and species-specific conservation measures intended to avoid and minimize potential effects on federally listed species and their habitats. Many of these are drawn from the USFWS Programmatic BO for the SBSP Restoration Project (USFWS 2008), but others are new or updated to address specific concerns related to the proposed Phase 2 activities and the species with the potential to occur in the Phase 2 Project areas and thus to be affected by those actions. As noted in Section 1.2, those species include salt marsh harvest mouse, California Ridgway's rail, western snowy plover, California least tern, and longfin smelt. The rationale by which the potential for each species (or its habitat) to be present and potentially affected was assessed as described in subsequent sections of the document.

2.6.1 Conservation Measures – Construction, Erosion Control, and Flood Risk Management

The following best management practices and conservation measures are included in the proposed Phase 2 Actions to avoid or minimize potential adverse effects to listed species during ecosystem restoration-related activities:

- A water truck would be used for dust control on the site if needed.
- If land-based equipment is used, light, low-pressure construction equipment and/or equipment on mats would be employed.
- Vehicles driving on levees to access the Bay, tidal sloughs, or channels for construction or monitoring activities would travel at speeds slow enough to minimize noise and dust disturbance.
- Vehicle staging, cleaning, maintenance, refueling, and fuel storage would be 150 feet or more from any stream, water body, or wetland.
- A hazardous spill plan would be developed prior to construction, and would state what actions would be taken in the event of a spill. This plan would also incorporate preventative measures to be implemented, such as the placement of refueling facilities, storage and handling of hazardous materials, etc.
- No more than 4,000 gallons of fuel would be transported at any one time.
- Staging areas would be established in upland (rather than wetland) areas that do not provide habitat for ESA-listed species; such staging areas would typically be located on bare ground, paved or graveled areas, ruderal habitat, or non-native grassland.
- Contaminants would be stored within bermed containment areas lined with an impermeable membrane and designed to hold 125 percent of total fuel capacity. Containment areas would be located as far from water as possible within the staging area. Contaminant absorbent materials would be stored within each containment area. Water collected within containment areas would be disposed of according to federal, state, and local regulations.
- Equipment would be refueled only in the staging area. Fuel absorbent mats would be used when refueling equipment.
- All equipment would be maintained free of petroleum leaks. No equipment would enter live water except for aquatic equipment or amphibious equipment designed specifically for aquatic or amphibious use.
- Absorbent materials would be maintained at each worksite in sufficient quantity to effectively immobilize the volume of petroleum-based fluids contained in the largest tank present at the site. Acceptable absorbent materials are those that are manufactured specifically for the containment and clean-up of hazardous materials. Sands or soil are not approved absorbent materials.

- In the event of a contaminant spill, work at the site would immediately cease while the absorbent materials are deployed to contain, control, and mitigate the spill. The contractor would immediately prevent further contamination notify appropriate authorities, and mitigate damage as appropriate.
- Site work would resume when the spill kit is resupplied with a sufficient quantity of material capable of effectively immobilizing the volume of petroleum-based fluids contained in the largest tank present at the site.
- Containers for storage, transportation, and disposal of contaminated absorbent materials would be provided on the Phase 2 Actions site. Petroleum products and contaminated soil would be disposed of according to federal, state, and local regulations.
- Any machinery that would be left on the temporary platform or parked within 150 feet of a water body including portable water pumps would be placed in a full containment cell.
- All vehicles operated within 150 feet of any water body would be inspected daily for leaks and, if necessary, repaired before leaving the staging area. Inspections would be documented in a record that is available for review on request from USFWS or NMFS.
- Machinery and implements that are used during the Phase 2 Actions would be in good repair, free of excessive leaks, free of excess dirt and weed seeds and steam cleaned off-site prior to entering the work area. Fluid leaks would either be repaired or contained within a suitable waste collection device (e.g., drip pads, drip pans). When changing hydraulic lines, care would be taken to keep hydraulic fluid from entering a water body or soils.
- There would be no debris introduction into the channels, wetlands, or environmentally sensitive areas from Phase 2 Action work.
- All disturbed areas would be stabilized within 12 hours of any break in work unless construction would resume work within 7 days. Earthwork would be completed as quickly as possible, and site restoration would occur immediately following use.
- A supply of emergency erosion control materials would be on hand at the Phase 2 Project Action Area.
- Any large wood, native vegetation, and weed-free topsoil displaced by construction would be stockpiled for use during site restoration. Additional boulders, rock, large wood, and any other necessary natural construction materials would be obtained from outside the Phase 2 Action Area.
- Boating activities would abide by the Marine Mammal Protection Act (1972) unless otherwise authorized by an approved permit from NMFS.
- Silt fences would be erected adjacent to areas of ground disturbance to define and isolate work areas from sensitive habitats.
- In all Phase 2 Actions involving the use of heavy equipment, best management practices would be employed, including using berms and/or silt fences to contain the placement of materials, implementing remedial measures, and minimizing the area impacted.
- All activity within vegetated marsh habitat would be minimized.
- For any activities that involve walking through a marsh repeatedly (e.g., monitoring), different paths through the marsh would be taken during consecutive visits to minimize impacts to habitat in any given area. A route would be determined which would minimize the amount of foot traffic in the marsh and maximize the use of existing roads, trails, and boardwalks to the maximum extent practicable.
- A construction personnel education program would be conducted by a qualified biologist prior to the initiation of construction or maintenance activities within tidal marsh or slough habitat, within

or adjacent to habitat that supports nesting western snowy plovers, California least terns, California Ridgway's rails, or other listed species. The program would consist of a brief presentation by persons knowledgeable in the biology of the pertinent species and legislative protection to explain threatened and endangered species concerns to contractors and their employees. The program would include the following: a description of the species and their habitat needs; a report of the occurrence of the relevant species in the Phase 2 Action Area; an explanation of the status of these species and their protection under the ESA; and a list of measures being taken to reduce Project-related impacts to these species during Phase 2 construction and implementation. A fact sheet conveying this information would be prepared for distribution to the above-mentioned people and anyone else who enters the Phase 2 project site.

- For any given Phase 2 construction project, a representative would be appointed by the applicant who would be the contact source for any employee or contractor who might inadvertently kill or injure a listed species or who finds a dead, injured, or entrapped individual. The representative(s) would be identified during the employee education program. The representative's name and telephone number would be provided to the USFWS and NMFS prior to the initiation of any construction or maintenance activities.
- Chemical concentrations and associated sampling plans and activity of upland fill material or site soils planned for use on-site would be reviewed and approved according to the Quality Assurance Program Plan (QAPP) developed specifically for the Phase 2 actions. That QAPP has been approved by the Regional Water Quality Control Board, as well as by the USFWS and NMFS. The data for upland fill material proposed for use in the Action Area would be provided to the agencies for review and approval according to the terms of the QAPP.
- Sediment suspension would be minimized when removing derelict piles or other infrastructure formerly associated with salt manufacturing or other aspects of water management. Measures to accomplish this would include cutting piles at or below the mudline or using a direct pull method to minimize sediment resuspension. Piles and other structures would be removed slowly to allow sediment to slough off at, or near, the mudline.
- Clean fill materials that would be used for islands, levees, or upland transition zones would be stockpiled on-site.

2.6.2 Conservation Measures – Public Access

- Interpretive signage prohibiting access to areas that are closed to the public, and indicating the importance of protection of sensitive biological resources, would 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 on public access trails would describe areas that are closed to boating access and describe measures to be implemented to avoid impacts to harbor seals, California Ridgway's rails, and other sensitive wildlife.
- After construction is complete trails adjacent to some nesting areas for sensitive bird species would be closed during the breeding season, if necessary. The locations of trail segments to be closed, and the periods of closure would depend on whether sensitive bird species, such as western snowy plovers or 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 would 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.

2.6.3 Conservation Measures – Predator and Invasive Spartina Control

- Traps set for predators would be checked daily to minimize stress to non-target species that are unintentionally captured.
- Any dogs or falcons used for hazing of predators would be well trained, and their activities would be closely controlled by their handlers.
- Eradication of perennial pepperweed would be done using the most recently approved and environmentally sensitive method available and would generally be limited to brackish marshes and upland transition areas.
- The USFWS-issued Formal Consultation for the Invasive Spartina Project Control Program and Restoration for 2012 on 188 sites; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties (USFWS 2012a), California provides additional conservation measures that apply to the removal of four species of non-native, invasive *Spartina*. Some of these measures include but are not limited to:
  - Pre-treatment Spartina and clapper rail monitoring data will be used to inform treatment crews operating within the marsh. GPS-mapped Spartina and clapper rail locations will be provided to treatment crews to avoid rail disturbance and minimize the *Spartina* search footprint during treatment work.
  - Prior to beginning monitoring, the prior year's site map will be examined and a route will be determined which will minimize the amount of foot traffic in the marsh and maximize the use of existing roads, trails, and boardwalks.

2.6.4 Conservation Measures – Invasive Plant Control

- Minimize vehicle travel through weed-infested areas;
- Minimize soil disturbance and the removal of existing vegetation (exotic or native) to the extent feasible during construction activities;
- Use only certified weed-free straw and mulch or weed-free fiber roll barriers or sediment logs;
- Use only seed mixes and plantings that are native or naturalized to the South Bay region and are appropriate to the pre-existing or adjacent natural habitat for revegetation (approved by Refuge staff);
- To prevent introduction and/ or transport of aquatic invasive species into or from creeks, sloughs, or other wetted channels in the project area, any equipment that comes into contact with the channel will be inspected and cleaned before and after contact, according to the most current Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species (DiVittorio et al. 2012).

2.6.5 Conservation Measures – Salt Marsh Harvest Mouse

- All vegetation within potential habitat for the salt marsh harvest mouse within the project area and within a 2-foot buffer around the project area shall be removed by hand using only non-mechanized hand tools *(i.e.,* trowel, hoe, rake, and shovel) prior to the initiation of work within these areas. All pickleweed stands will be removed by hand unless pickleweed is fully submerged during high tide and then a weed whacker may be used. Vegetation shall be removed to bare ground or stubble no higher than 1 inch. Vegetation shall be removed under the supervision of the USFWS-approved biologist. Vegetation removal may begin when no mice are observed and shall start at the edge farthest from the salt marsh or the poorest habitat and work its way towards better salt marsh habitat, and from center of project outward.

- Silt fences would be erected adjacent to construction areas to define and isolate potential mouse habitat.
- Temporary exclusion fencing shall be installed immediately after the hand removal of all vegetation (as described above) from the work area and a 2-foot buffer around the work area. The fence shall be made of a heavy plastic sheeting material that does not allow salt marsh harvest mice to pass through or climb, and the bottom shall be buried to a depth of 4 inches so that salt marsh harvest mouse cannot crawl under the fence. Fence height shall be at least 12 inches higher than the highest adjacent vegetation with a maximum height of 4 feet. All supports for the exclusion fencing shall be placed on the inside of the work area. The qualified biologist will have the ability to make field adjustments to the location of the fencing depending on site-specific habitat conditions.
- To the extent practicable, access through pickleweed vegetation would be minimized to avoid the loss of individual harvest mice.
- Prior to the initiation of work each day, the USFWS-approved biologist shall thoroughly inspect the work area and adjacent habitat areas to determine if salt marsh harvest mouse is present. Any necessary repairs to the exclusion fencing shall be completed within 24 hours of the initial observance of the damage. Work shall not continue within 300 feet of the damaged exclusion fencing until the fences are repaired and the site is surveyed by a qualified biologist to ensure that salt marsh harvest mouse has not entered the work area. In the event salt marsh harvest mice have entered the work area, the USFWS- approved biologist would contact the Refuge and the Refuge would relocate the mice prior to the start of construction in the project area.
- No work will occur within 50 feet of suitable tidal marsh habitat within two hours before and after an extreme high tide event (6.5 feet or higher measured at the Golden Gate Bridge and adjusted to the timing of local high tides) unless salt marsh harvest mouse-proof exclusion fencing has been installed around the work area.
- Anyone accessing salt marsh harvest mouse habitat will walk carefully through the marsh, avoiding high pickleweed cover and wrack where harvest mice are likely to nest or find cover.
- Any proposed levee alteration action involves the commitment to maintain intact, to the extent practicable, salt marsh harvest mouse corridors (i.e., corridors considered to be connected to larger areas of salt marsh harvest mouse habitat) on at least one side of levees while activities such as levee breaches, levee lowering, or placing dredged material on the levee take place. This would be done to the extent practicable after consultation with the USFWS and identification of suitable corridors.

2.6.6 Conservation Measures – California Ridgway's Rail

- Unless otherwise authorized by the USFWS and CDFW, operation of construction equipment and other construction, maintenance or monitoring activities within or adjacent to tidal marsh areas would be avoided to the maximum extent practicable during the California Ridgway's rail breeding season from February 1 through August 31 (Evans and Page 1983; DeGroot 1927; and USFWS unpublished data as cited in USFWS 2013). If project activities occur during rail breeding season, surveys may be conducted to determine if rail locations and rail territories can be avoided, or if the marsh is determined to be unsuitable rail breeding habitat by a qualified biologist.
- Preconstruction surveys for California Ridgway's rail would be conducted, by a USFWS-approved biologist, at and adjacent to areas of potential tidal and managed wetlands habitats for California Ridgway's rail. The surveys would focus on potential habitat that may be disturbed by

construction activities during the breeding season to ensure that these species are not nesting in these locations. Survey methods would follow USFWS-approved protocols used by biologists during surveys for the Phase 1 actions of the SBSP Restoration Project.

- If California Ridgway's rails are present in the immediate construction area, the following measures would apply during construction activities:
- To minimize or avoid the loss of individual California Ridgway's rails, activities within or adjacent to California Ridgway's rail habitat would not occur within 2 hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge), when the marsh plain is inundated, because protective cover for California Ridgway's rails is limited and activities could prevent them from reaching available cover.
- If breeding California Ridgway's rails are determined to be present, activities would 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 California Ridgway's rail calling center and any activity area is greater than 200 feet, it may proceed at that location within the breeding season.
- If a California Ridgway's rail nest is encountered during any Phase 2-related activity, the observers would immediately leave the vicinity of the nest; and if rail adults are encountered, observers would move away from the birds if they are giving alarm calls or otherwise appear alarmed.
- The project may elect, with the approval of the USFWS and USACE, to relocate activities (if feasible) to areas less likely to initially impact the California Ridgway's rail.
- To reduce indirect effects from levee servicing noise on California Ridgway's rails breeding in adjacent marshes, traditional California Ridgway's rail "High Use Areas" would be identified by the USFWS, and construction activities and noise within a pond or along a levee would be minimized to the extent possible adjacent to such areas.
- In order to minimize potential effects on salt marsh habitat and associated species (California Ridgway's rail and salt marsh harvest mouse), hunters would not be allowed to construct new permanent blinds in marsh areas.

2.6.7 Conservation Measures – Western Snowy Plover

- To the extent practicable, no construction, inspection, maintenance, monitoring, or research activities would be performed within 600 feet of an active western snowy plover nest during the western snowy plover breeding season, 1 March through 14 September (or as determined through surveys) without the approval of the USFWS.
- If chicks are present and are foraging along any levee that would be accessed by vehicles (e.g., for construction, inspection, or access), a qualified biologist would be present to ensure that no chicks are present within the path of the vehicle.
- Water-level manipulation (e.g., for site management) within ponds that contain suitable western snowy plover habitat would not be performed unless surveys are conducted to determine whether nesting plovers are present. If plovers are present, addition of water to the pond would be monitored closely to ensure that no nests are flooded.
- During restoration of tidal action in a pond, no levees would be breached on ponds that provide suitable nesting habitat for western snowy plovers during the snowy plover breeding season (1 March through 15 September) unless surveys demonstrate that nesting plovers are absent.

2.6.8 Conservation Measures – California Least Tern

- To the extent practicable, no construction, inspection, maintenance, monitoring, or research activities would be performed within 300 feet of an active least tern nest during the least tern breeding season, April 15 to August 15 (or as determined through surveys) without the approval of the USFWS.
- Water-level manipulation (e.g., for management) within ponds known to contain nesting least terns would be monitored closely to ensure that no nests are flooded.
- During restoration of tidal action in a pond, no levees would be breached on ponds known to contain nesting least terns during the breeding season (April 15 to August 15) unless surveys demonstrate that nesting least terns are absent.

2.6.9 Conservation Measures – Longfin Smelt[2]

- For any given activity, a biological monitor would be appointed who would be the contact source for any employee or contractor who might encounter a listed species. The representative(s) would be identified during the environmental awareness program. The representative's name and telephone number would be provided to USFWS and NMFS prior to the initiation of any activities.
- Longfin smelt of different life stages have the potential to occur in the Action Area year round. However in-channel work would be restricted to low tide to the extent practicable between May and September, when longfin smelt adults and larval stages are less likely to occur (adults were observed in the Island Ponds between October and April [Hobbs et al. 2012]).
- Complete seasonal avoidance of this special-status fish species is not possible. Therefore, pile driving would occur during low tide as feasible. This would minimize both the direct transmittal of noise through water in the work area; and the presence of special-status fish in the nearby shallow waters that remain.
- If necessary, cofferdams would be placed during low tide to keep fish and aquatic life out of the construction area for a maximum of two days.
- Qualified biologists would provide fish removal and relocation during dewatering and rescue any fish that may become stranded between the cofferdams.
- A "soft start" technique may be implemented during pile installation activities to reduce hydroacoustic effects on native fish. The soft start technique would allow for any longfin smelt in the vicinity work area to leave the Action Area before full pile driving began.

In addition to conservation measures, the SBSP Restoration Project includes a robust AMP with monitoring to regularly assess adverse short-term effects and ensure large-scale improvements for species and their habitats over the long-term (Appendix C). The plan includes tracking goals, triggers for species and habitats as well as potential actions for the adaptive management team if triggers are activated.

---

[2] Although longfin smelt are not a listed species covered in Section 7 of the ESA, they are a Candidate Species for ESA protection and therefore they are included in this BA. As per agreement between the USFWS and the CDFW, the species is covered by USFWS when the USFWS is acting as the lead federal agency.

3 Environmental Baseline

The term "South Bay" refers to the portion of San Francisco Bay south of Coyote Point on the western shore and San Leandro Marina on the eastern shore (Goals Project 1999). The South Bay is both a geographically and hydrodynamically complex system, with freshwater tributary inflows, tidal currents, and wind interacting with complex bathymetry (i.e., bed surface elevation below water).

3.1 Climate and Precipitation

The South Bay, like much of California's Central Coast, experiences a Mediterranean climate characterized by mild, wet winters and dry, warm summers. Air temperatures are mild due to proximity to the ocean. Winter weather is dominated by storms from the northern Pacific Ocean that produce nearly all the annual rainfall, while summer weather is dominated by sea breezes caused by differential heating between the hot interior valleys and the cooler coast. The South Bay typically receives about 90 percent of its precipitation in the fall and winter months (October through April), with the greatest average rainfall occurring in January. The average annual rainfall in the counties surrounding the South Bay is approximately 20 inches, although the actual rainfall can be highly variable due to the influence of local topography.

3.2 Hydrology

3.2.1 Hydrodynamics

The South Bay can be characterized as a large shallow basin, with a relatively deep main channel surrounded by broad shoals and mudflats. Tidal currents, wind, and freshwater tributary inflows interact with bathymetry to define the residual circulation patterns and residence time, and determine the level of vertical mixing and stratification. The most obvious hydrodynamic response is the daily rise and fall of the tides, although much slower residual circulation patterns also influence mixing and flushing processes within the South Bay.

The tides in San Francisco Bay are mixed semidiurnal tides (i.e., two high and two low tides of unequal heights each day). The tides exhibit strong spring-neap variability with the spring tides, which have a larger tidal range, occurring approximately every 2 weeks during the full and new moon. Neap tides, which have a smaller tidal range, occur approximately every 2 weeks during the moon's quarter phases. The tides also vary on an annual cycle, in which the strongest spring tides occur in late spring/early summer and late fall/early winter, and the weakest neap tides occur in spring and fall. The enclosed nature of the South Bay creates a mix of progressive and standing wave behavior, which causes tidal amplification as waves move southward (i.e., the tidal amplitude is increased by the harmonic addition of original waves plus reflected waves).

One of the most important factors influencing circulation patterns in the South Bay is bathymetry. Bathymetric variations create different flow patterns between the San Mateo Bridge and Dumbarton Bridge and in areas south of the Dumbarton Bridge. Circulation patterns also differ between the deep main channel and the expansive shoals. Currents in the South Bay are driven predominantly by tidally and wind-forced flows and their interaction with the bathymetry. Typically, winds drive a surface flow, which then induces a return flow in the deeper channels (Walters et al. 1985). In terms of circulation, the most significant winds are onshore breezes that create a horizontal, clockwise circulation pattern during the spring and summer. Density-driven currents occur when adjacent water bodies have differing densities, such as differences in temperature and/or salinity. Although density-driven currents are generally uncommon in the South Bay, in years of heavy rainfall, fresh water can flow from the Delta through the Central Bay and into the South Bay (Walters et al. 1985). In such events, the freshwater flows southward along the surface, while the more saline South Bay water flows northward along the bottom.

Currents and circulation affect the tidal excursion – the horizontal distance a water particle travels during a single flood or ebb tide. The tidal excursion varies between 6.2 and 12.4 miles within the main channels, and it ranges between 1.9 and 4.8 miles within the subtidal shoals; much smaller excursions occur on the intertidal mudflats (Cheng et al. 1993; Fischer and Lawrence 1983; Walters et al. 1985). Tidal dispersion is the dominant form of transport in the South Bay and the primary mechanism that controls residence times. Residence time is usually characterized as the average length of time a water parcel spends in a given waterbody or region of interest (Monsen et al. 2002). It is typically shorter during the winter and early spring during wet years and considerably longer during summer and/or drought years (Powell and Huzzey 1989; Walters et al. 1985). Residence time also varies with seasonal freshwater inflow and wind conditions.

The volume of water in the South Bay between mean low water and mean high water is the "tidal prism" of the South Bay. Tidal prism, in combination with bathymetry, determines the patterns and speed of tidal currents and subsequent sediment transport. The tidal prism for the South Bay is approximately 666,000 acre-feet, the majority of which is contained between the San Francisco-Oakland Bay Bridge and San Mateo Bridge (Schemel 1995). At mean lower low water, the volume of water in the far South Bay (south of the Dumbarton Bridge) is less than half the volume present at mean higher high water (MHHW). In addition, surface water area coverage at mean lower low water is less than half that at MHHW, indicating that over half of the far South Bay consists of shallow mudflats exposed at low tides (Schemel 1995).

3.2.2 Salinity

Salinity in the South Bay is governed by salinity in the Central Bay, exchange between the South Bay and Central Bay, freshwater tributary inflows to the South Bay, and evaporation. In general, the South Bay is vertically well mixed (i.e., there is little tidally averaged vertical salinity variation) with near oceanic salinities (33 parts per thousand [ppt]). Exceptions include areas within the far South Bay below the Dumbarton Bridge, which can remain brackish year-round due to wastewater treatment plant discharges.

Seasonal variations in salinity are driven by variability in freshwater inflows. High freshwater inflows typically occur in winter and early spring in wet years when fresh water from the San Francisco Bay Delta (Delta) intrudes into the South Bay. For example, during wet years when Delta outflow exceeds approximately 200,000 cubic feet per second (cfs), fresh water from the Delta intrudes into the South Bay during the winter and spring months, pushing surface salinities below 10 ppt. During dry years when Delta outflows are small, near surface salinity in the South Bay remains high (> 20 ppt) (PWA et al. 2005a). As Delta and tributary inflows decrease in late spring, salinity increases to near oceanic salinities. High freshwater inflows can result in circulation patterns driven by density gradients between the South Bay and Central Bay (Walters et al. 1985).

3.3 Sediment Characteristics

Bay habitats such as subtidal shoals, intertidal mudflats, and wetlands are directly influenced by sediment availability, transport and fate, specifically the long-term patterns of deposition and erosion. The main losses of sediment from the South Bay are exports to the Central Bay and sediment capture within marsh areas and restored ponds. Sediments carried on flood tides into a marsh or restored pond are typically deposited, causing the marsh or mudflat area to increase in elevation. Sediments can also be carried out with ebb tides if cohesive sediment deposition is inhibited. The rate of sedimentation a marsh or restored pond depends on the suspended sediment concentration (SSC) near the marsh or restored pond location, the elevation of the ground surface, and the degree of tidal exchange.

The capacity of many sloughs and channels in the South Bay has been gradually reduced by sediment deposition. Under natural conditions, channels adjacent to marsh lands experienced daily scouring from tidal flows. When these areas were diked off to create salt ponds, the scouring flows were reduced. Subsequent sedimentation has constricted channels, reducing cross-sectional areas and decreasing channel conveyance. Although the South Bay as a whole has undergone periods of net deposition and net erosion, the far South Bay below Dumbarton Bridge has remained largely depositional since bathymetric data collection began in 1857 (Foxgrover et al. 2004; Foxgrover et al. 2007; Krone 1996; Shellenbarger et al. 2013).

Suspended sediment concentrations in the South Bay exhibit short-term variability, primarily in response to variations in tidally driven resuspension, wind-driven resuspension, and riverine input from local tributaries and sloughs (Schoellhamer 1996). In the winter and early spring, the main sources of suspended sediments are local tributaries and the Central Bay. There is typically little direct input of suspended sediment in the dryer summer months; however, SSCs are often high due to increased wind-wave resuspension and reworking of previously deposited sediments. In recent, years, Shellenbarger et al (2014) have collected sediment flux data in the Alviso Slough. Their results show that winter storms and associated runoff have the greatest influence on sediment flux. Strong spring tides promote upstream sediment flux, and the weaker neap tides have a smaller net flux. During these neap tides, sediment transport during their weaker flood and ebb tides is suppressed by stratification of the water column, which dampens turbulence and limits sediment resuspension.

The transport and fate of suspended sediment has the potential to affect the transport and fate of contaminants, such as metals and pesticides, and the distribution of nutrients. Increasing SSCs are also directly correlated with increasing turbidity and decreasing light availability, thus affecting photosynthesis, primary productivity, and phytoplankton bloom dynamics.

3.4 Biological Conditions

The San Francisco Bay Estuary is the largest estuary on the west coast of North America and is an extremely productive and diverse ecosystem (Trulio et al. 2004). The South Bay includes some of the most important habitat remaining in the Bay Area for a number of wildlife species (Goals Project 1999). The habitats included in the South Bay are open waters and subtidal habitats to the upper reaches of tidal action, tidal and non-tidal wetlands, former salt evaporation ponds adjacent to the Bay, and the upland areas immediately adjacent to these features. The diversity of habitat types is largely responsible for the diversity of wildlife species that occur in the South Bay. Although the high productivity of these habitats allows those species that are not habitat-limited to achieve substantial numbers, the tidal salt marshes and open waters that sustain aquatic plants and phytoplankton and the ponds that sustain high biomass of invertebrates are the basis of the estuary's complex and productive food web. The San Francisco Estuary supports more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians (Siegel and Bachand 2002). Equally important, the San Francisco Estuary supports populations of species that are of regional, hemispheric, or even global importance. A number of special-status wildlife species—including endemic, endangered, threatened, and rare wildlife species or subspecies—reside in the San Francisco Bay Area.

3.4.1 Tidal Salt Marsh

Tidal salt marsh vegetation consists of halophytic (salt-tolerant) species adapted to occasional to regular (tidal) saltwater inundation. Tidal salt marsh occurs on the Bay's outboard portions of salt pond levees; these are often referred to as fringing marshes.

In tidal salt marsh, cordgrass (*Spartina* sp.) dominates low marsh areas. Pacific cordgrass (*Spartina foliosa*) has hybridized extensively with smooth cordgrass (*Spartina alterniflora*), a non-native species from the east and gulf coasts of North America. One or both of these species and/or their hybrids may be present at any one location.

The pickleweed and cordgrass salt marsh habitats are generally separated by elevation; cordgrass typically occurs below the MHW mark and pickleweed occurs above this mark and often extends into higher elevations. However, the hybridized cordgrass can extend into the pickleweed elevation in some marshes. Pickleweed (*Sarcocornia depressa* and *S. pacifica*) dominates middle marsh areas, and high marsh areas feature a mixture of pickleweed and other moderately halophytic species, including alkali heath (*Frankenia salina*), saltgrass (*Distichlis spicata*), saltmarsh dodder (*Cuscuta salina*), small flowered iceplant (*Mesembryanthemum nodiflorum*), fleshy jaumea (*Jaumea carnosa*), spearscale (*Atriplex prostrate*), perennial pepperweed (*Lepidium latifolium*), New Zealand spinach (*Tetragonia tetragonioides*), and marsh gumplant (*Grindelia stricta* var. *angustifolia*). High marsh species frequently occur above the high tide line, which is indicated by wrack material (water-transported organic and synthetic detritus). The outboard areas from pond levees and lower reaches of sloughs surrounding Ponds A1, A2W, and R4 typify tidal salt marsh in the project area.

In addition to the endangered salt marsh harvest mouse and the California Ridgway's rail, the Alameda song sparrow (*Melospiza melodia pusillula*), endemic to the Central and South San Francisco Bay, nests in dense herbaceous vegetation in salt and brackish marshes. The savannah sparrow (*Passerculus sandwichensis*) nests in pickleweed and peripheral halophytes in the upper marsh and upland transitional zones. The saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*) nests in tidal and non-tidal brackish and freshwater marshes and possibly also in low densities in salt marsh habitat (Shuford and Gardali 2008) in the South Bay. A wide variety of birds nest in the tidal marshes of the South Bay, including several species of ducks, Virginia rails (*Rallus limicola*), soras (*Porzana carolina*), black-necked stilts (*Himantopus mexicanus*), northern harriers (*Circus cyaneus*), and in a few locations herons and egrets (Gill 1977). Also, California black rails (*Laterallus jamaicensis coturniculus*) breed in small numbers in these marshes (Liu et al. 2005). In addition, non-breeding birds, including larger shorebirds, swallows, blackbirds, and other species, roost, occasionally in large numbers, in the tidal marsh. Tidal marshes (and mudflats) in several South Bay locations are also used as haul-out and pupping sites by harbor seals (*Phoca vitulina*).

3.4.2 Brackish Marsh

Brackish marsh occurs along the intertidal reaches of the creeks and sloughs that drain to the Bay, where salinities are lower due to freshwater input. Brackish marsh is found where intermediate interstitial soil salinities occur along creeks and sloughs; where freshwater channels experience periodic tidal inundation, and where groundwater emerges into tidal marshlands. Vegetative diversity and richness increase with greater freshwater influence. Where sediment deposits form terraced floodplains along low-flow channels, short bulrushes such as seacoast bulrush (*Bolboschoenus robustus*) and saltmarsh bulrush (*Bolboschoenus maritimus* ssp. *paludosus*) dominate the brackish habitat. These terraced areas may also support dense populations of the invasive perennial pepperweed, which can quickly develop into monotypic stands with increasing levels of disturbance. Other moderately halophytic plants such as brass buttons (*Cotula coronopifolia*) and taller bulrushes, including California bulrush (*Schoenoplectus californicus*) and hard stemmed tule (*Schoenoplectus acutus* var. *occidentalis*), occur in areas of lower soil salinity (e.g., toward the upland edges of brackish marsh). Tidal salt marsh species, including pickleweed, alkali heath, saltgrass, and spearscale, may also colonize brackish habitat. The periphery of Pond A19 and the adjacent Mud Slough are exemplary of brackish marsh in the project area.

Brackish marshes support many of the wildlife species that use salt marsh and freshwater marsh habitats. Species composition and the relative abundance of different species may vary spatially within brackish marshes depending on water salinity, vegetation type, and habitat structure. Variability in salinity within brackish marshes is likely most important for aquatic species, which are directly subject to variation in salinity. Brackish marshes are particularly important for anadromous fish (migrating from saline to fresh water to spawn), catadromous fish (migrating from fresh to saline water to spawn), and invertebrates such as shrimp, which use brackish marshes while physiologically acclimating to changing salinity on their migrations between saline and freshwater habitats.

The often taller and denser vegetation in brackish marshes supports large densities of breeding song sparrows, saltmarsh common yellowthroats, and marsh wrens (*Cistothorus palustris*) and large numbers of Virginia rails and soras during migration and winter.

3.4.3 Freshwater Marsh

Freshwater marsh vegetation in and around the project area exists along the upper reaches of sloughs and creeks and primarily consists of emergent vegetation adapted to freshwater wetland conditions. Though some freshwater marshes may experience tidal influence and periodic saltwater inundation, soil salinity remains relatively low due to freshwater flowing through these areas on a regular basis. The upper reach of Ravenswood Slough (along the eastern edge of Pond R3) demonstrates the vegetation transition that occurs as freshwater influence increases. Dense stands of California bulrush and hard-stemmed tule interspersed with perennial pepperweed (*Lepidium latifolium*) or curly dock (*Rumex crispus*) compose the majority of emergent vegetation in freshwater marsh habitat. Areas less frequently exposed to freshwater flow but still exposed to occasional saltwater inundation may also host halophytic species such as marsh gumplant and pickleweed. The

Guadalupe River side of Pond A8 is a location where freshwater species colonize the entire floodplain terrace.

Relatively limited areas of freshwater marsh occur in the South Bay, and the wildlife communities of these marshes (versus those of brackish and salt marshes) in the South Bay have been little studied. Where freshwater occurs along the inland margins of the project area, the Pacific treefrog (*Pseudacris regilla*), bullfrog (*Rana catesbeiana*), and western toad (*Bufo boreas*) are present. California tiger salamanders (*Ambystoma californiense*) (a species listed as Threatened under the federal and California ESAs) occur in vernal pool habitats in the Warm Springs Unit area, primarily on lands of the Refuge, adjacent to the SBSP Restoration Project area and the Newark salt ponds managed by Cargill.

Most wetland-associated birds respond more to food availability and habitat structure than to salinity and therefore may occur in abundance in freshwater, brackish, or salt marsh habitats with suitable habitat structure. Some birds that are typically associated with fresh (versus more saline) marshes during the breeding season, such as bitterns, Virginia rails, and soras, breed sparingly in the South Bay, likely due to the limited extent of freshwater marshes. In contrast, red-winged blackbirds (*Agelaius phoeniceus*), American coots (*Fulica americana*), common moorhens (*Gallinula chloropus*), pied-billed grebes (*Podilymbus podiceps*), song sparrows, saltmarsh common yellowthroats, and marsh wrens breed commonly in freshwater marsh habitats in the South Bay. A variety of mammals occur in these freshwater habitats as well, although with the exception of the muskrat (*Ondatra zibethicus*), none are associated primarily with this habitat type. Rather, mammals associated more with adjacent upland habitats use freshwater marsh for cover or foraging habitat.

3.4.4 Upland/Levees

The primary upland habitat existing in the Alviso-Island, Alviso-Mountain View, Alviso-A8, and Ravenswood pond clusters exists along the tops of levees and along the landward sides of the project area. Levees were constructed from native tidal salt marsh soils (silty clay) in the immediate vicinity and may occasionally be reinforced with concrete debris. Due to the high salinity of these soils and their inherent disturbed nature, many levees feature areas of bare soil or are otherwise populated by non-native halophytic species, including small flowered iceplant, New Zealand spinach, sea fig (*Carpobrotus chilensis* – FACU), Russian thistle (*Salsola soda*), and Australian saltbush (*Atriplex semibaccata*).

On levees and portions of levees where freshwater (groundwater or rain) has reduced soil salinity over time, other common ruderal species (non-native species that thrive in areas of disturbance) of forbs and grasses dominate; including black mustard (*Brassica nigra*), Italian thistle (*Carduus pycnocephalus*), yellow star thistle (*Centaurea solstitialis*), sweet fennel (*Foeniculum vulgare*), perennial pepperweed, common mallow (*Malva neglecta*), bird's foot trefoil (*Lotus corniculatus*), wild oats (*Avena fatua*), ripgut brome (*Bromus diandrus*), crabgrass (*Digitaria sanguinalis*), Italian rye grass (*Lolium multiflorum*), tall wheat grass (*Elymus ponticus*), and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*). Native shrubs may colonize more substantial levees (for instance, the coyote bush [*Baccharis pilularis]* found on the Pond A19 levees).

Due to the intense disturbance of much of uplands areas adjacent to the ponds, with most areas lacking an obvious transitional zone between the aquatic bayland habitats and adjacent habitats, most of the wildlife species found in these peripheral areas are common species adapted to urban or ruderal habitats. Reptiles such as the western fence lizard (*Sceloporus occidentalis*), gopher snake (*Pituophis melanoleucus*), and southern alligator lizard (*Elgaria multicarinata*) and mammals such as the house mouse (*Mus musculus*), California vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), California ground squirrel (*Spermophilus beecheyi*), black-tailed jack rabbit (*Lepus californicus*), cottontail (*Sylvilagus audubonii*), brush rabbit *(S. bachmani*), valley pocket gopher (*Thomomys bottae*), and striped skunk (*Mephitis mephitis*) all occur in the upland transitional areas along the edge of the Bay.

In most areas, the bird species that occur in the peripheral upland habitats are also common, widespread species. These include permanent residents such as the Anna's hummingbird (*Calypte anna*), mourning dove (*Zenaida macroura*), black phoebe (*Sayornis nigricans*), northern mockingbird (*Mimus polyglottos*), bushtit (*Psaltriparus minimus*), California towhee (*Pipilo crissalis*), red-winged blackbird (*Agelaius phoeniceus*), Brewer's blackbird (*Euphagus cyanocephalus*), house finch (*Carpodacus mexicanus*), lesser goldfinch (*Carduelis psaltria*); summer residents such as the barn swallow (*Hirundo rustica*) and cliff swallow (*Petrochelidon pyrrhonota*); transients (some of which breed at higher elevations in the Bay Area), including the Swainson's thrush (*Catharus ustulatus*); and winter residents such as the hermit thrush (*Catharus guttatus*), white-crowned sparrow (*Zonotrichia leucophrys*), golden-crowned sparrow (*Zonotrichia atricapilla*), yellow-rumped warbler (*Dendroica coronata*), and American pipit (*Anthus rubescens*).

In remote areas (e.g., levees between salt ponds far from the upland edge), South Bay levees are heavily used for nesting by birds such as double-crested cormorants (*Phalacrocorax auritus*), California gulls (*Larus californicus*), black-necked stilts, and American avocets (*Recurvirostra Americana*). Western snowy plovers have been identified nesting in relatively large numbers on some South Bay levees relatively recently, in the years since their construction. Before the development of the levees, western snowy plover primarily nested in natural dunes, many of which have been lost to development. Large numbers of shorebirds use salt pond levees for roosting, particularly when intertidal foraging habitats are inundated during high tide (Warnock 2004). Some species, including western snowy plovers, black-necked stilts, and least sandpipers (*Calidris minutilla*), also forage frequently along the margins of levees. Gulls, Forster's terns (*Sterna forsteri*), Caspian terns (*Hydroprogne caspia*), cormorants, pelicans, and other waterbirds also frequently roost on levees. The California least tern uses levees in the South Bay as post-breeding roosting sites. After breeding (primarily at Central Bay sites), adult California least terns bring their juvenile offspring to the South Bay to forage before migration. Mammals use levees for dispersal and to obtain access to foraging areas. Red foxes (*Vulpes vulpes*) and California ground squirrels often excavate dens within levees (usually near the upland edge). Levees with riprap or concrete debris provide some cover for other small mammals, including predators or nuisance species such as the Norway rat (*Rattus norvegicus*), roof rat (*Rattus rattus*), and feral cat (*Felis catus*), and peripheral halophytes along the lower edges of the levee provide high-tide refugia for species such as the salt marsh harvest mouse, California Ridgway's rail, and California black rail. These high-tide refugia may be quite important to the survival of individual rails and mice during extreme high-tide events. However, levees also provide corridors for mammalian predators to access marsh areas, which can lead to high levels of predation on marsh wildlife.

3.4.5 Mudflats

Naturally occurring mudflats on the outboard sides of many South Bay salt ponds begin at low tidal salt marsh areas and extend into the Bay. They form the overwhelming majority of intertidal habitat in the South Bay, with exceptions being only a narrow and deep channel near the center of the Bay and the fringing marshes and former salt ponds around the edges. Covered by shallow water during high tide, these mudflats are exposed during low tide. These intertidal habitats are inhospitable to most vascular emergent vegetation; typically supporting 0 to 10 percent cover of cordgrass or pickleweed. Narrow stretches of mudflat occur within slough and creek channels and at the mouths of major sloughs. Mudflats also exist in the basins of former salt ponds, such as Charleston Slough (adjacent to the Mountain View Ponds), and in portions of the Island Ponds (Ponds A19, A20, and A21) where the levees have been breached and the pond re-exposed to Bay waters and tides. Eventually, as sediment accretes, tidal marsh habitat is expected to replace mudflat habitat within the former salt ponds.

These mudflats are a key reason for the importance of the San Francisco Bay Area to west coast shorebird populations, with an average of 67 percent of all the shorebirds on the west coast of the United States using San Francisco Bay wetlands (Page et al. 1999). Gulls and some dabbling ducks forage on the exposed mudflats as well. Because benthic invertebrates often recede deeper into the mud as the tidal elevation drops, especially large concentrations of foraging birds usually occur along the edge of the receding or rising tideline. Although the largest numbers of shorebirds forage on the broad flats along the edge of the Bay at low tide, some shorebirds, gulls, and large waders (e.g., herons and egrets) feed on the exposed flats along sloughs and channels, and the smaller channels in the brackish and salt marshes are the favored foraging areas for the state and federally endangered California Ridgway's rail.

Shorebirds, gulls, terns, American white pelicans (*Pelecanus erythrorhynchos*), and ducks often use exposed mudflats as roosting or loafing areas when available, as do Pacific harbor seals (*Phoca vitulina richardsi*). When the tides rise, most of these birds return to roosting areas in salt ponds or other alternate habitats, and the seals move to open waters.

3.4.6 Former Salt Production Ponds

Salt ponds were previously managed for the purpose of commercial salt production. The margins and basins of some former salt ponds that are seasonally ponded but dry much of the year (e.g., Ponds R3 and R4 at the Ravenswood pond cluster) consist of bare ground and salt flat or salt panne (non-mudflat soils) areas. Historically, these basins were subject to regular tidal inundation, but following installation of levees and their use as salt ponds, the salinity has increased beyond the tolerance of most halophytic vegetation. Few vascular plant species surviving in this environment, such as are pickleweed, alkali heath, and the non-native small flowered iceplant (*Carpobrotus* spp.), which occur sparsely along the margins of the basins and on top of the soil terrace of the salt flats. Due to the paucity of vegetation, these ponds provide little to no cover for small mammals or reptiles and provide nesting habitat only for species that ground-nest on the levees and the occasional islands that have been created (by deposition of material dredged) within the ponds.

Many of the remaining ponds provide valuable roosting and foraging habitat for shorebirds and waterfowl. Higher-salinity ponds support high densities of brine shrimp and brine flies (especially *Ephydra millbrae*), which in turn serve as prey for eared grebes and other high-salinity specialists.

The ponds within the project area are, collectively, highly productive systems supporting large quantities of vertebrate and invertebrate biomass. However, much of the biomass produced by these ponds is unavailable to birds or fish due to water depths (for shorebirds) and salinities (for fish) that preclude these vertebrates' use of much of the invertebrates as food in the deeper, higher-salinity ponds.

3.4.7 Open Water and Subtidal Habitats

The open water category includes a variety of habitat types, including subtidal Bay waters, tidal sloughs and channels, and areas of standing or flowing waters within the salt ponds and tidal marshes. Deep water does not support emergent vegetation. Deep bays and channels are important for aquatic invertebrates, fishes, waterbirds, and harbor seals. The open waters of South San Francisco Bay support a high diversity of benthic and pelagic macroinvertebrates. Though most of the dominant invertebrates are non-native species, they nonetheless support native oyster populations, large fish populations representing several different trophic levels, including Pacific herring (*Clupea pallasii*), northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax caeruleus*), staghorn sculpin (*Leptocottus armatus*), several species of perch (Embiotocidae family), English sole (*Parophrys vetulus*), and California halibut (*Paralichthys californicus*). Many of these fish species in turn support harbor seals and piscivorous (fish-eating) birds such as the Forster's tern, California least tern, American white pelican, brown pelican (*Pelecanus occidentalis*), and double-crested cormorant. Waterfowl such as greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), canvasbacks (*Aythya valisineria*), and surf scoters (*Melanitta perspicillata*) dive for bivalves, crustaceans, and other invertebrates in shallower subtidal areas. Bird diversity in the open Bay waters is fairly low, as the species of birds that can exploit the subtidal areas are limited to those that can forage from the air (e.g., terns) or under water (e.g., scoters) and those that can swim. However, large densities of diving ducks (e.g., bufflehead [*Bucephala albeola*], greater scaup) occur in some areas where appropriate depths and concentrations of benthic invertebrates, particularly bivalves, provide a rich food source. Some species, such as gulls, also roost on the open waters of the Bay, especially at night.

The tidal sloughs and channels that circulate water around and in between salt ponds and marsh remnants and through the marshes provide important habitat for large numbers of benthic and pelagic invertebrates and fish. These detritus-rich channels serve as important nurseries and feeding areas for estuarine fish, including leopard sharks (*Triakis semifasciata*). California bay shrimp (*Crangon franciscorum*) spawn in the open ocean but spend much of their lives feeding in the brackish waters of South Bay sloughs (Baxter et al. 1999). Diving ducks generally avoid the smaller tidal channels but can be found in abundance, particularly during their nonbreeding season, near the mouths of the larger tidal sloughs, in open waters, and in deeper ponds. Thousands of diving ducks also roost and forage in the artificial lagoons in Foster City and Redwood Shores, north of the Ravenswood pond cluster, and in the Sunnyvale water treatment plant, southeast of the Alviso-Mountain View pond cluster, in winter. Dabbling ducks such as the gadwall (*Anas strepera*), green winged teal (*Anas crecca*), northern shoveler (*Anas clypeata*), and mallard (*Anas platyrhynchos*) reach high densities in the shallower ponds and in smaller and shallower channels, where they feed on aquatic plants (including algae, submerged aquatic vegetation, and plankton) and invertebrates. Terns often forage in the larger and mid-sized channels and ponds, and several species of herons and egrets forage in the shallows for fish. Many shorebirds feed along the exposed flats along tidal channels at low tide, as do rails and other tidal marsh birds.

4 Action Area

For the purposes of Section 7 consultation, the Action Area is defined as "all areas that may be affected directly or indirectly by the Federal action and not merely the immediate area directly involved in the action". As noted in Chapter 2, there are four pond clusters that are included in the proposed Phase 2 Actions: the Island Ponds, the A8 Ponds, the Mountain View Ponds (all part of the Alviso pond complex), and the Ravenswood Ponds at the Ravenswood pond complex. Each of these pond clusters has its own portion of Action Area, as illustrated on **Figure 4**, sheets **a** through **d**.

The project footprint for Phase 2 proposed actions is the area where work activities would occur, including all construction, dredging, and staging and access, as presented in the previous sections. The Action Area encompasses the geographic extent of environmental changes (i.e., the physical, chemical and biotic effects) that would result directly and indirectly from the Phase 2 actions (USFWS 2016b). The Action Area for the Phase 2 Project includes the project footprint at each of the pond clusters as well as the adjacent fringing marshes, uplands, mud flats, sloughs and other waterways, and Bay waters that could be affected by restoration or long-term operations, as described in greater detail below. These areas are defined conservatively and include much larger areas of waters, tidal mud flats and fringing marshes than are expected to be impacted when minor changes to the ponds and levees occur.

Other areas in the immediate vicinity of the footprint could be directly or indirectly affected by noise or dust resulting from the Phase 2's construction activities. With a few exceptions noted below, most of the loudest project construction would be conducted by excavators and bulldozers with an anticipated maximum in-air construction noise of 88 dBA at 50 feet (Phase 2 EIS/R, Section 3.12 Noise). This construction noise level is less than the 93 dBA that could result in temporary threshold shifts for birds (Dooling and Popper 2007). However construction noise may alter animal behavior over the distance which it is detectable above background noise conditions. Therefore, the Action Area extends well beyond the outer edge of the project footprint, to include noise- and dust-related effects as well as those associated with the potential for scour of nearby mudflats, marshes, channels, or levees and areas within this distance are also included in the Action Area.

The Action Area is inclusive of areas of potential effects on all federally listed species collectively, including those upland areas that are used by terrestrial species. Not all species would be affected in all portions of the Action Areas.

4.1 Island Ponds

The Action Area at the Island Ponds (Ponds A19, A20, and A21, hereafter "Island Ponds") is shown in **Figure 4a**. The Action Area includes the project footprint for the Island Ponds, which includes the ponds themselves, the surrounding levees, and those portions of the existing fringing marshes and mudflats that would be directly modified by the Phase 2 project action. The Action Area also includes existing fringing marshes, mudflats and creeks or sloughs that would not be directly modified by the proposed actions but that could be indirectly modified by changes in tidal flows and/or construction access roads. Coyote Creek and Mud Slough are the streams that could be affected by these changes or could be traversed by water-based construction equipment to access the Island Ponds. Marshes and levees across Mud Slough from the Island Ponds (and to a lesser extent, those across

Coyote Creek from the Island Ponds) could also be affected by the modified hydrology that the Phase 2 action would produce. In addition, portions of San Francisco Bay west of the Island Ponds could be affected by discharge of sediment during construction and changes in hydrology resulting from the SBSP Restoration Project. All of these areas are included within the Action Area. Work at the Island Ponds would be done by almost entirely by bulldozers and excavators. There would be no pile driving, jackhammering, demolition or removal of structures, or other notably loud activities, so the noise-related effects in this portion of the Action Area are not expected to exceed the background noise conditions.

4.2 A8 Ponds

The Action Area at the A8 Ponds (Ponds A8 and A8S, hereafter "A8 Ponds") is shown in **Figure 4b**. The project footprint for work at the A8 Ponds is limited to the southwest and southeast corners of these ponds, where the upland fill material from offsite excavation projects would be placed to form habitat transition zones. The Action Area also includes the remnants of the interior levee that formerly separate Pond A8 from Pond A8S, where there could be local turbidity increases during material placement. The Action Area also includes the A8 notch and a section of the channel connecting Alviso Slough to the A8 notch. It also includes the existing levee roads that extend from the Pond A8 notch and that wrap around the southern border of this pond cluster. Finally, work at the A8 Ponds would primarily be conducted by excavators, rollers, haul trucks and bulldozers. There would be no pile driving, jackhammering, demolition or removal of structures, or other notably loud activities so the noise-related effects in this portion of the Action Area are not expected to exceed the background noise conditions.

4.3 Mountain View Ponds

The Action Area at the Alviso-Mountain View Ponds (Ponds A1 and A2W, hereafter "Mountain View Ponds") is shown in **Figure 4c**. The Action Area includes the project footprint for the Mountain View Ponds, which include the ponds themselves, the levees that surround them, and those portions of the existing fringing marshes and mudflats that would be directly modified by the project action. The Action Area also includes existing fringing marshes, mudflats and creeks or sloughs that would not be directly modified by the proposed actions but that could be indirectly modified by changes in tidal flows. Stevens Creek, Whisman Slough, Permanente Creek, Mountain View Slough, and Charleston Slough are the streams and waterways that could be affected by these changes. Existing marshes and levees across from these surrounding waterways could also be affected by the modified hydrology that the Phase 2 action would produce. A portion of the City of Mountain View's Coast Casey Forebay (a stormwater detention basin) and one of the levees surrounding it would also be directly affected by the project; the rest of the forebay may be indirectly affected by construction-related activities. The uplands at Mountain View's Shoreline Park (a closed landfill) include a mix of grasslands and other upland vegetation communities. Portions of the park itself would be used for fill material delivery and stockpiling, so it is included in the Action Area. In addition, portions of San Francisco Bay north of the Mountain View Ponds could be affected by discharge of sediment during construction and changes in hydrology and mudflats as a result of the project. All of these are in the Action Area at the Mountain View Ponds.

Other areas in the immediate vicinity of the Mountain View Ponds could be directly or indirectly affected by noise resulting from the project's construction activities. Work at the Mountain View

Ponds would primarily be conducted largely by excavators, rollers, bulldozers, and haul trucks, but there would be some pile driving (for 1-2 days) to place supports for bridge abutments, demolition and removal of structures, and other notably loud activities. Only pile driving noise may exceed the 93 dBA level that was established for continuous noise and that could result in temporary threshold shifts for birds. Therefore, the Action Area at the Mountain View Ponds includes a conservative, larger radius of 0.5 mile from the pile-driving locations to include potential effects from in-air noise (note that because pile driving is an impulse noise and not a continuous noise, this is believed to be a very conservative approach). In addition, the Action Area includes all areas where the underwater noise assessment predicted regulatory thresholds to be exceeded. This includes a maximum distance of 385 feet from pile driving activity, as described in Appendix G, which is an analysis of underwater noise from pile driving.

4.4 Ravenswood Ponds

The Action Area at the Ravenswood ponds (Ponds R3, R4, R5, S5, and the S5 forebay, hereafter "Ravenswood Ponds") Phase 2 project activities is shown in **Figure 4d**. The Action Area includes the project footprint for the Ravenswood Ponds, which include the ponds themselves, the levees that surround them, and those portions of the existing fringing marshes and mudflats that would be directly modified by the project action. Further, a strip of the entry road into Menlo Park's Bedwell Bayfront Park (a closed landfill) would be temporarily excavated to place a culvert connecting the S5 forebay to Flood Slough (it would be rebuilt and paved afterward), which makes it part of the project footprint.

The Action Area also includes existing fringing marshes, mudflats and creeks or sloughs that would not be directly modified by the proposed actions but that could be indirectly modified by changes in tidal flows. Flood Slough, Ravenswood Slough, and West Point Slough are the streams and waterways that could be affected by these changes. Existing marshes and levees across from these surrounding waterways could also be affected by the modified hydrology that the Phase 2 action would produce. The uplands at Bedwell Bayfront Park include a mix of grasslands and other upland vegetation communities. Portions of the park itself would be used for fill material delivery, so it is included in the Action Area. In addition, portions of San Francisco Bay north of the Ravenswood Ponds could be affected by discharge of sediment during construction and changes in hydrology and mudflats as a result of the project.

Other areas in the immediate vicinity of the Ravenswood Ponds could be directly or indirectly affected by noise resulting from the project's construction activities. Work at the Ravenswood Ponds would primarily be conducted largely by excavators, rollers, bulldozers, and haul trucks, but there could be some pile driving (for 1-2 days) to place supports for pipe bridges. Only impact pile driving noise may exceed the 93 dBA level that could result in temporary threshold shifts for birds. As described above, however, this is a very conservative approach because pile driving is not a continuous noise-generative activity. The piles for the pipe bridges are relatively small and shallow, and they are fewer in number than the piles for the vehicle bridges at the Mountain View Ponds. They are likely to be vibrated in or augured and cast in place, and seasonal avoidance and preconstruction surveys would be used to the maximum extent practicable to avoid impacting nesting birds. Therefore, the Action Area at the Ravenswood Ponds does not include larger radius for in-air noise used at Mountain View. The Action Area includes all areas where the underwater noise assessment predicted regulatory thresholds to be exceeded. This includes a maximum distance of 385 feet from pile driving activity.

5 Species and Critical Habitats Considered

This section of the Biological Assessment (BA) presents the methods used to identify federally listed species that may be present in the Action Area and describes each select species in detail. No designated critical habitat for species regulated by the USFWS is present within the Phase 2 project Action Area.

5.1 Study Methods

5.1.1 Database Search

Preparation of this BA included reviews of multiple sources to identify threatened and endangered species and designated critical habitat that may be present in the vicinity of the proposed Action Area. A species list was generated for federally listed species with potential to occur within the Phase 2 Action Area. The following sources were used to confirm the list of species analyzed in this BA:

- USFWS IPaC website: An official list of federal candidate, proposed, threatened, and endangered species and their federally designated or proposed critical habitats known or having the potential to occur within Alameda, San Mateo and Santa Clara Counties was requested on June 8, 2016. The USFWS Official Species lists, returned on January 26, 2017, and are included in Appendix D **–** U.S. Fish and Wildlife Service Species List.
- CDFW's California Natural Diversity Database (CNDDB)/RareFind 5: A list of federally listed plant and wildlife species was prepared through an inquiry of documented species occurrences within the following topographic quadrangles: Milpitas (3712148), Mountain View (3712241), Newark (3712251), Niles (3712158), Palo Alto (3712242), and Redwood Point (3712252) (CDFW 2016a).This inquiry provided a list of species that is included in Appendix E – California Natural Diversity Database - RareFind 5 Occurrence Record and was used to generate a map of occurrence locations presented as **Figure 5**, sheets **a** and **b**.

The list of species generated through this inquiry was refined to reflect those that could reasonably be expected to occur within the Action Area based upon information presented in the Phase 2 EIS/R (2016), life history requirements for various species, results from extensive monitoring and reporting by Refuge staff within the Phase 2 Action Area, and an understanding of habitat conditions in the Action Area to determine species with potential to occur in the Action Area. Appendix F - Evaluation of Potential to Occur presents the results of this analysis and provides the rationale for exclusion of species from further discussion.

5.1.2 Additional Sources of Information

Several other sources were used to evaluate occurrence potential and assess effects from Phase 2 Actions. These sources include:

- The Programmatic Biological Opinion (PBO) for the SBSP Restoration Project (2007) and the Phase 2 EIS/R (2016) generally describe focal species and their habitats in the SBSP Project Action Area.
- The Federal Register contains information for the four federally listed species currently regulated by the USFWS.

- Species-specific studies presented in technical reports, scientific journals and other publications, including the various programmatic documents previously prepared for SBSP Restoration Project.
- Species-specific studies and observations presented in unpublished reports prepared by the Refuge.

5.2 Species Considered

The SBSP Restoration Project pond complexes themselves are not expected to support federally listed plants: vascular plants are entirely absent from artificial, hypersaline ponds, and levees; and remnant marshes provide peripheral halophytic habitat bearing little resemblance to the broad, relatively heterogeneous habitat of an intact upper marsh. Historic populations of federally listed plant species are largely considered to be extirpated from the action area (USFWS 2010). Several of the listed plants in the general area of the SBSP Restoration Project are closely associated serpentine soils or serpentine substrate. Serpentine soils are absent from the action area.

Based upon the results of the analysis described in Section 5.1, this document evaluates four federally protected and USFWS-regulated species that may be present within the Action Area: salt marsh harvest mouse, California Ridgway's rail, western snowy plover, and California least tern. In addition, a fifth species, longfin smelt, is a candidate species for federal listing and is listed as threatened under the California ESA. By agreement between the USFWS and CDFW, on projects for which the USFWS is a federal lead agency, take authorization for the California ESA and Section 7 coverage will be provided by the USFWS. Longfin smelt are therefore covered in this BA.

Some species from the PBO were not included in this BA because they are no longer listed (e.g., Brown Pelican) or because they have no potential to occur in the Action Area for Phase 2 (e.g., California Tiger Salamander). Additionally, since issuance of the PBO, the name for what was then known as "California clapper rail" was changed to "California Ridgway's rail," and is referred to in this BA as such. Species with no potential to occur in the Action Area are not addressed further in this document. Species regulated under the jurisdiction of the NMFS are identified and addressed in a separate BA.

5.2.1 Salt Marsh Harvest Mouse – Known Occurrences and Potential Habitat

Detailed life history and region-wide information on species distribution and conservation efforts are presented in the PBO and the Phase 2 EIS/R (2016). Within the Phase 2 Action Area, salt marsh harvest mouse and/or its habitat occur in a number of locations, although high-quality habitat is limited. Species distribution is described in more detail, below, by pond cluster. Salt marsh harvest mice known occurrences and areas of suitable habitat within the Action Area are shown for each of the pond clusters on **Figure 6a** through **Figure 6d**).

Island Ponds

Salt marsh harvest mouse habitat at the Island Ponds was previously limited to narrow bands of brackish marsh along the levees along Mud Slough and Coyote Creek. The area is currently transitioning to tidal salt marsh from the breaches made under the ISP. Prior to the breaches, the periphery of Pond A19 and the adjacent Mud Slough was exemplary of brackish marsh (wetland delineation report, AECOM September 2016). Suitable habitat now exists in Pond A21 as salt marsh harvest mice have been captured around Pond A21 (SCVWD and USFWS 2016). Salt marsh harvest mouse is expected to begin using in Pond A20 and eventually in Pond A19 as those ponds become vegetated.

A8 Ponds

In general salt marsh harvest mouse habitat is limited in this area. Small, isolated patches of pickleweed occur around the interior of the southern end of Pond A8S. These patches are typically 1-3 feet across and located just above the highest tidal elevations in this muted tidal pond system, but do not appear to be used by salt marsh harvest mouse, probably because of the large distance from established populations and the physical barriers (large levees and roads, the deep-water ponds themselves). However, outside of the ponds, suitable tidal marsh habitat is found at higher elevations just above cordgrass-dominated marsh and extends upstream into Guadalupe Slough, and Alviso Slough. Brackish marsh replaces salt marsh moving upstream along Guadalupe Slough and Alviso Slough. Salt marsh harvest mice are known to use both salt marsh and brackish marsh habitats; however, no mice were caught within approximately 0.5 mile of the A8 Ponds during 2004 surveys (Harvey & Associates et al. 2005).

There are concerns about mercury exposure in these ponds, as described in Section 2.2.2. The effects from potential short-term exposure to mercury at this location have not been studied for salt marsh harvest mouse.

Mountain View Ponds

Suitable tidal marsh habitat is found at higher elevations in Permanente Creek/Mountain View Slough, Stevens Creek/Whisman Slough, outer Charleston Slough, and along the outer margins of the pond levees where there are cordgrass-dominated or pickleweed-dominated marsh. There are also strips of pickleweed marsh along much of the interior margins of Ponds A1 and A2W and on the Charleston Slough side of the levee between it and Pond A1. These are wider and somewhat higher-quality habitat than the similar patches at the A8 Ponds, but there are still connectivity barriers to mice reaching these patches. Harvest mice are not known to occur in the project footprint or within the Action Area at the Mountain View ponds. However, the species has been observed near Pond A1 in the pickleweed-dominated salt marshes west of Charleston Slough (H.T. Harvey & Associates, et al. 2005). Pond A1 is separated from the habitat where mice were observed by levees and trails (including the Bay Trail and the Adobe Creek Loop Trail).

Ravenswood Ponds

The Ravenswood Ponds are partially surrounded by salt marsh that consists of cordgrass marsh along the lower elevation fringes of the marsh and pickleweed marsh in the higher elevations of the marsh plain. However, salt marsh harvest mouse habitat is very limited in extent and quality (i.e., the tidal marshes are narrow and have little to no escape cover). With the exception of limited areas on nearby Greco Island and Ravenswood Slough, the extent of high marsh habitat and transition zones to higher areas (for refugia during the highest spring tides) is limited enough to constrain habitat quality for the salt marsh harvest mouse. As noted previously, these high-tide refugia are important to this species.

Salt marsh harvest mice have been observed outside of the Ravenswood Ponds in several locations: to the west at Greco Island and within Flood Slough (1988 survey by WESCO), to the southeast in a small patch of marsh habitat as well as to the northeast of Pond R1 and R2. Additional occurrences in the northeast of Ponds R1 and R2 are nearly a mile from the Action Area; salt marsh harvest mice would have to cross levees and Ravenswood Slough to disperse into the Action Area. Once Pond R4 is restored to tidal marsh, this species is expected to eventually occur in the Action Area by moving in from the known populations on Greco Island, Ravenswood Slough and/or Flood Slough.

5.2.2 California Ridgway's Rail – Known Occurrences and Potential Habitat

Detailed life history and region-wide information on species distribution and conservation efforts are presented in the PBO and the Phase 2 EIS/R (2016). Within the Phase 2 Action Area, California Ridgway's rails occur in a number of locations, although high-quality habitat is limited. Species distribution by pond cluster is described in more detail below. California Ridgway's rail known occurrences and areas of suitable habitat within the Action Area are shown with salt marsh harvest mouse for each of the pond clusters on **Figure 6a** through **Figure 6d**.

Island Ponds

This species is present in brackish marshes in Mud Slough and Coyote Creek, and in smaller marsh remnants along sloughs and the Bay edge. The area is currently transitioning to tidal marsh after being breached as part of the Initial Stewardship Plan. Suitable habitat now exists in the tidal marsh areas forming in Ponds A20 and A21. Two breeding rails were recorded in the A21 Pond in July 2015 (SCVWD and USFWS 2016).

A8 Ponds

Limited suitable habitat exists for the rails within the A8 Ponds. However, brackish marsh replaces pickleweed-dominated salt marsh upstream along Guadalupe Slough (outside of the western edge of pond A8S) and Alviso Slough (outside of the northeastern part of A8). Ridgway's rails have been recorded in both Alviso and Guadalupe Soughs which border the A8 ponds (Olofson Environmental, Inc. 2015). Since 2010, the number of rails detected during surveys has varied between 0 and 9 in suitable tidal marsh habitat along the two sloughs.

There are concerns about mercury exposure in these ponds, as described in Section 2.2.2. Phase 1 construction activities temporarily increased mercury levels in Forster's tern eggs in this pond (Slotton, pers. comm.). Mercury levels in Forster's eggs have since decreased and again resemble the reference areas. Mercury contamination in the San Francisco Bay has been shown to decrease body condition and impair reproduction of rails (Ackerman et al 2012), but the effects from potential short-term exposure to mercury as a result of restoration has not been studied for California Ridgway's rails. Mountain View Ponds

Suitable habitat is located in limited areas at the Mountain View Ponds. Salt marsh dominated by cordgrass is found at lower elevations bordering the mudflats and along the fringing lower elevations of Mountain View Slough (between Ponds A1 and A2W) and Stevens Creek (eastern edge of Pond A2W). Pickleweed-dominated salt marsh is found at higher elevations just above cordgrass-dominated marsh and extends upstream into Mountain View Slough and Stevens Creek. The section on salt marsh harvest mouse described strips of pickleweed marsh on the internal faces of the Pond A1 and Pond A2W levees. That habitat is potentially suitable for this species as well, but it is also very low quality for the California Ridgway's rail because of its low cover and patchy distribution. Brackish marsh replaces salt marsh moving upstream along Mountain View Slough and Stevens Creek. Low numbers of California Ridgway's rails have been detected in all the sloughs surrounding the Mountain View Ponds within the last few years (Olofson Environmental, Inc. 2015). Surveys recorded the minimum number of rails detected as between 0 to 5 rails for years 2010-2015 for Stevens Creek, Mountain View Slough, and adjacent Charleston Slough. The recent 6-year average minimum detection was 2 rails for both Mountain View Slough and Charleston Slough.

Ravenswood Ponds

California Ridgway's rails occur in the existing marsh along Ravenswood Slough (east of Pond R4) in medium densities (0.2-0.5 rails per hectare, [Olofson Environmental, Inc. 2015] and along the northwest edge of Pond R4 immediately adjacent to Greco Island [Phase 2 EIS/R, 2016]). The vegetation along the levee edges provides high-tide refugia for cover from predators during extreme high tides, but otherwise California Ridgway's rail habitat along the edges of other ponds in the complex is very limited. Extensive habitat exists near large California Ridgway's rail populations on Greco Island, to the northwest, and in East Palo Alto and Palo Alto marshes, to the south. However, no rails were detected in nearby Ravenswood Open Space Preserve, east of Ravenswood Pond SF2 (Olofson Environmental, Inc. 2015).

5.2.3 Western Snowy Plover – Known Occurrences and Potential Habitat

Detailed life history and region-wide information on species distribution and conservation efforts are presented in the PBO and the Phase 2 EIS/R (2016). Site-specific species distribution is described below by pond cluster. Western snowy plover known occurrences and areas of suitable habitat within the Action Area are shown for each of the pond clusters on **Figure 7c** through **Figure 7d**.

Island Ponds

There is no suitable western snowy plover nesting habitat within the Action Area at the Island Ponds. Within the SBSP Restoration Project area, substantial breeding populations occur in the Warm Springs ponds (Ponds A22 and A23) directly adjacent to the Island Ponds. At Warm Springs, Ponds A22 and A23 are used, with more than 12 nests observed during the 2014 nesting season, and a high count of 32 individual plovers at Pond A22 in 2004 (Tokatlian et al. 2014).

A8 Ponds

Prior to flooding from Phase 1 actions, low densities of western snowy plovers were previously recorded during the breeding season at the A8 Ponds (Ryan and Parkin 1998; Strong *et al.* 2004). Since the Phase 1 actions were implemented, converting them to muted tidal systems, suitable habitat no longer exists for this species at A8 Ponds. Western snowy plover have nested in nearby ponds such as A12, A13, A16, A9 (when dry), and in New Chicago Marsh. However, 2014 and 2015 monitoring observed no nests in Pond A12, the pond closest to the A8 Ponds (Tokatlian et al. 2014; Pearl et al. 2015). Monitoring in 2015 has found a small number of nests in A13 (Pearl et al. 2015).

Mountain View Ponds

There is no suitable western snowy plover nesting habitat within the Action Area at the Mountain View Ponds. The 2014 monitoring in nearby Crittenden Marsh observed 14 snowy plover nests (Tokatlian et al. 2014). In 2015, one nest was observed in Crittenden Marsh (Pearl et al. 2015), just outside the 0.5-mile noise radius around a pile driving site. Because of this observation, the Action Area at the Mountain View Ponds was expanded.

Ravenswood Ponds

The seasonally dry salt pannes at the Ravenswood Ponds provide large areas of suitable nesting habitat for western snowy plover, and the remnant slough channels and borrow ditches within these former salt production ponds provide forage habitat for western snowy plover. Breeding populations occur in the Action Area at the Ravenswood Ponds. Reports from the early 2000s indicate that most of the Ravenswood Ponds were used regularly for nesting (e.g., more than 40 adults found during the 2003 breeding season) (Strong and Dakin 2004). High counts during the 2004 nesting season included 53 birds at Pond R2, 23 birds at Pond SF2, and 18 birds at Pond R1 (Strong et al. 2004). More recently, western snowy plovers were observed breeding and wintering in ponds throughout the Ravenswood pond complex as a whole (Ponds R1, R2, R3, R4, R5, SF2, and S5) (Donehower et al. 2013, Tokatlian et al. 2014). Twenty-eight percent (28%) of western snowy plover nests monitored in the San Francisco Bay in 2015 occurred in the Ravenswood pond complex, though not necessarily in the Phase 2 portion of that complex (Pearl et al. 2015). During the 2012 and 2014 surveys, the most plover nests were found in Pond R1 (Donehower et al. 2013; Tokatlian et al. 2014). In 2015, Pond S5 had four active nests; no nests had been found in that pond since 2012. Phase 1 restoration actions modified Pond SF2 to provide habitat islands and improved forage for plovers. Of the Phase 2 Ravenswood Ponds (R3, R4, R5, and S5), plovers tend to use Ponds R4 and R3 most often, likely because they are larger and further from human disturbance. However, there were nesting plover in Ponds R5 and S5 in recent years, as noted above.

5.2.4 California Least Tern – Known Occurrences and Potential Habitat

Detailed life history and region-wide information on species distribution and conservation efforts are presented in the PBO and the Phase 2 EIS/R (2016). There is no breeding habitat for the species within the Action Area, but the California least tern uses levees in the South Bay as post-breeding roosting sites. After breeding (primarily at Central Bay sites), adult California least terns bring their juvenile offspring to the South Bay to forage before migration (Phase 2 EIS/R, 2016). California least tern known occurrences and areas of suitable foraging and roosting habitat within the Action Area are shown for each of the pond clusters on **Figure 8a** through **Figure 8d**. Site-specific species distribution is described below by pond cluster.

Island Ponds

Open water habitat within the Action Area at the Island Ponds provides suitable foraging habitat and levees surrounding the ponds provide limited suitable roosting habitat for the species. There are no documented occurrences of the species at these ponds.

A8 Ponds

The managed muted tidal ponds within the A5, A7 and A8 Ponds currently provide suitable foraging and roosting habitat for the species. Mercury exposure to foraging birds in this pond is an ongoing unknown. Increased mercury levels were observed in Forster's tern eggs in this pond immediately after Phase 1 construction activities. Levels have since decreased to reference area levels, but have not been studied in California least terns.

Mountain View Ponds

The deep water in Ponds A1 and A2W and adjacent sloughs provides foraging habitat, and California least terns are known to forage in these ponds. Levees, islands and artificial structures within the Mountain View Ponds also provide roosting habitat.

Ravenswood Ponds

Currently, the seasonally dry and hydraulically isolated Ravenswood Ponds do not provide foraging habitat for the species; however, California least terns have the potential to occur in foraging habitat available in adjacent Ravenswood Slough, Flood Slough, and the portion of the San Francisco Bay within the Action Area at the Ravenswood Ponds. Potential roosting habitat for the species exists on levees, but is not currently used. Pond R3 has been used for sporadic and limited nesting attempts, (Hurt 2004; Wetlands Research Associates 1994), but there are no records of similar attempts in recent years.

5.2.5 Longfin Smelt – Known Occurrences and Potential Habitat

Detailed species life history information, including region-wide information on species distribution and conservation efforts, is presented below for longfin smelt because the species was not yet a candidate species at the time of the PBO and was therefore not included.

On April 12, 2012, the USFWS found that the San Francisco Bay-Delta Distinct Population Segment of longfin smelt warranted consideration for protection under the ESA, but the USFWS was precluded at that time from drafting a formal listing rule. An account of the status, taxonomy, ecology, and biology of longfin smelt is presented in the *12- month Finding on a Petition to List the San Francisco Bay-Delta Population of the Longfin Smelt as Endangered or Threatened* and the references cited therein (USFWS 2012b). The longfin smelt is also a state-listed threatened species under CESA.

The longfin smelt is a small (approximately 9-11 cm standard length at maturity), euryhaline fish present throughout the San Francisco Estuary year round (USFWS 2009). The population found within the San Francisco Bay represents the largest known longfin smelt population in California (Rosenfield and Baxter 2007). In addition, this population is located within the southernmost known range for the longfin smelt (Rosenfield and Baxter 2007, USFWS 2009). Longfin smelt spawning typically occurs between February and April in areas with low salinity; however, spawning can occur between early-November to late-June (Moyle 2002, USFWS, 2009). Although there is no current data on specific spawning locations within the San Francisco Bay, recently published reports indicate spawning probably occurs near the mixing zones between fresh and brackish water (Rosenfield and Baxter 2007). Moyle (2002) indicated spawning in the San Francisco Bay estuary probably occurs downstream of Medford Island (San Joaquin River) and Rio Vista (Sacramento River). Additionally, spawning may occur in the portion of Suisun Bay near Pittsburgh and Montezuma Slough (Moyle 2002). Females lay 5,000 to 24,000 adhesive eggs (Moyle 2002 and USFWS 2009). Buoyant larval longfin smelt hatch within 40 days and are transported downstream into brackish estuarine waters (Moyle 2002, USFWS 2009). Depending on water temperature, larval longfin smelt morph into their juvenile form 30-60 days post-hatch (Moyle 2002, USFWS 2009, DRERIP 2010). Juveniles and sub-adult longfin smelt utilize deep water habitats often foraging on opossum shrimp (*Neomysis mercedis*) (USFWS 2009, DRERIP 2010). Longfin smelt undergo two distinct growth periods during their two year life span. During the first 9-10 months, longfin smelt reach 6-7 cm standard length. Growth rates decrease until the "second summer and fall, when they reach 9-11 cm standard length" (Moyle 2002). This second growth spurt could be attributed to gonad production. Typically, after two years longfin smelt become mature and die shortly after spawning.

Several long-term programs monitor longfin smelt abundance within the estuary. These studies include the Fall Midwater Trawl Survey and the San Francisco Bay Study conducted by CDFW, which observed dramatically decreased abundancies for this species since 1967 and 1980 respectively. The record low of 4 for that trawl survey's abundance index in 2015 was a 99% decline from the 1967 value (CDFW 2016b). According to Moyle (2002), populations of longfin smelt in California have historically been known from the San Francisco estuary. Adults occur seasonally throughout San Francisco Bay, but they are concentrated in Suisun, San Pablo, and North San Francisco bays. They concentrate in most years in San Pablo Bay in April through June and become more dispersed (many moving into Central San Francisco Bay) in late summer. The exact distribution pattern varies from year to year. During winter months, when fish are moving upstream to spawn, high outflows may push many back into San Francisco Bay, whereas drought years may find them concentrating in Suisun Bay.

Site-specific species distribution is described below by pond cluster. Longfin smelt known occurrences and areas of suitable habitat within the Action Area are shown for each of the pond clusters on **Figure 9a** through **Figure 9d**.

Island Ponds

Longfin smelt are known to be present in open water habitat at the Island Ponds: individuals were caught in the Island Ponds and adjacent Coyote Creek during fish sampling efforts in 2010 and 2011 (Hobbs et al. 2012). Some fish were gravid adults but no larval fish have been observed during fish surveys (Hobbs et al. 2012).

A8 Ponds

Longfin smelt have been caught in Coyote Creek and Alviso Slough and could potentially enter the A8 Ponds when the A8 notch is open. Additionally, though there are fish surveys of these ponds conducted as part of the ongoing mercury studies there, longfin smelt have not been detected within the A8 Ponds. Given that work would be conducted entirely within the ponds, they are not anticipated to be in the Action Area at the A8 Ponds, though the ponds are potentially suitable habitat.

Mountain View Ponds

The Mountain View Ponds have extremely limited habitat connectivity to the Bay. There is one tide gate from outer Charleston Slough into Pond A1, and there is one outflow gate from Pond A2W into the Bay. A siphon under Mountain View Slough connects these two ponds. Many piscivorous birds are known to forage in these ponds, so bay-dwelling fish species are known to inhabit these ponds. Fish surveys have sampled many other fish but have not detected longfin smelt in the Mountain View Ponds (Mejia et al. 2008). However, longfin smelt are known to be present throughout the San Francisco Bay, and other Bay-dwelling fish species have been encountered in these ponds. Given the presence of other fish species in the Mountain View Ponds, the species is inferred to be present as well.

Ravenswood Ponds

The Ravenswood Ponds are seasonal ponds that collect rainwater in winter and then dry out in summer. They have no hydraulic connection to the Bay or adjacent sloughs. There is thus no suitable fish habitat within them. However, longfin smelt are known to be present throughout the San Francisco Bay and open water habitat within the Action Area at the Ravenswood Ponds, including

Ravenswood Slough, Flood Slough, and open Bay adjacent to Greco Island and Pond R4. These waters are suitable to the species. The species was not detected in the Pond SF2 surveys conducted from 2010-2011 (Hobbs et al. 2012), which were the closest survey of managed ponds near the Phase 2 project area.

5.3 Critical Habitat Considered

The Phase 2 project Action Area at these four pond clusters does not contain any federally designated or federally proposed critical habitat for these or other species.

This page intentionally left blank

6 Effects of the Proposed Action

This section describes the effects of the proposed action on federally listed species.

6.1 General Effects

Tables in Section 2.3 summarize the areas that would be filled, cut, or otherwise modified by the proposed project components that make up those footprints. These include habitat transition zones, islands, or wider levees at each of the four project locations. They also include the areas of waters that would be made newly available through adding connections where none currently exist (such as at the Ravenswood Ponds) or where that connectivity is strictly confined through a water control structure (at the Mountain View Ponds). A discussion of the effects of the proposed action on each listed species within the Action Area for each pond cluster restoration activities is provided below.

The following sections describe the species-specific effects from the proposed project. They would refer to and make use of the extents and types of effects from the proposed actions that are summarized in **Table 20**. **Table 20** was calculated by exporting the acreages of five different types of habitat changes (create, enhance, degrade, loss, or no change) on each species considered in this BA. Potential Effects to species are as follows:

- Potential direct loss of an individual
- Habitat loss, degradation, enhancement, or creation of new habitats
- Construction disturbance
- Disturbance from operations and maintenance and public access

Those areas were derived in GIS by overlaying the project designs on the habitat maps presented earlier as **Figures 6** through **Figures 9**.

Table 20. Areas of Habitat Effects from Project Activities, by Species and Pond Cluster

SPECIES	POND CLUSTER	AREA OF HABITAT CHANGE (ACRES)				
		CREATED/ NEWLY OPENED	ENHANCED/ IMPROVED	NO CHANGE	DEGRADED/ CONVERTED	LOST
Salt Marsh Harvest Mouse	Island	0.0	324.8	374.0	0.0	0.4
	A8	4.2	20.4	37.2	0.0	0.0
	Mountain View	705.2	6.2	290.4	0.0	0.8
	Ravenswood	571.6	1.6	299.8	0.0	1.7
	Total[1]	**1281.0**	**353.1**	**1001.4**	**0.0**	**2.9**
California Ridgway's Rail	Island	0.0	324.8	374.0	0.0	0.4
	A8	4.2	20.4	37.2	0.0	0.0
	Mountain View	705.2	6.2	290.4	0.0	0.8
	Ravenswood	571.6	1.6	299.8	0.0	1.7
	Total[1]	**1281.0**	**353.1**	**1001.4**	**0.0**	**2.9**
Western Snowy Plover	Island	0.0	0.0	0.0	0.0	0.0
	A8	0.0	0.0	0.0	0.0	0.0
	Mountain View	0.0	0.0	38.4	0.0	0.0
	Ravenswood	0.0	290.0	2.2	19.3	379.6
	Total[1]	**0.0**	**290.0**	**40.6**	**19.3**	**379.6**
California Least Tern	Island	0.0	0.6	685.1	5.2	2.5
	A8	0.0	157.6	16.4	21.1	0.0
	Mountain View	0.0	19.0	1011.1	25.4	0.0
	Ravenswood	340.3	4.6	76.0	27.1	0.0
	Total[1]	**340.3**	**181.8**	**1788.6**	**78.8**	**2.5**
Longfin Smelt	Island	3.1	329.6	371.6	1.9	0.0
	A8	0.0	20.4	180.4	0.0	4.2
	Mountain View	1.5	721.8	347.7	2.8	11.9
	Ravenswood	284.1	0.0	582.4	0.0	0.0
	Total[1]	**288.7**	**1071.7**	**1482.1**	**4.7**	**16.1**

[1] The habitat areas for these species are not mutually exclusive. For example, salt marsh harvest mouse and California Ridgway's Rail may utilize the same habitat areas.

6.2 Salt Marsh Harvest Mouse

6.2.1 Island Ponds

Direct Loss of Individuals

As described in Section 4.2.1, salt marsh harvest mice have the potential to occur in the Island Ponds. The implementation of conservation measures would minimize direct injury or mortality of salt marsh harvest mice, but it is possible that some mice could be killed or injured during construction that involves excavation of pilot channels, levee lowering, and levee breaching through existing fringing marsh.

Conservation measures include preconstruction surveys, construction of fencing to isolate potential habitat, maintaining corridors, limiting construction during high tides, and hand removal of pickleweed prior to construction activities. These actions (described in further detail in Section 2.6) would minimize any potential salt marsh harvest mouse mortalities from construction at the Island Ponds.

Habitat Effects

Excavation of pilot channels, levee lowering and levee breaching, and construction of ditch blocks would result in the direct temporary loss of some bands of suitable marsh habitat on the outside of the levees. Most of the strips of habitat are of comparatively poor quality for the salt marsh harvest mice and are probably used infrequently.

Although these activities would result in small loss of tidal marsh habitat, these losses would be rapidly overtaken by huge gains in suitable habitat as marsh is restored in the pond cluster. Marsh is already developing within the Island Ponds as a result of previous levee breaches and the proposed work is expected to hasten the development of additional high-quality breeding and foraging habitat, especially within Pond A19. The additional acres of tidal marsh restoration in this area would contribute to achieving the goals for recovery of the species in this unit.

Construction Disturbance

Construction and excavation activities could result in short-term increased levels of disturbance to harvest mice from noise and vibrations from equipment and construction activities. Disturbance would result in temporary displacement of salt marsh harvest mice – if they are present – from protective cover and their territories/home ranges (through noise and vibrations) and/or direct injury or mortality (through crushing). These disturbances would disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and could result in the displacement of salt marsh harvest mice from their territory/home range in the areas where their habitat is converted. 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 salt marsh harvest mice may experience increased predation, competition, mortality, and reduced reproductive success.

Implementing conservation measures would limit potential adverse effects from construction disturbance on salt marsh harvest mice at the Island Ponds. Preconstruction surveys, construction of exclusion fencing to isolate potential habitat from the work areas, maintaining habitat corridors, limiting construction during high tides to the extent practicable, and hand removal of pickleweed (in areas where doing so is suitable) prior to construction activities would limit disturbance to individuals of this species if they are present.

Additionally, the long-term benefits of habitat restoration include increased habitat connectivity and complexity, broader areas of marsh establishment, and some increase in the rate of marsh formation by filling the borrow ditches in the pond interiors. These benefits are expected to far exceed any adverse effects of construction activities at the Island Ponds on salt marsh harvest mice.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the Island Ponds (a few visits per year) and the effects of these activities on the salt marsh harvest mouse were covered under the PBO. No new monitoring or maintenance activities are planned for the Island Ponds under the Phase 2 actions. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to salt marsh harvest mice.

6.2.2 A8 Ponds

Direct Loss of Individuals

It is possible, although highly unlikely, that some salt marsh harvest mice would be killed or injured during construction activities related to creating the transition zone because salt marsh harvest mice are not known to occupy the small, low-quality, and isolated habitat in the A8 Ponds. Construction activities would be limited to areas within the pond and on the roads, where mice are not likely to be present and construction is expected to be limited in duration. The implementation of conservation measures, including biological monitoring and exclusion fencing (see Section 2.6), would minimize direct injury or mortality of salt marsh harvest mice.

Habitat Effects

There would be no loss of existing tidal salt marsh habitat for salt marsh harvest mice when transition zones are created. The transition zones are expected to increase habitat for the salt marsh harvest mice in the long-term. The Pond A8 Phase 2 actions are not expected to result in mobilization of mercury because the mercury concentrations in the upland fill that that would be placed above the tidal zone would be screened to ensure that the fill meets guidelines for reuse. In addition, the fill to be placed would likely cover older sediment with higher concentrations of mercury (AECOM 2016).

Construction Disturbance

Salt marsh harvest mouse habitat in the A8 Ponds area is limited to small isolated patches, but some individuals could be present in nearby areas during construction. If present, disturbance from construction activities would be similar to that described at the other locations. However, disturbance would be much less in the A8 Ponds because there would be no levee breaches and the construction work associated with creating transition zones is less that the activities planned for the Island Ponds. Construction activities would be largely limited to areas within the pond and on the roads, where mice are not likely to be present. There are small, isolated patches of pickleweed on the slope between the road and the pond, but these are not thought to host harvest mice. The implementation of conservation measures such as conducting preconstruction surveys, fencing and isolating potential habitat, and maintaining habitat corridors would further reduce the potential for adverse effects on the salt marsh harvest mouse. Therefore, the disturbance from construction activities is expected to be minimal. Additionally, the long-term goal for these ponds is to return them to full tidal action. The benefits of tidal marsh habitat restoration are expected to far exceed any potential adverse effects of activities at the A8 Ponds on salt marsh harvest mice.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the A8 Ponds (a few visits per year). Occasional visits for control of invasive plant species or mosquito abatement are possible but not expected to be frequent or extensive. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to salt marsh harvest mice.

6.2.3 Mountain View Ponds

Direct Loss of Individuals

Salt marsh harvest mice could potentially enter the Mountain View Ponds project footprint during construction. Mice could be killed or injured if present during activities related to excavation of pilot channels, levee lowering, levee breaching, levee raising, channel armoring, bridge construction, and material placement for construction of habitat transition zones or raising PG&E tower footings. However, this species is not thought to use these areas now, even though minimal, low-quality habitat exists. Additionally, the implementation of conservation measures such as biological monitoring and exclusion fencing would minimize direct injury or mortality of salt marsh harvest mice from construction. Following construction, the habitat should develop and begin supporting harvest mouse populations that disperse in from nearby areas.

Habitat Effects

In the short-term, excavation of pilot channels, levee lowering and levee breaching, and construction of ditch blocks would result in the temporary direct loss of small amounts of outboard, tidal marsh habitat thought to be used by salt marsh harvest mice. Most of habitat lost would be in narrow corridors of pickleweed on the inside fringes of the levees that are minimal, low-quality habitat but not thought to be used by this species at the present time.

The PG&E tower and boardwalk improvements or additions could impact small areas of suitable habitat and may also provide minimal amounts of increased perching opportunities for predators of salt marsh harvest mice, but no new towers or power lines would be added. The addition of public access areas also has the potential to disturb salt marsh harvest mice once they are present. Disturbances could disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal and would likely result in the displacement of salt marsh harvest mice from their territory/home range in the areas where they are disturbed. 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 could cause abandonment or failure of the current litter. Thus, displaced harvest mice may experience increased predation, competition, mortality, and reduced reproductive success. These effects could create temporary disturbances that would degrade the current habitat for mice within the existing Mountain View Ponds if they are present, but these public access features would be limited to the borders of the ponds on levee tops only, leaving large areas of restored tidal marsh for use by harvest mice.

In the long-term, the SBSP Restoration Project's Phase 2 actions are expected to result in the creation of large extents (several hundred acres) of diverse tidal marsh habitat and transition zones at the Mountain View Ponds. A diverse tidal marsh habitat would be established, offering increased habitat, cover and dispersal corridors for the salt marsh harvest mice. The additional acres of tidal restoration in this area would contribute to achieving the goals for recovery of the species in this unit. The benefits of habitat restoration are expected to far exceed any adverse effects of short-term construction activities or minor effects from public disturbance and predators at the Mountain View Ponds on salt marsh harvest mice.

Construction Disturbance

Salt marsh harvest mouse individuals may be present during construction. The construction effects associated with multiple activities proposed for the Mountain View Ponds could include visual/vibrational/noise disturbance associated with equipment operation. Small fringe areas of marsh habitat exist along the levees in the Mountain View Ponds and along the external sides of levees projecting into the adjacent sloughs. Potential effects could occur to marsh habitat during construction (similar to those described in the Island Ponds), but those effects would be temporary. Because the Mountain View Ponds construction activities would include 1-2 days of pile driving, the noise levels could be greater than in the Island Ponds or the A8 Ponds, but would still be limited to brief periods and not expected to reach locations known to be used by salt marsh harvest mouse.

Implementing conservation measures would limit any potential adverse effects from construction disturbance on salt marsh harvest mice at the Mountain View Ponds. Conservation measures include preconstruction surveys, construction of fencing to isolate potential habitat, maintaining habitat corridors, limiting construction during high tides, and hand removal of pickleweed in areas where it is appropriate to do so prior to construction activities would limit disturbance if mice are present.

The benefits of habitat restoration in the Mountain View Ponds are expected to far exceed any adverse effects of temporary disturbance from construction activities on salt marsh harvest mice. With the implementation of conservation measures the effects from construction disturbance are expected to be minimal.

Operations and Maintenance Disturbance

Ongoing monitoring, maintenance and additional public access could result in increased levels of disturbance to salt marsh harvest mice similar to those noted above for construction (many elements previously discussed in the PBO). However, implementation of conservation measures would minimize these minor effects. Conservation measures included signage prohibiting access to areas closed to the public, as well as maintaining corridors that would connect salt marsh harvest mouse habitat (see Section 2.6 for further details).

With the implementation of conservation measures disturbance is expected to be minimal and the benefits of habitat restoration in the Mountain View Ponds are expected to far exceed any adverse effects of temporary disturbance from monitoring and maintenance activities on salt marsh harvest mice.

6.2.4 Ravenswood Ponds

Direct Loss of Individuals

The implementation of conservation measures would minimize direct injury or mortality of salt marsh harvest mice. However, because salt marsh harvest mouse habitat is located at the edges of the Ravenswood Ponds, there is a small chance that individual mice could be killed or injured during construction activities related to levee lowering, levee breaching, levee raising, construction of habitat transition zones, water control structure, and public access trails, platforms, benches, and fences.

Conservation measures to limit potential adverse effects from construction on salt marsh harvest mice at the Ravenswood Ponds include preconstruction surveys, construction of fencing to isolate potential habitat, maintaining habitat corridors, limiting construction during high tides, and hand removal of pickleweed prior to construction activities where it is practicable to do so. These measures would limit disturbance and the potential for take for this species.

Habitat Effects

In the short-term, temporary loss of pickleweed-dominated habitat would be caused by the breaching, channel excavation, and lowering of part of the outboard levee of Pond R4 and to a lesser extent in the eastern section of R3, where the water control structures would be placed. Also in Ponds R5 and S5, existing pickleweed patches could be flooded as the area transitions to managed pond habitat. The latter of these are technically suitable for harvest mice, but they are small and very isolated patches and quite unlikely to support individuals of this species.

Additionally, and similar to the Mountain View Ponds, the addition of public access areas has the potential to degrade habitat for salt marsh harvest mice through disturbance associated with trail use. These disturbances could disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of salt marsh 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 cause abandonment or failure of the current litter. Thus, displaced harvest mice may experience increased predation, competition, mortality, and reduced reproductive success. However, these public access features would be limited to a small part of the borders of the ponds on the levee tops, leaving large areas of restored tidal marsh on the interior for use by harvest mice.

Overall, Phase 2 restoration activities would increase tidal marsh habitat suitable for salt marsh harvest mice in the long run. The Ravenswood Ponds are adjacent to large pickleweed marshes, and their elevation is appropriate for marsh formation; therefore, suitable habitat is expected to quickly colonize and develop along restored tidal sloughs and habitat transition zones in the restored marsh. Any temporary losses or on-going degradation to a small area of this vegetation type would be more than offset by the restoration of tidal marsh habitat in Pond R4. Almost 300 acres of restored tidal marsh habitat in Pond R4 would offer large amounts of increased habitat and dispersal corridors for the salt marsh harvest mice, contributing to the long-term recovery of this species.

Construction Disturbance

Salt marsh harvest mice individuals may be present during construction. The construction impacts associated with multiple activities proposed for the Ravenswood Ponds could include visual/vibrational/noise disturbance associated with equipment operation. Potential effects could occur to marsh habitat during construction (similar to those described in the Island Ponds), but effects would be temporary. Because the Ravenswood Ponds activities would include some pile driving to support the water control structures, the noise-related effects could be greater than in the Island Ponds or the A8 Ponds but still limited to brief periods

Implementing conservation measures would limit any potential adverse effects from construction disturbance on salt marsh harvest mice at the Ravenswood Ponds. Conservation measures include preconstruction surveys, construction of fencing to isolate potential habitat, maintaining habitat corridors, limiting construction during high tides, and hand removal of pickleweed in areas where it is appropriate to do so, prior to construction activities. These would limit disturbance to this species.

The benefits of habitat restoration in the Ravenswood Ponds are expected to far exceed adverse effects of temporary disturbance from construction activities on salt marsh harvest mice.

Operations and Maintenance Disturbance

Ongoing monitoring and maintenance could result in increased levels of disturbance to salt marsh harvest mice similar to those noted above for construction (many elements previously discussed in the PBO). However, implementation of conservation measures would minimize these temporary and minor effects. Conservation measures include signage prohibiting access to areas closed to the public, as well as hand pulling of invasive weeds in newly created tidal marsh habitat (see Section 2.6 for further details).

Similarly to the other ponds clusters, with the implementation of conservation measures the adverse effects from operations and maintenance disturbance are expected to be minimal and the benefits of habitat restoration in the Ravenswood Ponds are expected to far exceed any adverse effects of temporary disturbance from monitoring and maintenance activities on salt marsh harvest mice.

6.2.5 Salt Marsh Harvest Mouse Effects Summary

Phase 2 tidal restoration activities would require habitat loss or alteration (e.g., levee breaching, excavating channels through the marsh, filling, changing of the tidal prism) that would permanently remove a small amount of existing tidal marsh habitat. On the inboard sides of the ponds, this habitat is generally low quality habitat. It is of higher quality outside the ponds and in some locations may be occupied by harvest mice. The proposed action would result in a small amount of short-term habitat loss for salt marsh harvest mouse because of channel excavation. Ongoing activities such as monitoring, maintenance and public accessing viewing platforms and trails could have some adverse effects on salt marsh harvest mice by increasing disturbance of salt marsh harvest mice. Additionally, individuals could be killed or disturbed during construction related activities including levee breaches or the creation of habitat transition zones and public access areas.

However, the risk of taking salt marsh harvest mice is anticipated to be small with the implementation of extensive conservation measures (see Section 2.6). In the long-term, there would be an overwhelmingly positive benefit to salt marsh harvest mice from the proposed Phase 2 action, as several hundred acres of new marsh would be created over an extended period. For tidal marsh-associated species such as the salt marsh harvest mouse, Phase 2 of the SBSP Restoration Project is expected to result in considerable increases in available habitat in the long-term, thereby augmenting populations far beyond the minor, temporary and local effects that would occur during Phase 2 activities.

6.3 California Ridgway's Rail

6.3.1 Island Ponds

Direct Loss of Individuals

California Ridgway's rails could be present during the Phase 2 construction activities; rails have been observed in Pond A21. Conservation measures would minimize direct injury or mortality of California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include the following: avoidance of work during breeding and nesting season as well as during extreme high tides as possible, preconstruction surveys, biological monitoring, and exclusion fencing.

Some individual birds could be killed or injured during construction activities that involve excavation of pilot channels, levee lowering, and levee breaching through existing fringing marsh. However, given that few individuals are currently present in the general area, work would not be conducted in Pond A21 (where the best habitat for this species is), conservation measures would be implemented, and that the birds have the ability to leave the work area, direct take from construction activities is highly unlikely.

Habitat Effects

Excavation of pilot channels, levee lowering and levee breaching would result in the direct temporary loss of some bands of suitable marsh habitat on the outside of the Island Ponds' levees. Most of the strips of habitat outside of Pond A19 and Pond A20 are narrow and of comparatively poor quality for California Ridgway's rail and are likely used infrequently.

Although these activities would result in small loss of tidal marsh habitat, these losses would be rapidly replaced by gains in suitable habitat by several orders of magnitude as marsh becomes established in these ponds. Marsh habitat is already developing within the Island Ponds as a result of previous levee breaches, and the proposed work is expected to hasten the development of additional high-quality breeding and foraging habitat, especially within Pond A19, which has lagged behind Ponds A20 and A21 in forming new marsh. The additional acres of tidal restoration in this area would contribute to achieving the goals for recovery of the species in this unit.

Construction Disturbance

Construction and excavation activities would result in short-term increased levels of disturbance to California Ridgway's rails from noise and vibrations from equipment and construction activities. Rails are very sensitive to human disturbance, although reactions to disturbance may vary spatially and within seasons (Albertson 1995). Disturbance would result in temporary displacement of California Ridgway's rails from protective cover and their habitat (through noise and vibrations). These disturbances are likely to disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and are likely to result in the displacement of California Ridgway's rails from their habitat when it is lost or disturbed. Displaced California Ridgway's rails may be more vulnerable to predators. Disturbance during the nesting period may mean abandonment or failure of the nests. Thus, displaced California Ridgway's rails may suffer from increased predation and reduced reproductive success. Implementation of conservation measures would reduce the direct and indirect effects of construction disturbance to California Ridgway's rails, but indirect loss of individuals may potentially occur.

However, few individuals are currently present in the area. Additionally, conservation measures would minimize disturbance to California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include avoidance of work during breeding and nesting season as well as during extreme high tides as possible, preconstruction surveys, exclusion fencing and minimizing effects to habitats via access roads.

Additionally, the benefits of habitat restoration are expected to far exceed the adverse effects of temporary disturbance from construction activities on California Ridgway's rails at the Island Ponds.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the Island Ponds site (a few visits per year) and is covered under the PBO. No new monitoring or maintenance activities are planned for the Island Ponds under the Phase 2 Actions. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to California Ridgway's rails.

6.3.2 A8 Ponds

Direct Loss of Individuals

California Ridgway's rails could be present during the Phase 2 construction activities because limited numbers of California Ridgway's rails are known to occupy habitat nearby. They have been detected in small numbers within the Action Area in adjacent Guadalupe Slough (Olofson Environmental, Inc. 2015). Conservation measures would minimize direct injury or mortality of California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include the following: avoidance of work during breeding and nesting season as well as during extreme high tides as possible, preconstruction surveys, exclusion fencing, and minimizing effects to habitats via access roads.

Some individual birds could be killed or injured during construction activities that involve importing material and placing it in the ponds to create habitat transition zones. However, given that few individuals are currently present in the general area, none are present inside the pond itself, implementation of conservation measures including biological monitors to assess the area for species presence, and the birds have the ability to leave the work area, direct take from construction activities is highly unlikely.

Habitat Effects

There would be no loss of habitat for California Ridgway's rail when transition zones are created. The transition zones would be beneficial to California Ridgway's rail because they are expected to increase habitat for the species in the long-term. The proposed Phase 2 actions in the A8 Ponds are not expected to result in mobilization of mercury because the mercury concentrations in the upland fill that that would be placed above the tidal zone would be screened to ensure that the fill meets guidelines for reuse. In addition, the fill to be placed would likely cover older sediment with higher concentrations of mercury, providing some habitat enhancement.

Construction Disturbance

California Ridgway's rail habitat in the A8 pond area is limited, but some individuals may be present during construction. If present, disturbance from construction activities could be similar to those described for the Island Ponds. However, habitat disturbance would be less in the A8 Ponds because there would be no levee breaches and the construction work associated with creating habitat transition zones is less that the activities planned for the Island Ponds.

Conservation measures would minimize disturbance to California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include limiting work during the nesting season to the extent practicable, conducting preconstruction surveys, and minimizing effects to habitats via access roads.

The long-term goal for this Pond is to return it to full tidal action. The benefits of tidal marsh habitat restoration are expected to far exceed any negative short-term effects of construction activities at A8 Ponds on California Ridgway's rail.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the A8 Ponds (a few visits per year). Occasional visits for control of invasive plant species or mosquito abatement are possible but not expected to be frequent or extensive. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to California Ridgway's rails.

6.3.3 Mountain View Ponds

Direct Loss of Individuals

California Ridgway's rails could be present during the Phase 2 construction activities that include excavation of pilot channels, levee lowering, levee breaching, levee raising, bridge construction, building habitat transition zones and islands, adding public access areas, and raising PG&E towers and boardwalks. However, limited numbers of rails were detected within the Action Area in Stevens Creek, Mountain View Slough, and Charleston Slough (Olofson Environmental, Inc. 2015), so it is unlikely that this species would be present. Further, conservation measures would minimize direct injury or mortality of California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include limiting work during the nesting season to the extent practicable, conducting preconstruction surveys, using biological monitors during construction, and minimizing effects to habitats via access roads.

Some individual birds could be killed or injured during construction activities. However, given that few individuals are currently present in the general area, implementation of conservation measures including biological monitors to assess the area for species presence, and the birds have the ability to leave the work area, direct take from construction activities is highly unlikely.

Habitat Effects

In the short-term, excavation of pilot channels, levee modification, improvements to PG&E infrastructure, and placing fill to build habitat transition zones and islands would result in the direct loss of small amounts of tidal marsh habitat suitable for California Ridgway's rails. Most of the habitat lost would be in narrow corridors of pickleweed on the fringes of the levees. The new length of boardwalk adjacent to Pond A1 and PG&E tower improvements may provide minimal amounts of increased perching opportunities for predators of California Ridgway's rail, but no new towers or power lines would be added.

Additionally, increased disturbance may occur from the new public access. As an avoidance measure,gates would be installed and closed as necessary to reduce effects from increased disturbance during nesting time. These gates are anticipated to be open at all times when disturbance to nesting birds is not anticipated. Rails are very sensitive to human disturbance, although reactions to disturbance may vary spatially and within seasons (Albertson 1995). Human disturbance of nesting birds can result in abandonment of nests and chicks, resulting in decreased reproductive success and increased predation, particularly of eggs and young. Disturbance of foraging and roosting may decrease the effectiveness or increase the stress of these activities. The viewing platforms in the Mountain View Ponds have some potential to increase these types of disturbance of rails. This could degrade the habitat for rails within the existing Mountain View Ponds.

However, in the long-term, the proposed Phase 2 Actions are expected to result in the creation of large extents (several hundred acres at the Mountain View Ponds alone) of diverse tidal marsh habitat with increased cover, dispersal corridors, and transition zones suitable for California Ridgway's rails. The additional acres of high quality tidal marsh in this area would contribute to achieving the goals for recovery of the species. The benefits of habitat restoration are expected to far exceed any adverse effects of short-term construction activities or minor effects from public disturbance and predators at the Mountain View Ponds on California Ridgway's rails.

Construction Disturbance

California Ridgway's rail habitat at the Mountain View Ponds is limited, but some individuals may be present during construction. If present, disturbance from construction activities could be similar to those described for the Island Ponds and A8 Ponds. The construction impacts associated with multiple activities proposed for the Mountain View Ponds could include visual/vibrational/noise disturbance associated with equipment operation. Small fringe areas of marsh habitat exist along the levees in the Mountain View Ponds (especially Stevens Creek) and in outer Charleston Slough. Potential effects could occur to marsh habitat during construction (similar to those described in the Island Ponds), but effects would be temporary.

Conservation measures would minimize disturbance to California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include limiting work during the nesting season to the extent practicable, conducting preconstruction surveys, using biological monitors during construction, and minimizing effects on habitats via access roads.

The proposed Phase 2 action for these ponds would restore to full tidal action and initiate tidal marsh restoration. The benefits of tidal marsh habitat restoration are expected to far exceed any negative short-term effects on California Ridgway's rail of construction activities at the Mountain View Ponds.

Operations and Maintenance Disturbance

Ongoing monitoring, maintenance and public accessing nearby habitat could result in increased levels of disturbance to California Ridgway's rails similar to those noted above for construction (many elements previously discussed in the PBO). However, implementation of conservation measures would minimize these temporary and minor effects. Similar to the other ponds clusters, the benefits of habitat restoration at the Mountain View Ponds are expected to far exceed any adverse effects of temporary disturbance from monitoring and maintenance activities on California Ridgway's rails.

6.3.4 Ravenswood Ponds

Direct Loss of Individuals

California Ridgway's rails are likely to be present within the Action Area during the Phase 2 construction activities because they occur in medium densities in Ravenswood Slough and high densities in nearby Greco Island (Olofson Environmental, Inc. 2015). Conservation measures would minimize direct injury or mortality of California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include limiting work during the nesting season to the extent practicable, conducting preconstruction surveys, using biological monitors during construction, and minimizing effects to habitats via access roads.

Because of the higher densities of California Ridgway's rails at Ravenswood, it is more likely that individuals could be killed or injured during construction activities that involve levee lowering and breaching through existing marsh, constructing habitat transition zones, placing water control structures and public access features. However, direct take of individuals would be minimized by implementation of conservation measures and the fact that the birds have the ability to leave the work area.

Habitat Effects

In the short-term, temporary loss of strips of pickleweed-dominated habitat would be caused by the levee breaching and channel excavation outside of Pond R4 and a small permanent loss on the eastern section of R3, where the water control structures would be placed. Also in Ponds R5 and S5, existing pickleweed patches could be flooded as the area transitions to managed pond habitat. The latter of these are technically suitable for California Ridgway's rail, but these are small and very isolated patches and quite unlikely to support individuals of this species.

Additionally, and similar to the Mountain View Ponds, the addition of public access areas has the potential to degrade habitat for Ridgway's rails. Rails are very sensitive to human disturbance, although reactions to disturbance may vary spatially and within seasons (Albertson 1995). Human disturbance of nesting birds can result in abandonment of nests and chicks, resulting in decreased reproductive success and increased predation, particularly of eggs and young. Disturbance of foraging and roosting may decrease the effectiveness or increase the stress of these activities. The public access in the Ravenswood Ponds has some potential to increase these types of disturbance of rails. This could create temporary disturbances that would degrade habitat for rails within the existing Ravenswood Ponds.

In the long-term, the proposed Phase 2 actions are expected to add almost 300 acres of tidal marsh habitat suitable for California Ridgway's rails. The Ravenswood Ponds are adjacent to large tidal marshes, and their elevation is appropriate for marsh formation; therefore, suitable habitat is expected to quickly colonize and develop along restored tidal sloughs and habitat transition zones in the restored marsh. Any temporary losses or on-going degradation to a small area of this vegetation type would be more than offset by the huge increase in diverse tidal marsh habitat, cover and dispersal corridors in Pond R4 for the California Ridgway's rails and contribute to their recovery.

Construction Disturbance

California Ridgway's rail habitat at the Ravenswood Ponds is present, and some individuals are expected to be present during construction. If present, disturbance from construction activities could be similar to those described for the other pond clusters. The construction impacts associated with multiple activities proposed for the Ravenswood Ponds could include visual/vibrational/noise disturbance associated with equipment operation. Fringe areas of marsh habitat exist along the external borders of the pond levees, especially along Ravenswood Slough. Construction could disturb rails in similar ways as described above for public access effects on habitat quality, but these effects would be temporary.

Conservation measures would minimize disturbance to California Ridgway's rail individuals. Those measures are described in detail in Section 2.6, and include limiting work during the nesting season to the extent practicable, conducting preconstruction surveys, using biological monitors during construction, and minimizing effects to habitats via access roads.

Ridgway's rail individuals may be present during construction. The construction impacts associated with multiple activities proposed for the Ravenswood Ponds could include visual/vibrational/noise disturbance associated with equipment operation. Potential effects could occur to marsh habitat during construction, but effects would temporary.

The proposed Phase 2 action for these ponds would restore to full tidal action and initiate tidal marsh restoration. The benefits of tidal marsh habitat restoration are expected to far exceed any negative short-term effects on California Ridgway's rail of construction activities at the Ravenswood Ponds.

Operations and Maintenance Disturbance

Ongoing monitoring, maintenance and public access to nearby habitat could result in increased levels of disturbance to California Ridgway's rails similar to those noted above for construction (many elements of which are previously discussed in the PBO). However, implementation of conservation measures would minimize these temporary and minor effects. Similar to the other ponds clusters, the benefits of habitat restoration at the Mountain View Ponds are expected to far exceed any adverse effects of temporary disturbance from monitoring and maintenance activities on California Ridgway's rails.

Similar to the other pond clusters, with the implementation of conservation measures, the adverse effects from operations and maintenance disturbance are expected to be minimal and the benefits of habitat restoration in the Ravenswood Ponds are expected to far exceed any adverse effects of temporary disturbance from monitoring and maintenance activities on California Ridgway's rails.

6.3.5 California Ridgway's Rail Effects Summary

Phase 2 tidal restoration activities would require habitat loss or alteration (e.g., levee breaching, levee lowering, filling, adding public access, changing of the tidal prism) that would permanently remove some existing tidal marsh habitat on the outboard sides of the ponds, resulting in a small loss of habitat for California Ridgway's rails. Ongoing activities such as monitoring, maintenance and public accessing viewing platforms and trails could also degrade habitat by increasing disturbance of California Ridgway's rails if present and potentially providing a minor increase in perching opportunities for raptor predators. Additionally, though unlikely, individuals could be killed or disturbed during construction activities including levee breaches, channel excavation, and the creation of habitat transition zones and public access areas.

However, the number of individuals potentially killed or disturbed is anticipated to be small with the implementation of extensive conservation measures. In the long-term, there would be an overwhelmingly positive benefit to California Ridgway's rails from tidal marsh restoration as several hundred acres of new marsh and improved habitat connectivity and quality would be created. For tidal marsh-associated species such as the California Ridgway's rail, Phase 2 of the SBSP Restoration Project is expected to result in considerable increases in habitat in the long-term, thereby augmenting populations far beyond the minor, temporary and local effects that would occur during Phase 2 activities.

6.4 Western Snowy Plover

6.4.1 Island Ponds

Direct Loss of Individuals

Western snowy plovers do not currently occur within the Action Area at the Island Ponds. Thus, there is a negligible chance of direct physical injury to an individual bird. There is, however, some potential for loss of western snowy plover eggs or chicks if construction noise disturbs nesting plovers nearby in Ponds A22 or A23 if they were close to the borders of those ponds. Conservation measures to minimize construction impacts to plovers include seasonal avoidance to the maximum extent practicable, and construction monitoring. Given the short duration of construction, distance from construction noise and implementation of conservation measures, loss of western snowy plover individuals is highly unlikely. As described below, preconstruction surveys and biological monitors would be used to determine whether a 600-foot buffer distance around a nest is necessary to avoid these effects, though seasonal avoidance may completely avoid this risk if it is able to be fully implemented.

Habitat Effects

No nesting habitat is present in the Phase 2 Action Area at the Island Ponds for western snowy plovers, and the species is not known to forage there. Therefore, no habitat loss or degradation is anticipated.

Construction Disturbance

There is some potential for noise disturbance of western snowy plovers as a result of Phase 2 construction when levees are lowered and breached on the north side of Ponds A19 and A20. These construction activities could disturb nesting snowy plovers in the ponds nearby (A22 and A23), if nests are present. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult plovers during the breeding season, and loss of foraging opportunities could result from disturbance of foraging plovers. 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.

However, there is a low probability that construction noise would disturb western snowy plover individuals at or near the Island Ponds. Construction activities are expected to be limited in duration with each channel excavation and levee breeches lasting approximately one or two days each. Construction noise is expected to be minimal, because no pile driving would occur at this location. Additionally, conservation measures would be implemented to minimize effects. These measures include avoiding work during breeding and nesting period to the maximum extent practicable, construction monitoring, and preconstruction surveys and biological monitoring of the locations of active nests and chicks as a part of the SBSP Restoration Project. A 600-foot buffer distance from an active nest would be implemented if one is present, and the construction locations reordered or rescheduled as needed to comply with that buffer. Consultation with Refuge personnel prior to construction and other conservation measures (see Section 2.6 for details) would further minimize the potential for disturbance to western snowy plovers.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the Island Ponds site (a few visits per year) and is covered under the PBO. No new monitoring or maintenance activities are planned for the Island Ponds under the Phase 2 Actions. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to western snowy plovers.

6.4.2 A8 Ponds

Direct Loss of Individuals

The area where construction would occur is a minimum of 2,500 feet from habitat for western snowy plovers; therefore, no direct losses are anticipated.

Habitat Effects

The area where construction would occur is a minimum of 2,500 feet from habitat for western snowy plovers; therefore, no habitat loss or degradation is anticipated.

Construction Disturbance

The area where construction would occur is a minimum of 2,500 feet from habitat for western snowy plovers; therefore, no habitat disturbance from construction is anticipated.

Operations and Maintenance Disturbance

The area where maintenance operations would occur is a minimum of 2,500 feet from habitat for western snowy plovers; therefore, no habitat disturbance from operations and maintenance is anticipated.

6.4.3 Mountain View Ponds

Direct Loss of Individuals

Western snowy plover have not been known to roost, forage, or nest at the Mountain View Ponds themselves, but nesting been observed in the Action Area in nearby Crittenden Marsh (Tokatlian et al. 2014, Pearl et al. 2015). Therefore, there is potential for indirect loss of western snowy plover eggs or chicks disturbed from construction noise if plovers are present during construction activities such as pile driving or bulldozing at the Mountain View Ponds. Conservation measures to minimize construction effects on plovers include seasonal avoidance to the maximum extent practicable, preconstruction surveys, and construction monitoring (see Section 2.6 for details). Given the implementation of conservation measures, loss of western snowy plover individuals is unlikely.

Habitat Effects

No nesting habitat for western snowy plover is present within the Mountain View Ponds project area. The nearby suitable and occasionally used nesting habitat at Crittenden Marsh would not be affected by the project action. The species is not known to forage in the Mountain View Ponds. Therefore, no habitat loss or degradation is anticipated.

Construction Disturbance

There is some potential for noise-related disturbance of western snowy plovers as a result of Phase 2 construction when levees are lowered and breached, habitat transition zones are created and during pile driving, if those activities occur when individuals are present. These construction activities could potentially disturb nesting snowy plovers in Crittenden Marsh. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult plovers during the breeding season. Loss of foraging opportunities could result from disturbance of foraging plovers. 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.

However, noise-related disturbance is unlikely to occur, given that the dry areas at Crittenden Marsh are barely within the outer edge of noise-buffered Action Area at the Mountain View Ponds and that plover do not use those areas for nesting every year. Construction activities are expected to be limited in duration with channel excavation and levee breaches lasting approximately one to two days each. Similarly, pile driving is expected to last only 1-2 days. Most importantly, conservation measures would be implemented to minimize effects. These measures include seasonal avoidance to the maximum extent practicable as well as careful preconstruction surveys and construction monitoring. Consultation with Refuge personnel prior to construction and other conservation measures (see Section 2.6 for details) would further minimize the potential for disturbance to western snowy plovers.

Operations and Maintenance Disturbance

Ongoing monitoring, maintenance, and public access to nearby habitat could result in increased levels of disturbance to western snowy plovers similar to those noted above for construction (many elements previously discussed in the PBO) if plovers are present at other locations nearby. However, implementation of conservation measures would minimize these temporary and minor effects.

6.4.4 Ravenswood Ponds

Direct Loss of Individuals

Western snowy plovers currently occur within the Action Area at Ravenswood Ponds, mostly frequently nesting in Ponds R4 and R3 but having also made use of Ponds R5 and S5 as well. There is potential for loss of western snowy plover eggs or chicks if construction activities disturb nesting plovers or crush chicks and eggs. Careful preconstruction surveys and biological monitoring of the locations of active nests and chicks, consultation with Refuge personnel prior to construction, and other conservation measures (e.g., seasonal avoidance to the maximum extent practicable) would minimize the potential for loss of western snowy plovers to the greatest extent practicable.

Habitat Effects

All of the habitat in Ponds R4, R5 and S5 that has been used in the past by nesting western snowy plovers would be substantially modified under the proposed Phase 2 action. With the exception of the bird island proposed to be constructed from the existing levee between Ponds R5 and S5, potential nesting habitat would be permanently lost in these ponds when they are flooded for tidal marsh restoration or converted to enhanced managed ponds. However, the SBSP Restoration Project is committed to meeting the recovery plan goal for the western snowy plover. Pond R3 would be enhanced for western snowy plover. Restoration would also increase foraging opportunities in the habitat transition zones and the improve foraging along the marsh channels and sloughs. These actions are expected to benefit foraging small shorebirds, including western snowy plover. Enhancement actions in other parts of the SBSP Restoration Project have proven effective. Recent monitoring efforts in enhanced areas noted the South Bay western snowy plover population trend is on trajectory to meeting the Recovery Unit 3 goal of 500 birds (Zias and Valoppi, 2016; Notes from South Bay Salt Pond Restoration Project Annual Principal Investigators Meeting). Thus, while western snowy plover nesting habitat would no longer be available in Ponds R4, R5 and S5, other ponds within the SBSP Restoration Project such as Eden Landing, Warm Springs, and Ravenswood Pond R3 would be managed intensively for the species.

Construction Disturbance

There is potential for disturbance of snowy plovers during Phase 2 construction actions that include bulldozers and pile driving. Nest abandonment or loss of eggs or chicks due to exposure or predation could result from disturbance of adult plovers during the breeding season, and loss of foraging opportunities could result from disturbance of foraging plovers. 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.

Construction activities are expected to be limited in duration with channel excavation and levee breeches lasting approximately one day each. Most importantly, conservation measures would be implemented to minimize effects. These measures include seasonal avoidance to the maximum extent practicable as well as careful preconstruction surveys and biological monitoring of the work areas and surroundings. Consultation with Refuge personnel prior to construction and other conservation measures (see Section 2.6 for details) would further minimize the potential for disturbance to western snowy plovers.

Operations and Maintenance Disturbance

Maintenance, vegetation and predator control, monitoring and public accessing nearby habitats are among the activities that could disturb western snowy plovers. These ongoing activities could be disruptive to snowy plover breeding efforts especially if they occur in or near occupied habitat during the breeding season. Implementation of conservation measures would minimize these temporary and minor effects and would be consistent with measures found in the programmatic BO and the AMP.

6.4.5 Western Snowy Plover Effects Summary

Phase 2 tidal restoration activities would result in loss of western snowy plover nesting habitat when Ponds R4, R5, and S5 are converted to tidal marsh. Ongoing activities such as monitoring, maintenance and public viewing platforms and trails may also temporarily disturb foraging individuals (also discussed in the PBO). Additionally, individuals could be killed or disturbed during construction-related activities including levee breaches or the creation of habitat transition zones and public access areas.

However, the direct loss of individuals are expected to be extremely unlikely and limited with the implementation of extensive conservation measures, including those that would reduce impacts from construction, predator and non-native invasive plant species control, and public viewing access. These measures include seasonal avoidance of construction to the maximum extent practicable, as well as preconstruction surveys and biological monitoring of the locations of active nests and chicks.

Additionally, the SBSP Restoration Project is committed to meeting recovery goals for the western snowy plover. Enhancement actions in other parts of the SBSP Restoration Project intended to increase densities of nesting western snowy plovers within the greater Project area and enhanced conditions for breeding plovers have proven effective. The creation of nesting islands and the management of suitable water levels, nesting island conditions (e.g., through vegetation management, and improved substrate on habitat islands), and predators is expected to support higher densities of nesting western snowy plovers. Recent monitoring efforts noted that South Bay western snowy plovers are on a trajectory to meet the Recovery Unit 3 goals. Thus, while snowy plover habitat would be converted to tidal marsh or managed pond habitats in Ponds R4, R5 and S5, other ponds within the SBSP Restoration Project such as Ravenswood Pond R3, Eden Landing, and Warm Springs would be managed intensively for the species.

6.5 California Least Tern

6.5.1 Island Ponds

Direct Loss of Individuals

Because California least tern use levees in the South Bay as post-breeding roosting sites, adult California least terns could bring their juvenile offspring to the Island Ponds to forage before migration. The existing habitat at the Island Ponds provides minimal foraging and roosting habitat for the California least tern (Phase 2 EIS/R, 2016). Terns are likely to leave the area when Phase 2 construction or maintenance activities occur. Although disturbance could disrupt foraging behavior, it is extremely unlikely that any individuals would be killed or injured as a result of Phase 2 activities in the Island Ponds.

Habitat Effects

The existing habitat at the Island Ponds provides minimal foraging and roosting habitat for the California least tern. The area of disturbance would be relatively small compared with the range of this species in the San Francisco Bay estuary. Tidal-marsh restoration is not likely to increase habitat for the species, but is expected to benefit prey fish populations for the California least tern. However, cascading effects on California least terns as a result of improved numbers of forage fish species are unknown. No habitat loss or degradation is expected for California least terns at the Island Ponds.

Construction Disturbance

The existing habitat at the Island Ponds provides minimal foraging and roosting habitat for the California least tern. Therefore, construction is expected to result in little disturbance, if any, to California least terns.

Operations and Maintenance Disturbance

The future vegetated tidal marsh habitat at the Island Ponds would continue to provide some foraging and roosting habitat for the California least tern. Following construction, minimal monitoring and maintenance would occur at the Island Ponds site (a few visits per year) and is covered under the PBO. No new monitoring or maintenance activities are planned for the Island Ponds under the Phase 2 Actions. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to California least terns.

6.5.2 A8 Ponds

Direct Loss of Individuals

Because California least terns use levees in the South Bay as post-breeding roosting sites, adult California least terns could bring their juvenile offspring to the A8 Ponds to forage before migration. The existing habitat at the A8 Ponds provides suitable foraging habitat within the pond and roosting habitat on the levees for California least terns (Phase 2 EIS/R, 2016), but this species has not been observed to use these areas frequently or in large numbers. However, terns are likely to leave the area when Phase 2 construction, monitoring or maintenance activities occur. Although disturbance could disrupt foraging behavior, it is extremely unlikely that any individuals would be killed or injured as a result of Phase 2 activities in the A8 Ponds.

Habitat Effects

In the short-term, a small amount of foraging habitat in the A8 Ponds would be converted to habitat transition zones. This area is not large in absolute terms or relative to the total area of the ponds, and the resulting configuration would still provide adequate foraging habitat for California least terns. Also, the surrounding levees and upper portions of the habitat transition zones would provide roosting habitat that could benefit California least terns.

The Pond A8 Phase 2 actions are not expected to result in mobilization of mercury. Any mercury concentrations in the upland fill that that would be placed would be screened to ensure that the fill meets guidelines for reuse. In addition, the fill to be placed would likely cover older sediment with higher concentrations of mercury (AECOM 2016).

Construction Disturbance

The existing habitat at the A8 Ponds provides foraging habitat in the pond and roosting habitat for the California least tern on the levees. The duration of disturbance would be limited to a few months of activity that is similar to the current practice of trucking in dirt and dredge material and placing it on the levees or into the ponds. Finally, implementation of conservation measures, such as seasonal avoidance would further minimize these temporary and minor effects.

Operations and Maintenance Disturbance

Minimal monitoring and maintenance would occur at the A8 Ponds (a few visits per year). Occasional visits for control of invasive plant species or mosquito abatement are possible but not expected to be frequent or extensive. Therefore, operations and maintenance are not expected to result in increased levels of disturbance to California least tern.

6.5.3 Mountain View Ponds

Direct Loss of Individuals

California least tern use levees and other built structures in the South Bay as post-breeding roosting sites. California least terns adults and offspring are known to forage in the Mountain View Ponds before migration. They also use levees and the PG&E infrastructure for roosting (Phase 2 EIS/R, 2016). Terns are likely to leave the area during Phase 2 construction, monitoring or maintenance activities. Additionally, conservation measures such as seasonal avoidance are expected to minimize any potential disturbance on California least terns. Although disturbance could disrupt foraging behavior, with the implementation of conservation measures it is extremely unlikely that any individuals would be killed or injured as a result of Phase 2 activities.

Habitat Effects

After Phase 2 implementation, California least terns that forage and roost in the Mountain View Ponds would probably continue to use these areas and adjacent open water. The proposed islands and remaining levees would also provide opportunities for roosting. Construction of habitat islands would result in a small loss in the amount of foraging habitat while increasing the quality of roosting and potentially nesting habitat. Deep-water foraging within Ponds A1 and A2W would gradually be lost, but over time the tidal marsh would develop into fish nursery habitat that could improve deep-water foraging in the adjacent sloughs and the channels that form within the ponds. Effects on the California least tern associated with the loss of foraging habitat in Ponds A1 and A2W would be partially offset through improved foraging in adjacent sloughs and the creation of roosting islands in the ponds. Due to these improvements and the availability of adjacent open bay foraging habitat, adverse effects to the California least tern would be minor and in the long-term potentially benefit the species.

Construction Disturbance

There could be temporary disturbance to California least tern foraging and roosting habitat in the Mountain View Ponds during construction of the PG&E boardwalk and tower foundations, island and habitat transition zone creation, channel excavations, and levee modifications. However, California least terns forage over the entire Bay and amount of habitat to be disturbed is comparatively insignificant for the species. Finally, implementation of conservation measures, such as seasonal avoidance to the extent practicable, preconstruction surveys, and biological monitoring would minimize these temporary effects.

Operations and Maintenance Disturbance

Ongoing operations, monitoring, and maintenance could temporarily disturb California least terns foraging and roosting within the Mountain View Ponds. Invasive plant control on levees and transition zones may disturb California least terns if they are in the vicinity (discussed in the PBO). Human use of the public access trails could also disturb foraging California least terns. However, implementation of conservation measures, including seasonal avoidance, and adaptive management plan elements and restricted access at the Pond A2W eastern levee trail as necessary would minimize these effects. In the long-term restored areas are expected to provide benefits to the forage fish prey for California least terns.

6.5.4 Ravenswood Ponds

Direct Loss of Individuals

Currently, the Ravenswood Ponds do not provide foraging habitat for the California least tern, but levees could provide roosting habitat for individuals foraging in the Bay nearby. Therefore it is extremely unlikely that any individuals would be killed or injured as a result of Phase 2 activities.

Habitat Effects

Currently, the Ravenswood Ponds do not provide foraging habitat for the California least tern. Potential roosting habitat exists on levees, but is not frequently used in these areas. A small amount of potential roosting habitat would be lost as levees are breached and Pond R4 is converted to tidal marsh habitat. However, these losses would not be significant because the habitat is not frequently used.

Overall, the Phase 2 Actions would be beneficial to the California least tern in the Ravenswood Ponds because they would increase foraging habitat. The introduction of tidal action in Pond R4 would provide additional habitat for foraging. As the tidal marsh develops, improved fisheries could increase the foraging quality within Pond R4 and also outside of this pond. Also, Ponds R5 and S5, functioning as enhanced managed ponds, may provide some potential roosting habitat for California least terns.

Construction Disturbance

Currently, the Ravenswood Ponds do not provide foraging habitat for the California least tern. However, because California least tern use levees in the South Bay as post-breeding roosting sites, adult California least terns could bring their juvenile offspring to the Ravenswood Pond levees to forage in the Bay (Phase 2 EIS/R, 2016). Terns are likely to leave the area when Phase 2 construction, monitoring or maintenance activities occur. Although this unlikely disturbance could disrupt foraging behavior, it would be temporary in nature.

Operations and Maintenance Disturbance

Ongoing operations and maintenance could potentially temporarily disturb California least terns foraging and roosting within the Ravenswood Ponds. However, as above, since this species does not currently use this area, and the proposed Phase 2 action would open up several hundred acres of new aquatic habitat for foraging, the net effect would be a benefit. Invasive plant control on levees and transition zones may disturb California least terns if they are in the vicinity (as discussed in the PBO). However, implementation of conservation measures, including seasonal avoidance, would minimize these temporary and minor effects. In the long-term, restored areas are expected to provide benefits to the forage fish prey for California least terns.

6.5.5 California Least Tern Effects Summary

Phase 2 tidal restoration activities would require habitat loss or alteration (e.g., levee breaching, levee lowering, filling, adding public access) resulting in a minor loss of foraging habitat and roosting habitat for California least terns. Ongoing activities such as monitoring, maintenance and public accessing viewing platforms and trails could also temporarily disturb foraging and roosting individuals. However, the number of foraging and roosting individuals disturbed is anticipated to be small with the implementation of extensive conservation measures, including those that would reduce impacts from construction through seasonal avoidance.

In the long-term tidal marsh restoration is expected to benefit prey fish populations for the California least tern, as miles of sloughs and channels are expected to be restored by the project. Phase 2 actions likely to benefit California least terns include increased foraging habitat at Ravenswood Ponds, higher quality roosting and potential nesting habitat at the Mountain View Ponds (with the creation of islands), as well as improved quality of foraging habitat with tidal marsh restoration at all pond clusters.

6.6 Longfin Smelt

6.6.1 Island Ponds

Direct Loss of Individuals

Longfin smelt have been detected in the Island Ponds during surveys conducted between October and April. The species is known to use these ponds. There is thus the potential for individuals to be killed or injured during construction that involves in-water work including excavation of pilot channels, levee lowering, and levee breaching. However, the implementation of conservation measures would minimize direct injury or mortality of longfin smelt individuals. In-water work would be timed with the tides and seasonally to the extent practicable to avoid effects on fish that might be present within the ponds or adjacent sloughs.

Habitat Effects

No permanent habitat loss from the project is expected in the Island Ponds for longfin smelt. On the contrary, the improved aquatic habitat connectivity between Ponds A19 and A20 and Mud Slough to the north is specifically intended to benefit fish.

Construction Disturbance

Longfin smelt have been detected at the Island Ponds. Construction and excavation activities, such as pilot channel excavation and levee breaches, would result in ground disturbance and are likely to temporarily increase turbidity and suspended sediment. These actions could negatively impact longfin smelt if they are present. Effects on longfin smelt potentially include temporarily degrading water quality, reducing prey resources, disturbing habitat, and impeding movements of longfin smelt. Spills or other chemical contamination from construction equipment could also negatively affect longfin smelt habitat if they occur. None of the work at the Island Ponds is expected to create noise levels that would exceed NMFS, USFWS, or CDFW interim in-water sound pressure level criteria (i.e., 206 peak dB for all fish, 187 dB cumulative sound exposure level [cSEL] for fish greater than 2 grams and 183 dB cSEL for fish less than 2 grams [FHWG 2008]) that can have potential to cause injury or mortality impacts on longfin smelt. Re-suspended sediments can sometimes elevate toxic levels in water. Potentially elevated turbidity is not likely to be altered beyond tolerable limits for longfin adapted living in turbid environments.

Conservation measures are provided to eliminate or minimize construction effects. These include seasonal avoidance and working at low tide to the extent practicable, biological monitoring, and preconstruction surveys. The amount of disturbance would be temporary in nature and comparatively insignificant compared with the range of this species in the San Francisco Bay estuary.

Operations and Maintenance Disturbance

Ongoing monitoring and operations associated with the SBSP Restoration Project could also disturb longfin smelt habitat. Operations and maintenance activities at the Island Ponds would be limited to occasional monitoring and other research actions, aside from the monitoring and management activities of the AMP and continued maintenance of the existing UPRR track. These ongoing activities are detailed in the previous BOs and other documents, though their potential effects were not directly applied to longfin smelt. Nevertheless, the effects on longfin smelt are not expected to be much different from those on other listed fish, including steelhead and green sturgeon. In general, the disturbance may be similar to construction effects, but would be temporary in duration.

Although these activities may result in short-term negative habitat effects on longfin smelt habitat, in the long-term programmatic level restoration of tidal marshes are expected to benefit longfin smelt by improving habitat quality (e.g., increasing invertebrate productivity in nursery habitats) as well as improving connectivity between estuarine habitat and the existing open waters of the Bay.

6.6.2 A8 Ponds

Direct Loss of Individuals

Longfin smelt are not anticipated to be within the Action Area of the A8 Ponds, as they are not known to use these ponds. Therefore, direct losses of individuals are extremely unlikely but still possible to occur during placement of material to build the habitat transition zones. Fish are able to swim away from the southernmost edges of the pond, where that activity would take place. Therefore, adverse effects to longfin smelt within the A8 Ponds are not anticipated.

Habitat Loss or Degradation

A small portion of aquatic habitat loss is expected to be permanently lost in the A8 Ponds as the habitat transition zones are built. However, an increase in fish habitat quality and complexity is expected. Longfin smelt have not been observed within the ponds but have been observed in nearby Coyote Creek and Alviso Slough.

Construction Disturbance

There is some potential for construction activities in the A8 Ponds to re-suspend mercury into the water, but these changes are expected to be short-lived and unlikely to affect longfin smelt, which do not frequent these ponds. Additionally, the RWQCB accepted QAPP for upland fill material would ensure that any fill used in the creation of habitat transition zones or islands is free of contaminants that may enter the water. Therefore, no effects are anticipated for longfin smelt within the A8 Ponds.

Operations and Maintenance Disturbance

Operations and maintenance (including operation of the A8 notch and invasive plant control on the habitat transition zones) associated with the Project could temporarily disturb longfin smelt habitat by temporarily degrading water quality, but this is unlikely. Therefore, no effects are anticipated for longfin smelt within the A8 Ponds.

6.6.3 Mountain View Ponds

Direct Loss of Individuals

Longfin smelt have not been observed in the Mountain View Ponds, which have very limited and muted tidal connection through a single water intake. However the presence of longfin smelt in the ponds cannot be discounted because other fish species have been observed within the ponds (Mejia et al. 2008). Additionally longfin smelt could be present outside of the ponds in nearby Stevens Creek, Mountain View Slough, Charleston Slough, and in the Bay. Therefore, their presence is inferred, and there is the potential for individuals to be killed or injured during construction activities that involve in-water work including excavation of pilot channels, levee modifications, creating habitat transition zones or islands, and pile driving to build the bridge abutments. Individuals could be crushed or injured by equipment, or noise from pile driving can also harm fish if they are too small or close when pile driving occurs.

The implementation of conservation measures would minimize direct injury or mortality of longfin smelt individuals. These measures include timing in-water work with the tides to the extent practicable to avoid fish presence within the ponds or in nearby sloughs. Additionally, standard best management practices for in-water construction could be employed such as using exclusion nets and flushing cofferdams prior to closure. Biological monitors skilled in fish removal and relocation would perform the work. A “soft start” technique would be implemented during pile installation activities to reduce hydroacoustic impacts, which are further described in Appendix G– Underwater Noise Analysis for Phase 2 Construction Memo. The soft start technique would allow for any longfin smelt in the vicinity work area to leave the Action Area before full pile driving began.

During pile driving operations to install bridges and armored braches, there is potential for sound pressure impacts on longfin smelt. The results of the underwater noise analysis for this potential effect are presented in Appendix G and are summarized in **Table 21**. The area of disturbance would be relatively small compared with the range of this species and temporary in nature (no more than a few days for pile driving). None of the work is expected to create noise levels that would exceed NMFS, USFWS and CDFW interim criteria for potential injury to fish (FHWG 2008). The distance to the 187 dB cSEL threshold is estimated at 24 feet – individual fish are not expected to be present in such a small and proximal area long enough to experience temporary threshold shifts (a temporary loss in hearing capacity) from accumulated noise exposure. Thus, the potential effects of underwater noise on longfin smelt are limited to behavioral changes. For the analysis included in this BA a threshold of 150 dB RMS was examined to determine potential behavioral impacts to fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas. This threshold is not currently used to regulate impacts on fish from in-water noise and is a very conservative analysis to determine effects on fish species from in-water noise.

Re-suspended sediments can sometimes elevate toxic levels in water. Potentially elevated turbidity is not likely to be altered beyond tolerable limits for longfin smelt adapted living in turbid environments.

Table 21. Estimated Distances of to Regulatory Thresholds for Pile Driving Noise – Fish

PILE TYPE	SOURCE LEVELS AT 10 METERS (DB)				DISTANCE TO THRESHOLD[1] (FEET)		
	PEAK NOISE LEVEL	SEL, SINGLE STRIKE[2]	SEL, ACCUMULATED	RMS	206 DB PEAK	187 DB ACCUMULATED SEL	150 DB RMS
Impact Driving							
14-inch square concrete (4 per day)	183	154	185	166	NE	24 (assumed)	385
Vibratory Driving/Extraction							
24-inch sheet pile (6 per day)	174	142	175	142	NE	5	10

Notes:

dB decibels

NE threshold not exceeded

SEL sound exposure level

[1] The distance from the pile over which the effects threshold of 206 dB peak sound level (injury), 187 dB accumulated SEL (temporary threshold shifts), and 150 dB RMS (behavioral effects) would be exceeded. These threshold values apply to fish over 2 grams in weight.

[2] For vibratory driving, the Single Strike SEL represents the SEL of one second of pile driving.

Habitat Effects

No habitat loss is expected to be permanently lost in the Mountain View Ponds for longfin smelt. On the contrary, the proposed action would improve existing potential habitat by opening over 700 acres (Table 20) of currently inaccessible pond habitat to full tidal flows and thereby benefit fish species. In addition, the Phase 2 actions in the Mountain View Ponds are expected to benefit estuarine fish like longfin smelt over time because conversion of the managed ponds to tidal marsh would improve water quality problems associated with low dissolved oxygen releases from managed ponds (2016 EIR/S, 2016).

Construction Disturbance

Construction activities, such as earth moving, and pile driving, would result in noise and soil disturbance that could temporarily increase turbidity and suspended sediment within the Mountain View Ponds and nearby Stevens Creek and other sloughs. These actions could negatively impact longfin smelt that may be present. Effects of increased turbidity and suspended sediment may temporarily degrade water quality, reduce prey resources, disturb habitat, and impede movements of longfin smelt. Spills or other chemical contamination from construction equipment could also negatively affect habitat of managed species.

As above, there is some potential for sub-lethal noise-related disturbance on smelt. Underwater sound pressure resulting from pile driving could affect longfin smelt by causing behavioral avoidance of the construction area. The radius of behavioral disturbance is a distance of 385 feet from the source) but could be reduced by working at low tides to the extent practicable. Also, the duration over which the noise-related aspects of construction disturbance would occur is very brief, as pile-driving would not occur for more than a few hours at a time over only a few days.

The implementation of conservation measures would minimize disturbance of longfin smelt individuals. Conservation measures include timing in-water work seasonally and with the tides to the extent practicable to avoid fish presence within the ponds or in nearby sloughs. Additionally, standard best management practices for in-water construction would be employed such as using exclusion nets and flushing cofferdams prior to closure. Biological monitors skilled in fish removal and relocation would perform the work. The “soft start” technique would be implemented during pile installation activities to reduce hydroacoustic impacts.

Operations and Maintenance Disturbance

Monitoring, maintenance and operations associated with the SBSP Restoration Project are also likely to temporarily disturb longfin smelt and their habitat. These activities include invasive vegetation control, placing fill to address erosion of levees retained for PG&E access, PG&E’s own operations and maintenance, mosquito abatement, annual bridge inspections and repairs as necessary, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBO, Refuge management plans, and other permits and consultations. The PG&E operations and maintenance actions are covered under separate permits. The additional or different operations and maintenance activities associated with the proposed action at the Mountain View Ponds are vegetation control on habitat transition zones, islands, and improved levees; mosquito abatement; and bridge maintenance. These are likely to temporarily disturb habitat potentially occupied by fish. The effects of these disturbances would be similar to construction effects, but would be temporary, infrequent, and of a reduced magnitude.

The overall disturbance may be similar to construction effects, but implementation of conservation measures would minimize these temporary and minor effects on habitat. Further, the overall disturbance would be almost entirely around the pond margins, and several hundred acres of improved habitat would be made newly available by the proposed action.

6.6.4 Ravenswood Ponds

Direct Loss of Individuals

The Ravenswood Ponds are seasonal ponds with no hydraulic connection to the Bay or surrounding sloughs. They are not longfin smelt habitat. However, longfin smelt may occur in the Action Area in the adjacent sloughs and the South Bay. There is some potential for individuals to be killed or injured during construction activities that involve in-water work including excavation of levee breaches, creating water control structures and pile driving at Flood Slough and Ravenswood Slough.

Individuals could be crushed or injured by equipment, harmed by high turbidity, or harmed by noise if they are very small or too close when these dynamics occur.

The implementation of conservation measures would minimize direct injury or mortality of longfin smelt individuals. Conservation measures include timing in-water work with the tides to the extent practicable to avoid fish presence in nearby sloughs and the Bay. Additionally, standard best management practices for in-water construction would be employed such as using exclusion nets and flushing cofferdams prior to closure. Biological monitors skilled in fish removal and relocation would perform the work.

A “soft start” technique would be implemented during pile installation activities to reduce hydroacoustic impacts, which are further described in Appendix G – Underwater Noise Analysis for Phase 2 Construction Memorandum. That memorandum describes that a soft start technique would allow for any longfin smelt in the vicinity work area to leave the Action Area before full pile driving began. In addition, underwater noise from pile driving would be short in duration (not more than a few days). Underwater noise from pile installation activities would not exceed USFWS, NMFS and CDFW criteria for potential onset of injury (i.e., 206 peak decibels, and 187 dB cSEL) to fish. The distance to the 187 cSEL threshold is 24 feet – individual fish are not expected to be present in such a small and proximal area long enough to experience temporary threshold shifts (a temporary loss in hearing capacity) from accumulated noise exposure. Thus, the potential effects of underwater noise on longfin smelt are limited to behavioral changes. For the analysis included in this BA a threshold of 150 dB RMS was examined to determine potential behavioral impacts to fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas. This threshold is not currently used to regulate impacts on fish from in-water noise and is a very conservative analysis to determine effects on fish species from in-water noise. The likelihood of an individual longfin smelt being in that area is negligible; no injury or mortality is expected from underwater noise. Implementation of these conservation measure and best management practices would minimize fish stranding or the potential of being directly harmed during in-water activities if fish are present.

Habitat Effects

Because the ponds are currently dry and unconnected to the Bay, no longfin smelt habitat loss would be permanently lost in the Ravenswood Ponds Action Area. The opening of Pond R4 to tidal flows would actually increase longfin smelt habitat by several hundred acres. Within Ravenswood Slough and Flood Slough, brief periods of habitat degradation from noise or increased turbidity are possible when levees are breached or water control structures are placed (see Construction Disturbance below). But the proposed Phase 2 actions are expected to benefit estuarine fish like longfin smelt over time because conversion of the dry ponds to tidal marsh is expected to increase habitat quantity and quality in the long term (2007 EIS/R).

Construction Disturbance

Construction activities, such as earth moving and pile driving would result in noise and other disturbances that and are likely to temporarily increase turbidity and suspended sediment within the sloughs and along the edge of the Bay immediately adjacent to the Ravenswood Ponds where in-water construction occurs. These actions could negatively impact individual longfin smelt that may be present. Effects of increased turbidity and suspended sediment may temporarily degrade water quality, reduce prey resources, disturb habitat, and impede movements of longfin smelt. Spills or other chemical contamination from construction equipment could also negatively affect habitat of managed species.

As above, there is some potential for sub-lethal noise-related disturbance on longfin smelt. The radius of behavioral disturbance from pile driving is a distance of 385 feet from the source) but could be reduced by working at low tides to the extent practicable. Also, the duration over which the noise-related aspects of construction disturbance would occur is very brief, as pile-driving would not occur for more than a few hours at a time over only a few days.

Operations and Maintenance Disturbance

Monitoring, maintenance and operations associated with the SBSP Restoration Project are also likely to temporarily disturb longfin smelt habitat. These activities include invasive vegetation control, placing fill to address unwanted erosion of levees, mosquito abatement, water control structure operations and maintenance, and ongoing species counts and other Refuge management actions. Many of these ongoing activities have been included in the PBO, Refuge management plans, and other permits and consultations. Disturbance may be similar to construction effects, but implementation of conservation measures would minimize these temporary and minor effects.

In the post-construction period, the two managed ponds here (Ponds R5/ S5 [these two ponds would be a single pond after construction] and Pond R3) would have gated hydraulic connectivity with surrounding sloughs through water control structures. Operation of the water control structures would be done to manage water levels in the R3 and R5/ S5 ponds. The proposed water control structures for the managed Ravenswood Ponds are accessible to longfin smelt. As a result, operating the water control structures as intakes has the potential to entrain very small numbers of longfin smelt into the managed ponds, where they may be exposed to increased predation, decreased DO, or other stressors.

Additionally, if the residence times of water in the managed ponds R3 and R5/S5 are long, the water in them could be stagnant and rich in nutrients, particularly in summer months. Dissolved oxygen concentrations could thus be low, which would temporarily reduce habitat quality in the surrounding waterways after release. Adaptive management measures (e.g., changing residence times and/or water depths) would be implemented by Refuge management during low dissolved oxygen conditions to reduce the potential for these adverse conditions. That would avoid mortality of aquatic or benthic organisms, odors that cause nuisance, degraded habitat, or unacceptably high methylmercury production rates. Longfin smelt are thus unlikely to be affected by long residence time.

6.6.5 Longfin Smelt Effects Summary

Multiple life stages of longfin smelt are known to live in the Bay estuary, including the South Bay, year round. Because of their potential to be present, Phase 2 actions could injure, kill or temporarily disturb a small portion of the longfin smelt population during construction and may degrade water quality, reduce prey resources, and impede movements of longfin smelt. Individuals could be disturbed or killed during construction related activities if they are present within the area during construction. Disturbance may cause fish, if present, to temporarily avoid the work area at times when construction activities are being conducted. Noise related effects including direct loss of individuals or habitat exclusion are also possible, though again unlikely. Ongoing activities such as monitoring, and maintenance may also intermittently disturb habitat or individual longfin smelt.

Extensive conservation measures would minimize the likelihood of take or disturbance to longfin smelt and their habitat. Conservation measures include timing in-water work with the tides to the extent practicable to avoid fish presence within the ponds or in nearby sloughs. Additionally, standard best management practices for in-water construction would be employed such as using exclusion nets and flushing cofferdams prior to closure. Biological monitors skilled in fish removal and relocation would perform the work. The “soft start” technique would be implemented during pile installation to reduce hydroacoustic effects. Implementation of these conservation measures and best management practices would minimize fish stranding or the potential of being crushed during in-water activities if fish are present.

Although these activities may result in short-term habitat degradation in a small portion of longfin smelt individuals within the estuary, in the long-term programmatic level restoration of tidal marshes, are expected to increase available nursery foraging habitat, improve longfin smelt habitat quality (e.g., by increasing invertebrate productivity) as well as improve connectivity between estuarine habitat and the existing open waters of the Bay.

6.7 Cumulative Effects

Cumulative effects, as defined by the ESA, are those effects of future state or private activities that are reasonably certain to occur in the Action Area [50 CFR 402.02]. Future federal actions that are unrelated to the completed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA (16 USC 1536).

The SBSP Phase 2 Final EIS/R (AECOM 2016) contains a detailed analysis of past, present, and reasonably foreseeable future projects within the San Francisco Bay Area, and having effects similar to or that would interact with those of the proposed action. These cumulative projects include other tidal restoration and/or flood protection projects in the Bay Area which could result in the same types of adverse effects and beneficial effects as those of the proposed action. Other cumulative projects with which the SBSP Restoration Project would be evaluated in combination include construction projects proposed by local, regional or state agencies in and around the Action Area not covered by the larger SBSP Restoration 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; and recreation-related projects proposed by local municipalities, Association of Bay Area Governments, park districts, or other non-governmental agencies.

The projects listed below are considered in the cumulative effects discussion of the Final EIS/R for Phase 2 to determine if the combined effects of all the projects would be cumulatively considerable and would result in adverse cumulative effects. More details of each project, which were identified as having potential cumulative effects to biological and other resources, are discussed in Section 4 of the SBSP Phase 2 Final EIS/R (AECOM 2016):

- Restoration Projects:
  - Redwood City Inner Harbor Studies and Plans
  - San Jose/Santa Clara Water Pollution Control Plant (WPCP) Master Plan
  - Final Damage Assessment and Restoration Plan for the November 7, 2007 Cosco Busan Oil Spill
- Flood Protection Projects:
  - San Francisquito Creek Flood Reduction, Ecosystem Restoration, and Recreation Project San Francisco Bay to Highway 101
  - Sunnyvale East and West Channel Flood Protection Project
  - Santa Clara Valley Water District Stream Maintenance Program
  - Landfill Erosion Protection
  - Lower Permanente Creek Levee and Floodwall Improvements
  - Golf Course Facilities High Ground Augmentation
  - Lower Stevens Creek Levee Improvements
  - Lower Permanente Creek Storm Drain Improvements
  - Sailing Lake Intake Pump Station Modification
  - Safe, Clean Water & Natural Flood Protection Program
  - Bayfront Canal and Atherton Channel Project
- Development Projects
  - Newby Island Sanitary Landfill
  - Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay, Fiscal Years 2015–2024
  - Zanker Materials Recycling Facility
  - San Jose/Santa Clara Water Pollution Control Plan
  - Menlo Gateway Project
  - South Bay Advanced Recycled Water Treatment Facility (ARWTF) Project
  - Cooley Landing Park
  - The Preserve at Redwood Shores Precise Plan
  - Stanford University Medical Center Facilities Renewal and Replacement (SUMC Project)
  - Yahoo! Santa Clara Campus
  - Google campus expansion
  - Creekside Landing Project
- Transportation Projects
  - Stevens Creek Crossings Project
  - Los Gatos Creek Bridge Replacement/South Terminal Phase III Project
  - Pacific Gas and Electric Company (PG&E) NERC Compliance Efforts

- Recreation Projects
  - San Francisco Bay Area Water Trail Plan
  - Facebook Campus State Route 84 Overpass Trail
  - Coyote Creek Trail Project: Story Road to Phelan Avenue

Generally speaking, many of the above projects would only have minor and indirect influences on the species and tidal habitats that are the subject of this BA. These influences include minor alterations to patterns of runoff, small amounts of fill in aquatic habitats (from levee improvements or other flood protection measures), and stream crossings. Many of the other projects above are themselves restoration projects that would bring direct or indirect benefits to the species covered in this BA. Note too that many of the above projects are considered federal actions because they involve Clean Water Act Section 404 permitting, occur on federal lands, or involve federal funding, either for restoration or for the project itself. As a result, relatively few of the above projects have the potential to result in cumulative effects that would not also be subject to future Section 7 consultation. Most would also therefore receive permits from the USACE, the RWQCB, and/or the BCDC with terms and conditions that would limit their adverse effects.

Because of the large geographic and temporal scale of the SBSP Restoration Project, the Programmatic Project would be the primary influence on salt marsh harvest mouse, California Ridgway's rail, and western snowy plover populations, within the Project's Action Area, having a net beneficial effect on these species. By comparison, actions associated with other projects and/or in other locations (e.g., at colony sites for the California least tern, estuary-wide for longfin smelt) are expected to be the primary drivers of population sizes of these species in the Action Area.

7 Determinations

This section presents the effect determinations and rationale for those determinations. Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

For Phase 2 actions, general and species specific conservation measures are proposed that would avoid and minimize, to the maximum extent practicable, the proposed actions' potential effects on salt marsh harvest mouse, California Ridgway's rail, western snowy plover, California least tern and longfin smelt. Given the implementation of the avoidance and minimization measures listed above, the following listed species effects and determinations have been identified and made for the proposed Phase 2 actions.

7.1 Salt Marsh Harvest Mouse

Due to the short-term loss of tidal marsh habitat from scour, breaching, and channel excavation, the potential for direct loss of individuals during construction, and temporary disturbance associated with ongoing SBSP Restoration Project activities (e.g., maintenance, monitoring, and public viewing). Phase 2 of the SBSP Restoration Project is **likely to adversely affect** the salt marsh harvest mouse. Conservation measures were designed specifically to avoid and minimize adverse effects on this species, but that potential cannot be completely eliminated. Additionally, the proposed Phase 2 actions would create large areas (several hundred acres) of high-quality tidal marsh habitat suitable for the salt marsh harvest mouse and near adjacent populations. This habitat would greatly benefit the species and partially fulfill the requirements of the Recovery Plan. These long-term benefits would outweigh any short-term adverse effects associated with the proposed action, and the Phase 2 Project is thus considered to be a net long-term benefit to the species. Yet, because the short-term adverse effects cannot be completely avoided the Phase 2 proposed action is likely to adversely affect but not jeopardize the species' continued existence.

7.2 California Ridgway's Rail

Similar to the salt marsh harvest mouse, Phase 2 of the SBSP Restoration Project is **likely to adversely affect** the California Ridgway's rail due to the short-term loss of tidal marsh habitat from scour, breaching, and channel excavation, the potential for direct loss of individuals during construction, and temporary disturbance associated with ongoing SBSP Restoration Project activities (e.g., maintenance, monitoring, and public viewing). Conservation measures were designed specifically to avoid and minimize adverse effects on the species, but that potential cannot be completely eliminated. Additionally, the proposed Phase 2 actions would create large areas (several hundred acres) of high-quality tidal marsh habitat suitable for the California Ridgway's rail. This habitat would greatly benefit the species and partially fulfill the requirements of the Recovery Plan. These long-term benefits would outweigh any short-term adverse effects associated with the proposed action, and the Phase 2 Project is thus considered to be a net long-term benefit to the species. Yet, because the short-term adverse effects cannot be completely avoided he Phase 2 proposed action is likely to adversely affect but not jeopardize the species' continued existence.

7.3 Western Snowy Plover

Due to the loss of breeding habitat in Ponds R4, R5, and S5, the potential for direct loss of individual eggs or chicks during construction, and temporary disturbance associated with ongoing SBSP Restoration Project activities (e.g., maintenance, monitoring, and public viewing), Phase 2 of the SBSP Restoration Project is **likely to adversely affect** the western snowy plover. Conservation measures were designed specifically to avoid and minimize adverse effects on this species but that potential cannot be completely eliminated. Additionally, that proposed action includes the enhancement and targeted management Pond R3 for western snowy plover nesting habitat. That effort, along with the active control of predators and other aspects of the overall SBSP Restoration Project designed to benefit this species would likely increase the number of western snowy plovers in the South Bay, thereby contributing to the recovery goals for this species. Current efforts in other SBSP Restoration Project ponds are currently on a trajectory towards recovery goals for this species. These benefits to the western snowy plover from the SBSP Restoration Project as a whole are expected to offset the potential for adverse effects associated with the proposed Phase 2 action. Thus the Phase 2 proposed action is likely to adversely affect but not jeopardize the species' continued existence.

7.4 California Least Tern

The small loss of roosting habitat and temporary disturbance to foraging and roosting habitat resulting from construction and ongoing SBSP Restoration Project activities (e.g., maintenance, monitoring, and public viewing) from Phase 2 of the SBSP Restoration Project **may affect but is not likely to adversely affect** the California least tern. Conservation measures were designed specifically to avoid and minimize adverse effects on the species, but that potential cannot be completely eliminated. Additionally, Phase 2 Actions would have no direct effect on California least terns or their habitats in the immediate vicinity of their current nesting colonies, other than to potentially increase the abundance of prey fish in the South Bay as a result of tidal habitat restoration within the SBSP Restoration Project footprint. The long-term effect on this species is expected to be a large net benefit because of the several hundred acres of former salt pond habitat that would be made available as forage habitat for this species. Thus the Phase 2 proposed action is not likely to adversely affect this species.

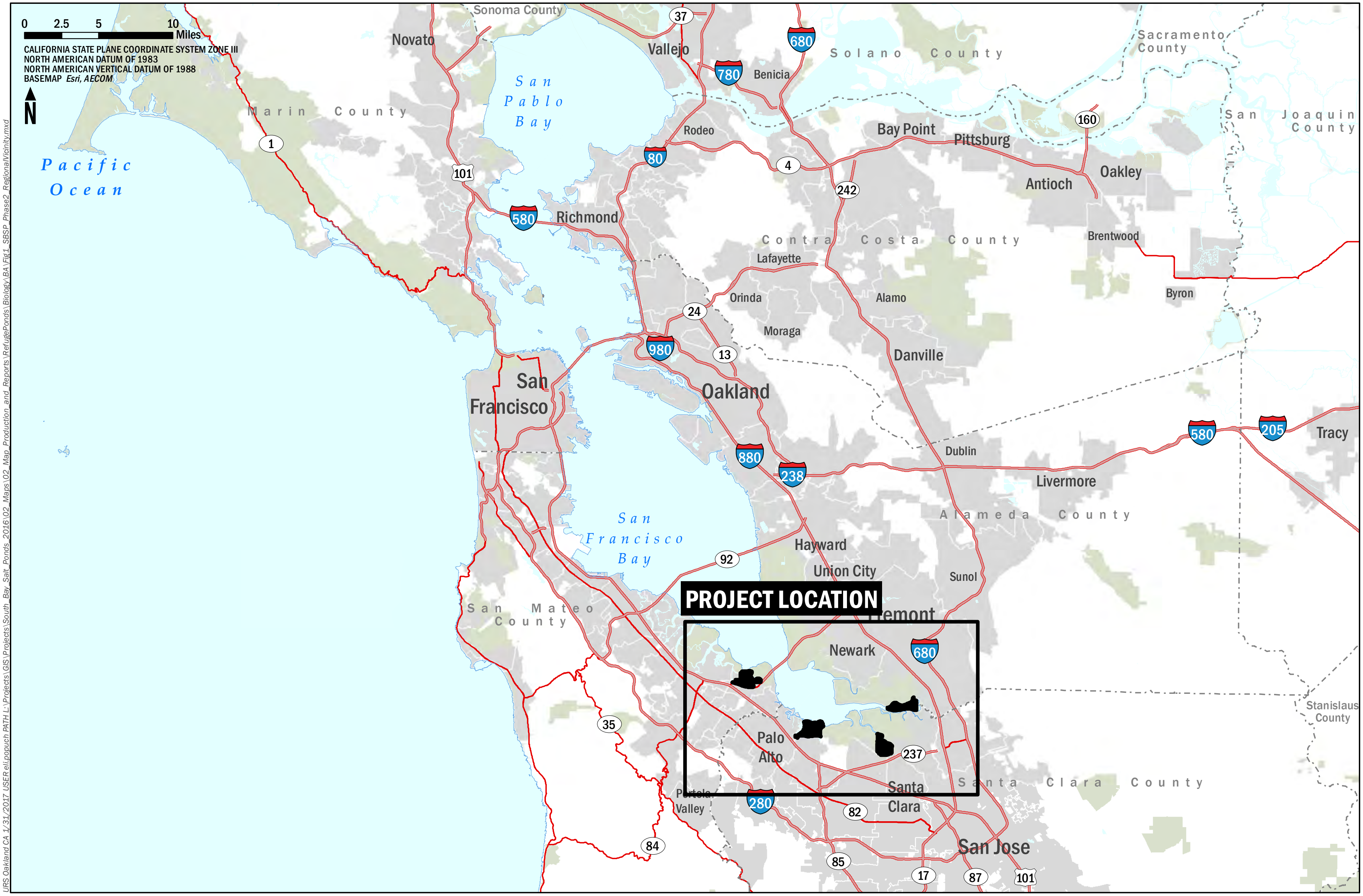
7.5 Longfin Smelt

Phase 2 of the SBSP Restoration Project is **likely to adversely affect** longfin smelt, primarily through temporary habitat disturbance during construction and the low but not completely discountable potential for direct injury to individuals if present. The implementation of conservation measures would reduce these potential effects to longfin smelt and habitat. Additionally, the ability of these species to move themselves out of the area affected by disturbance would further minimize the potential for adverse effects. The amount of habitat disturbance would be temporary and relatively small when compared to the existing habitat area already available to the species and to the large areas (several hundred acres) of former salt ponds that would be made newly available to this species. Phase 2 Actions may also increase the abundance of prey items in the South Bay as a result of tidal habitat restoration from the SBSP Restoration Project. Although the Phase 2 Actions are likely to bring a net benefit to longfin smelt, the potential for adverse effects in the short-term cannot be completely discounted. Thus the Phase 2 proposed action is likely to adversely affect but not jeopardize the species' continued existence.

This page intentionally left blank

8 Map Figures

This page intentionally left blank



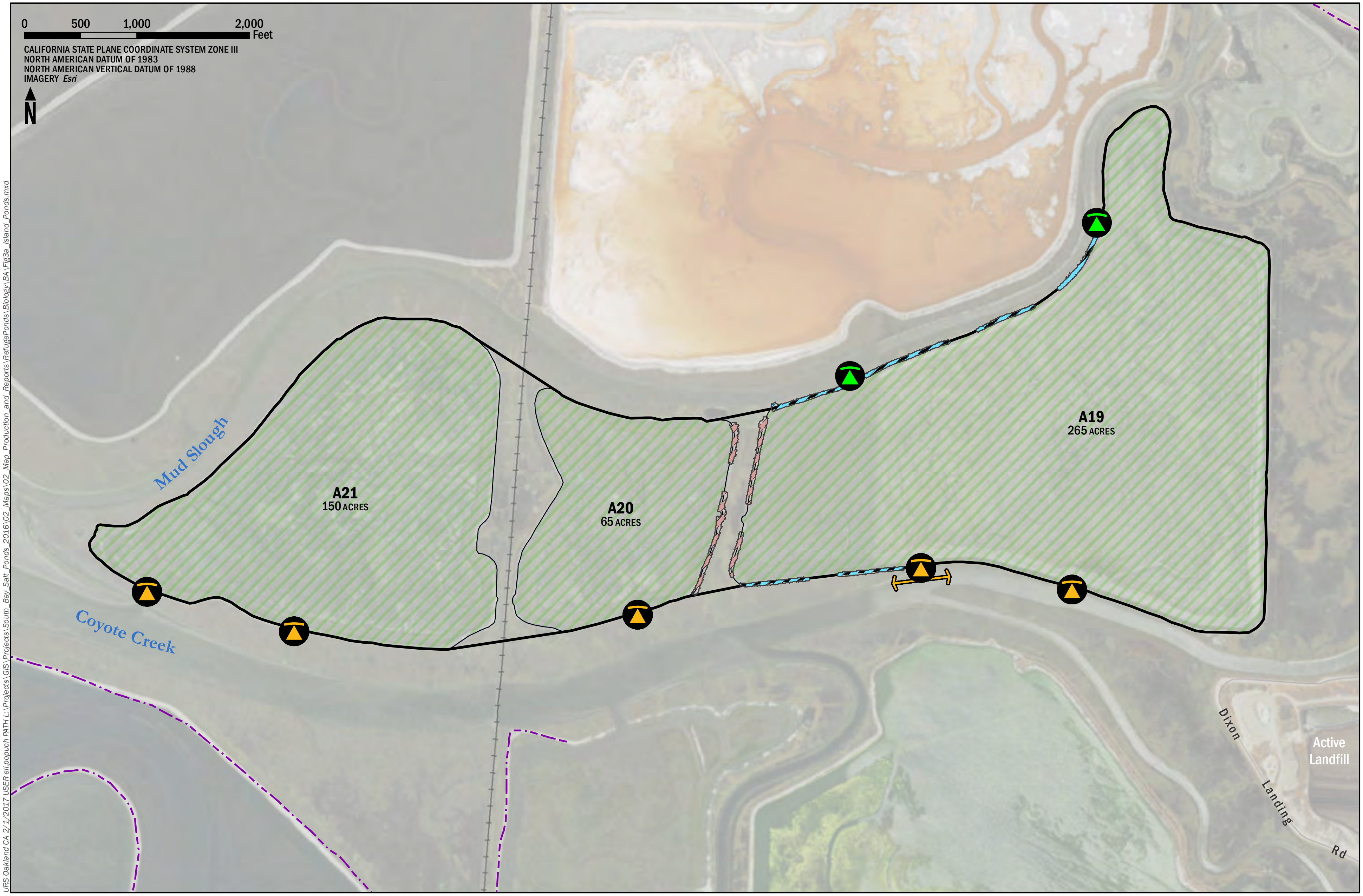
South Bay Salt Pond Restoration Project

Figure 1
SBSP Phase 2 Regional Location

URS Oakland CA 1/31/2017 USER eli.popuch PATH L:\Projects\GIS\Projects\South_Bay_Salt_Ponds_2016\02_Maps\02_Map_Production_and_Reports\RefugePonds\Biology\BA\Fig2_SBSP_Phase2_ProjectSites.mxd

AECOM
South Bay Salt Pond Restoration Project

Figure 2
SBSP Phase 2 Project Sites



URS Oakland CA 2/1/2017 USER eli.popuch PATH L:\Projects\GIS\Projects\South_Bay_Salt_Ponds_2016\02_Maps\02_Map_Production_and_Reports\RefugePonds\Biology\BA\Fig3a_Island_Ponds.mxd

LEGEND

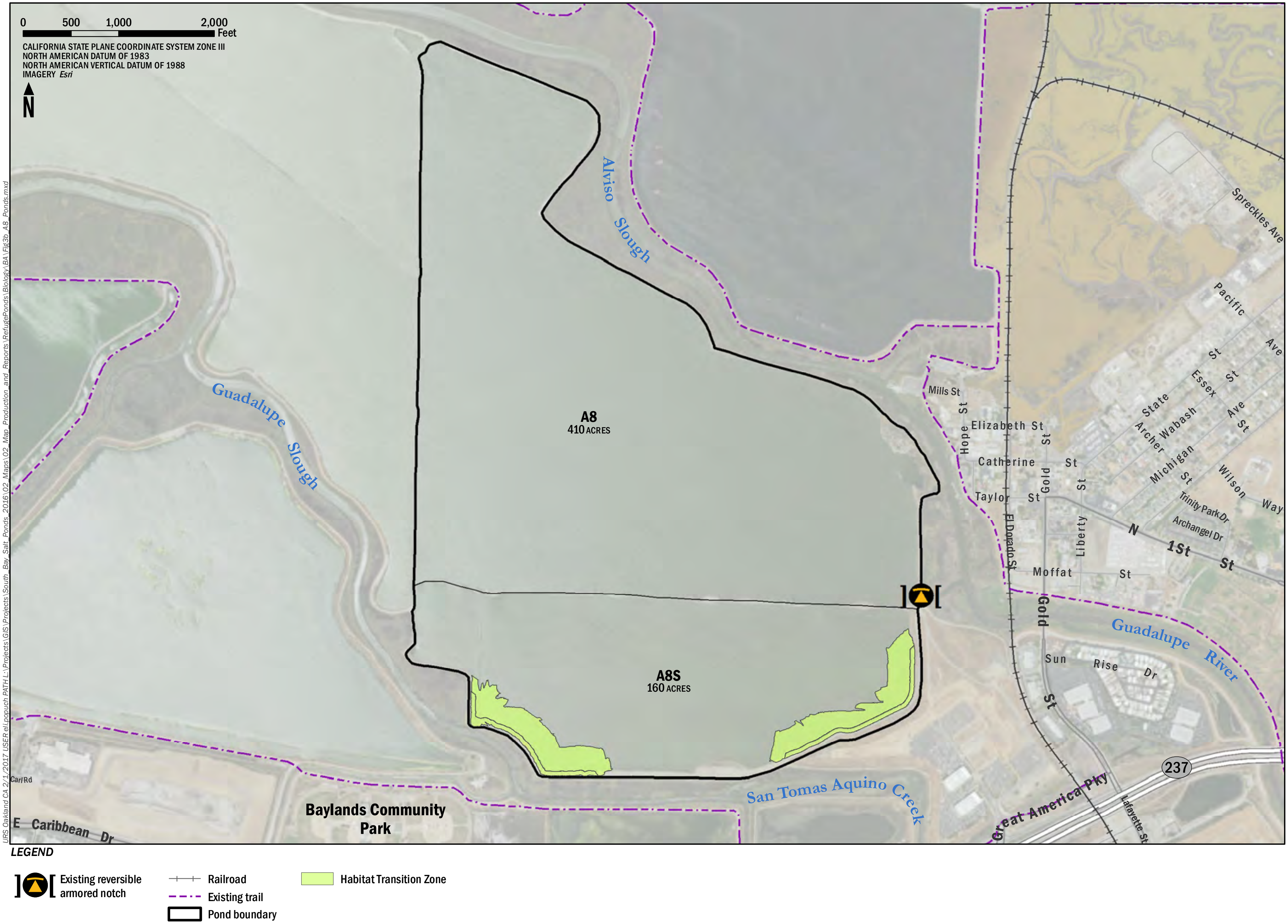
Proposed breach
Existing breach
Expand existing breach
Railroad
Existing trail
Removed levee
Lowered levee
Tidal marsh
Pond boundary

AECOM

South Bay Salt Pond Restoration Project

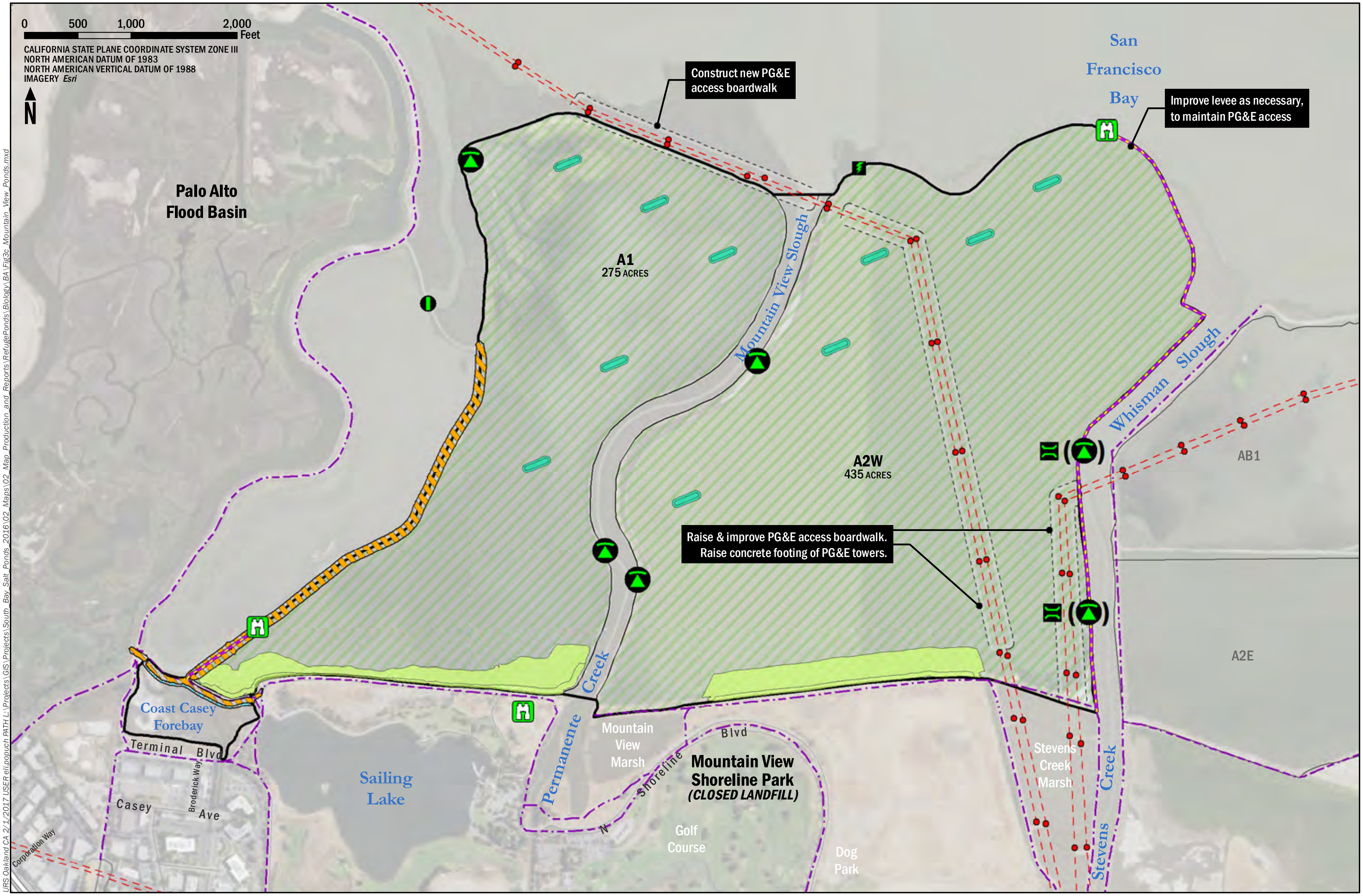
Figure 3a

Phase 2 Proposed Action - Alviso Island Ponds



AECOM
South Bay Salt Pond Restoration Project

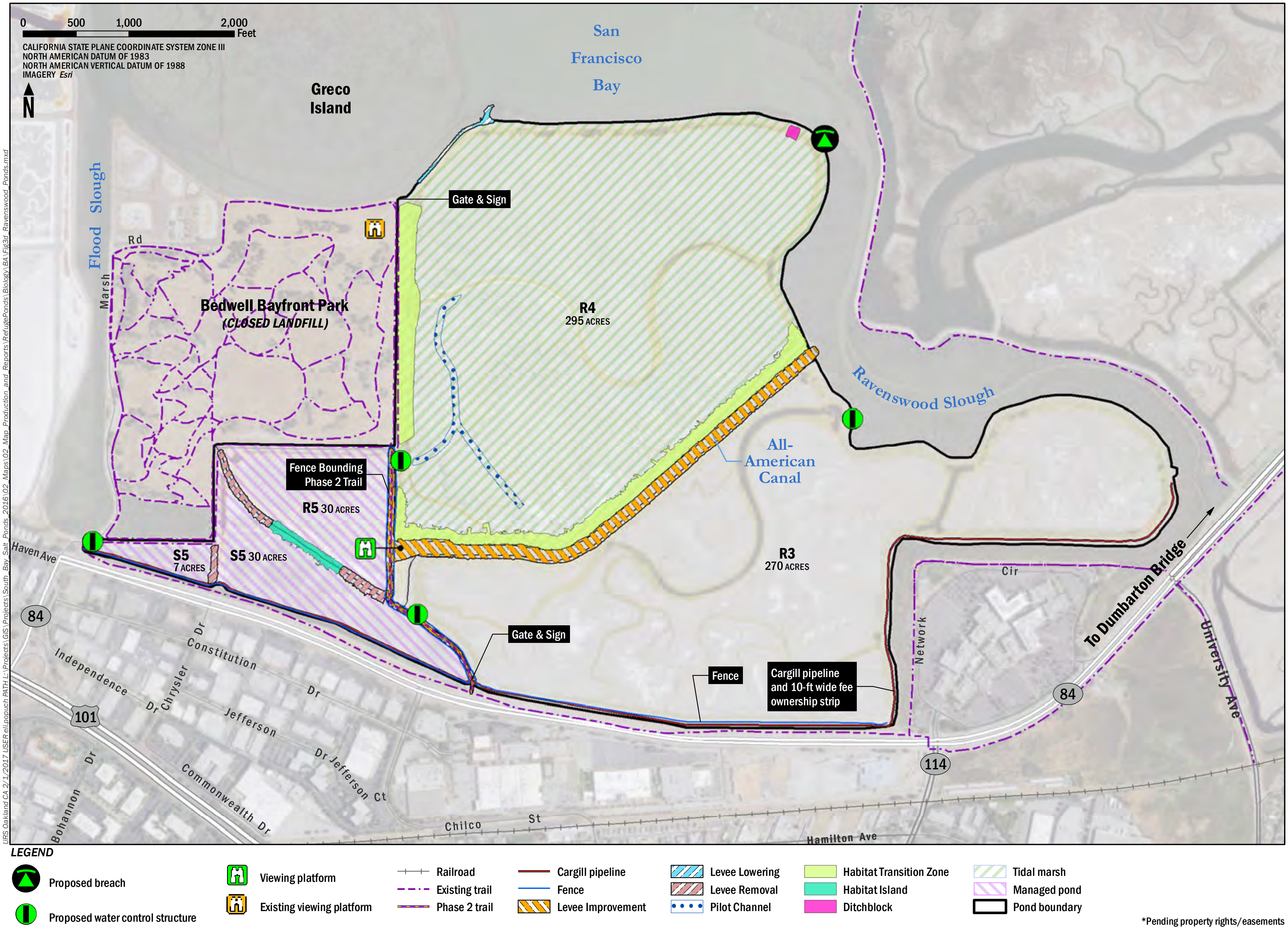
Figure 3b
Phase 2 Proposed Action - Alviso A8 Ponds



LEGEND

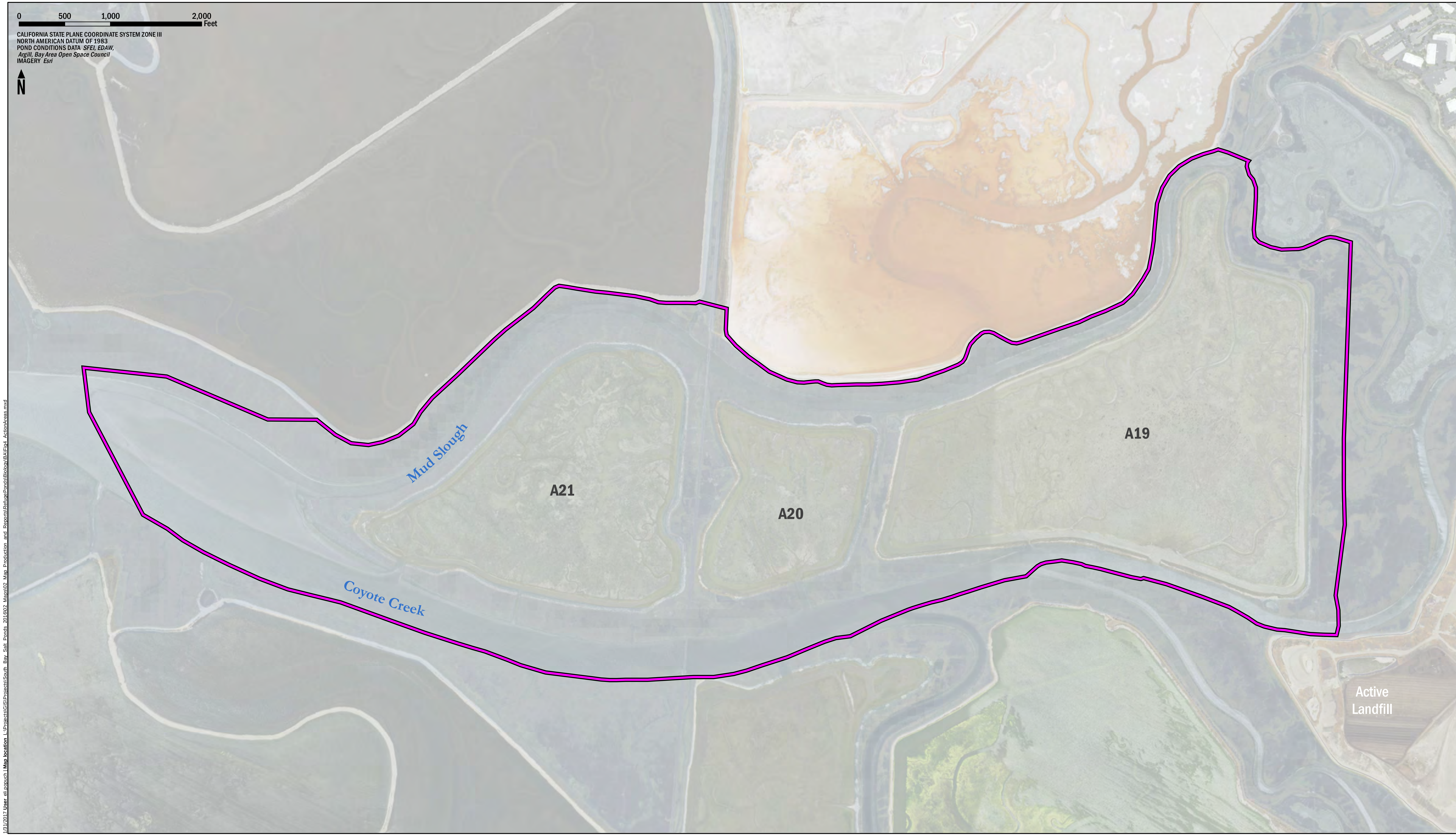
- Existing control gate
- Proposed breach
- Proposed armored breach (two sides)
- Bridge
- PG&E turnaround
- Viewing platform
- PG&E tower
- PG&E power line
- Phase 2 trail
- Existing trail
- Tidal marsh
- Levee Improvement
- Levee Lowering
- Habitat Transition Zone
- Habitat Island
- Pond Boundary

Figure 3c
Phase 2 Proposed Action - Alviso Mountain View Ponds



AECOM
South Bay Salt Pond Restoration Project

Figure 3d
Phase 2 Proposed Action - Ravenswood Ponds

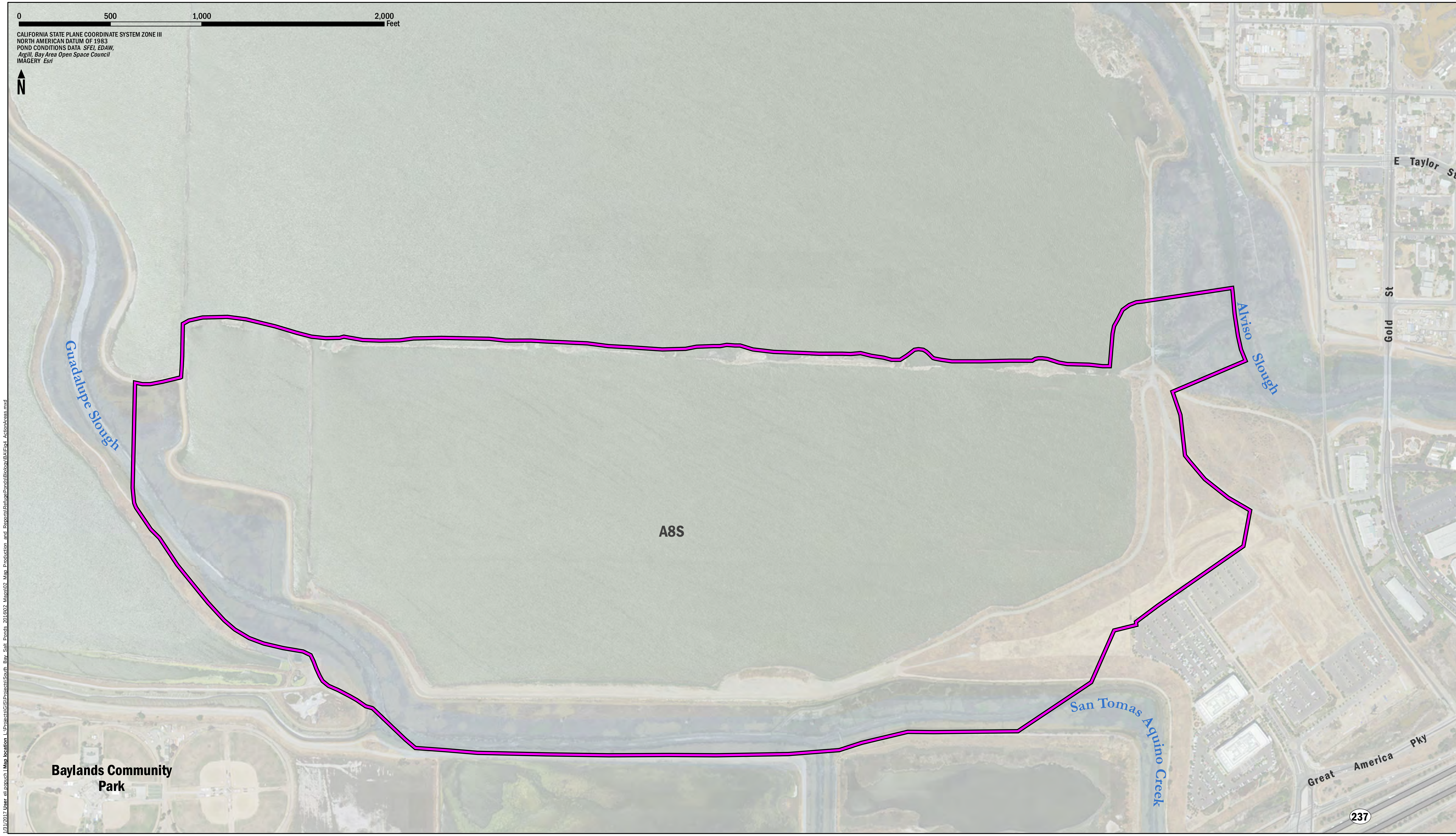


LEGEND

Phase 2 BA Action Area

AECOM
South Bay Salt Pond Restoration Project

Figure 4a
Alviso Island Ponds Action Area



LEGEND

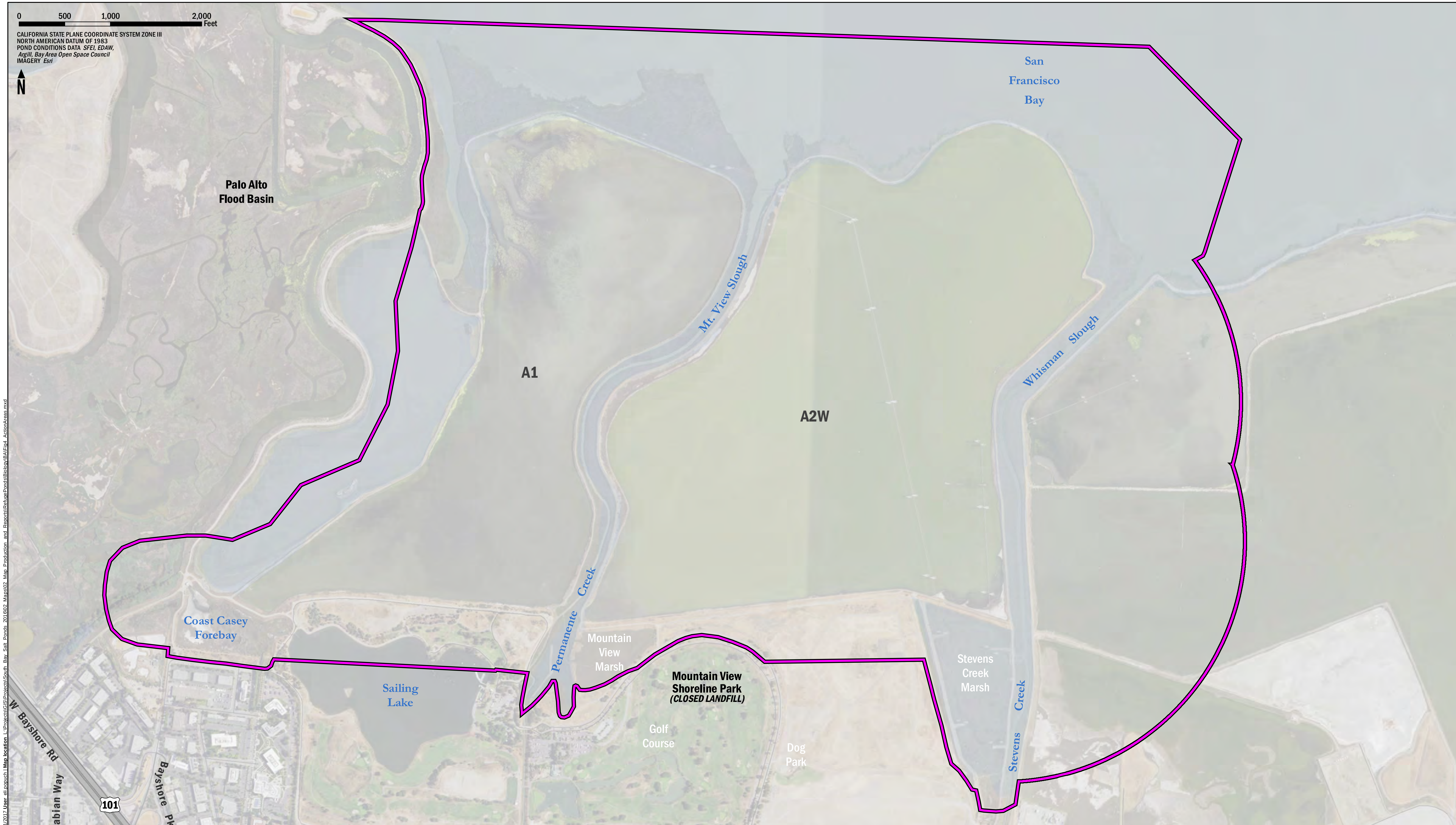
Phase 2 BA Action Area

AECOM

South Bay Salt Pond Restoration Project

Figure 4b

Alviso A8 Ponds Action Area

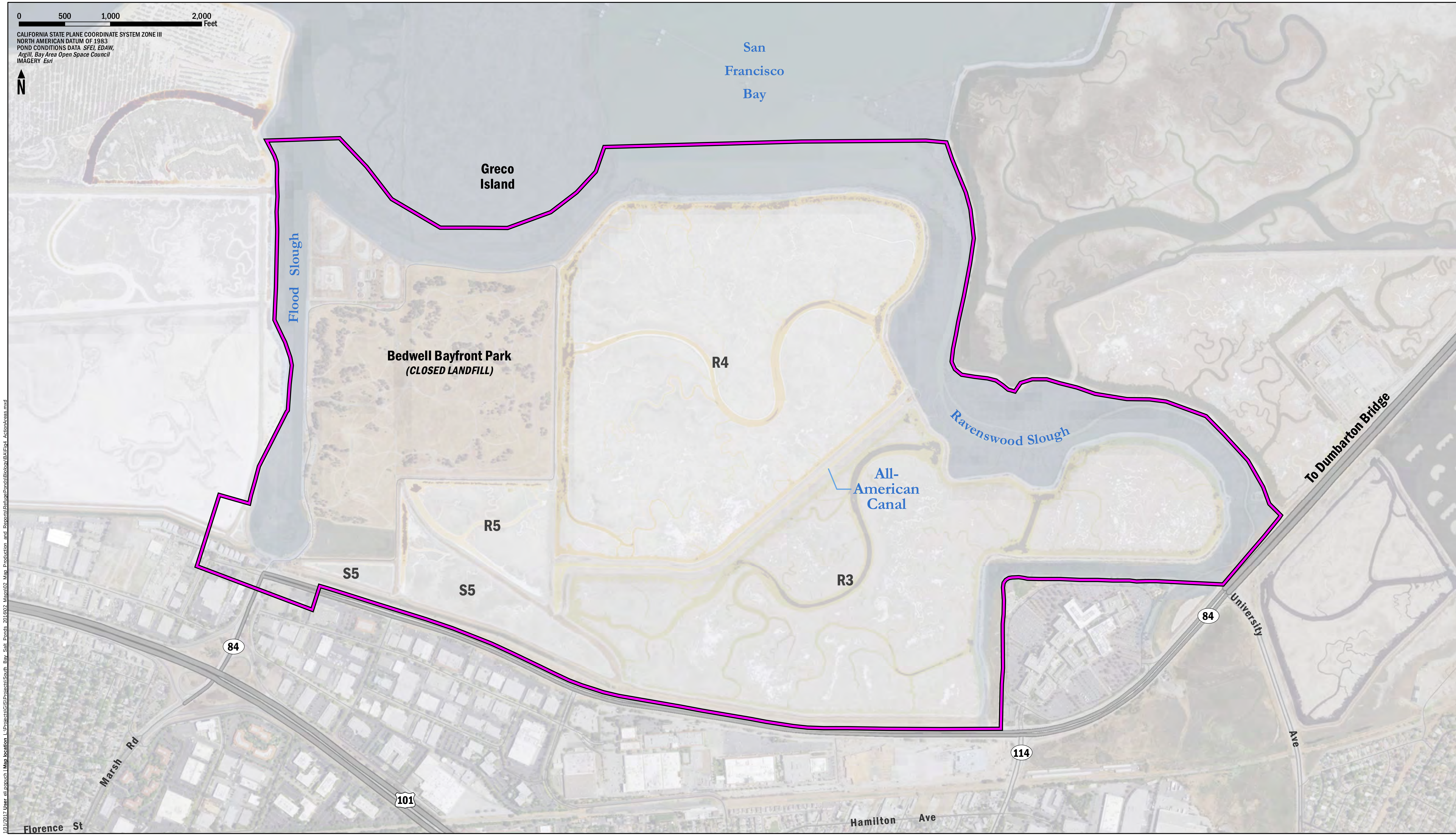


LEGEND

Phase 2 BA Action Area

AECOM
South Bay Salt Pond Restoration Project

Figure 4c
Alviso Mountain View Ponds Action Area

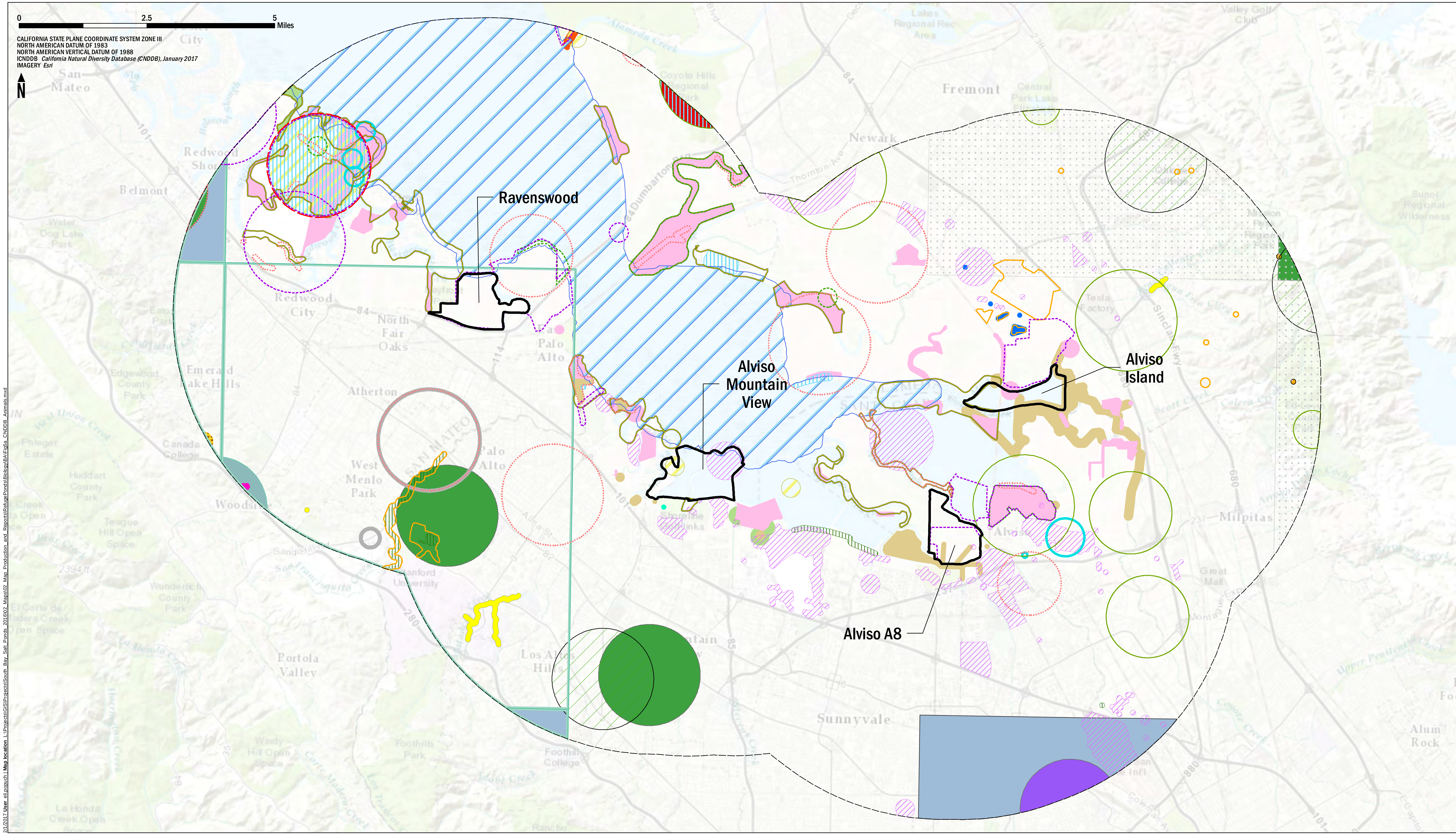


LEGEND

Phase 2 BA Action Area

AECOM
South Bay Salt Pond Restoration Project

Figure 4d
Ravenswood Ponds Action Area

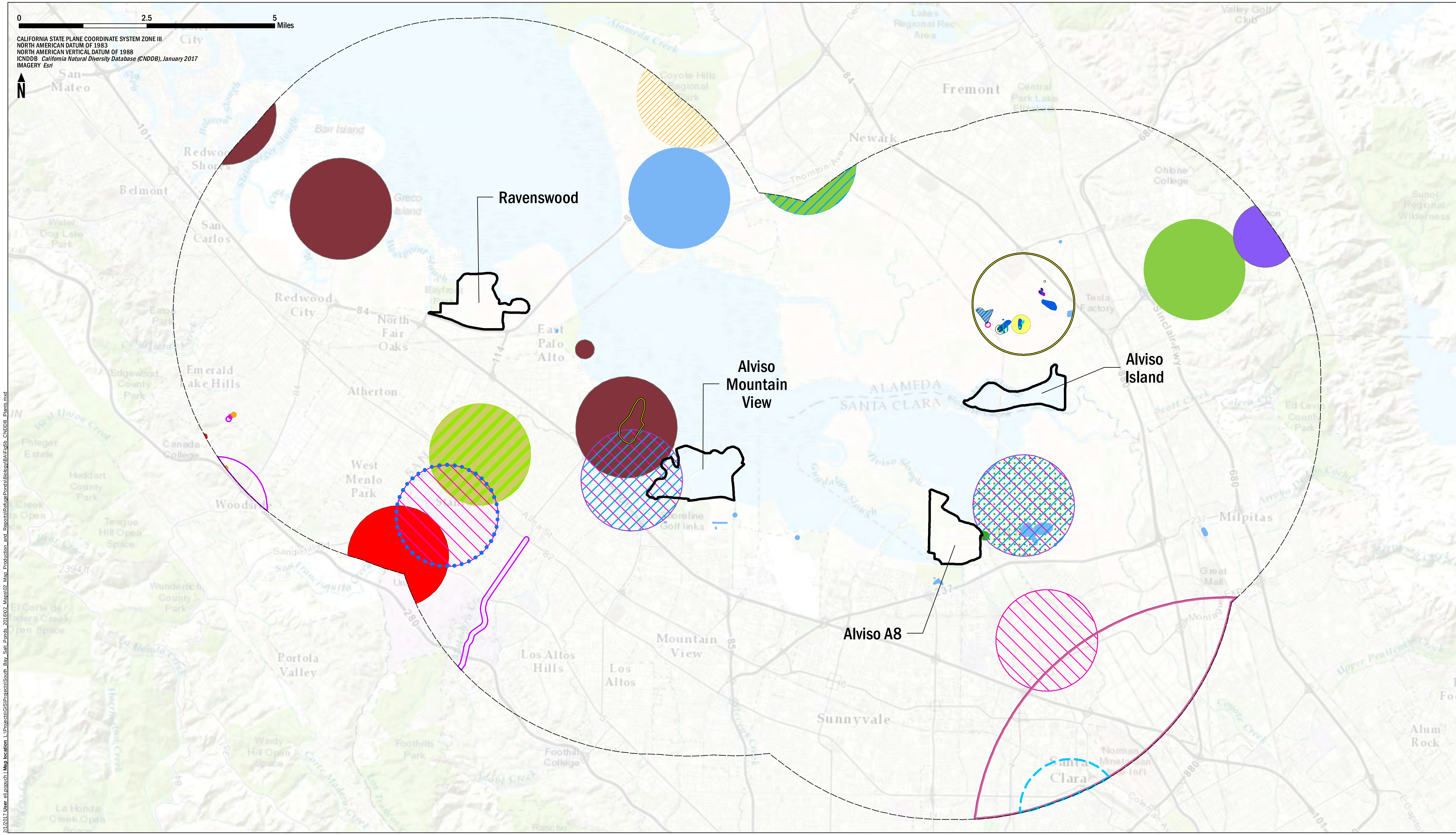


LEGEND

Phase 2 Project Boundary	Alameda whipsnake	Bay checkerspot butterfly	California clapper rail	California tiger salamander	Pallid bat	San Francisco gartersnake	Swainson's hawk	Western pond turtle
Phase 2 Project Boundary 5 Mile Buffer	American badger	black skimmer	California giant salamander	Golden eagle	Salt-marsh harvest mouse	San Francisco dusky-footed woodrat	Townsend's big-eared bat	Western snowy plover
Alameda song sparrow	American peregrine falcon	Burrowing owl	California least tern	Longfin smelt	Salt-marsh wandering shrew	Short-eared owl	Tricolored blackbird	White-tailed kite
	Bank swallow	California black rail	California red-legged frog	Northern harrier	Saltmarsh common yellowthroat	Steelhead - central California coast DPS	Vernal pool tadpole shrimp	

AECOM
South Bay Salt Pond Restoration Project

Figure 5a
CNDDB Special-Status Wildlife Species



LEGEND

- Phase 2 Project Boundary
- Phase 2 Project Boundary 5 Mile Buffer
- Alkali milk-vetch
- Arcuate bush-mallow
- Brittlescale
- California alkali grass
- California seablite
- Chaparral ragwort
- Congdon's tarplant
- Contra Costa goldfields
- Crystal Springs fountain thistle
- Fragrant fritillary
- Franciscan onion
- Hairless popcornflower
- Hoover's button-celery
- Lesser saltscale
- Lost thistle
- Marin western flax
- Most beautiful jewelflower
- Point Reyes salty bird's-beak
- Prostrate vernal pool navarretia
- Robust spineflower
- Saline clover
- San Francisco collinsia
- San Joaquin spearscale
- Slender-leaved pondweed
- Western leatherwood

AECOM
South Bay Salt Pond Restoration Project

Figure 5b
CNDDB Special-Status Plant Species

Legend

Phase 2 BA Action Area

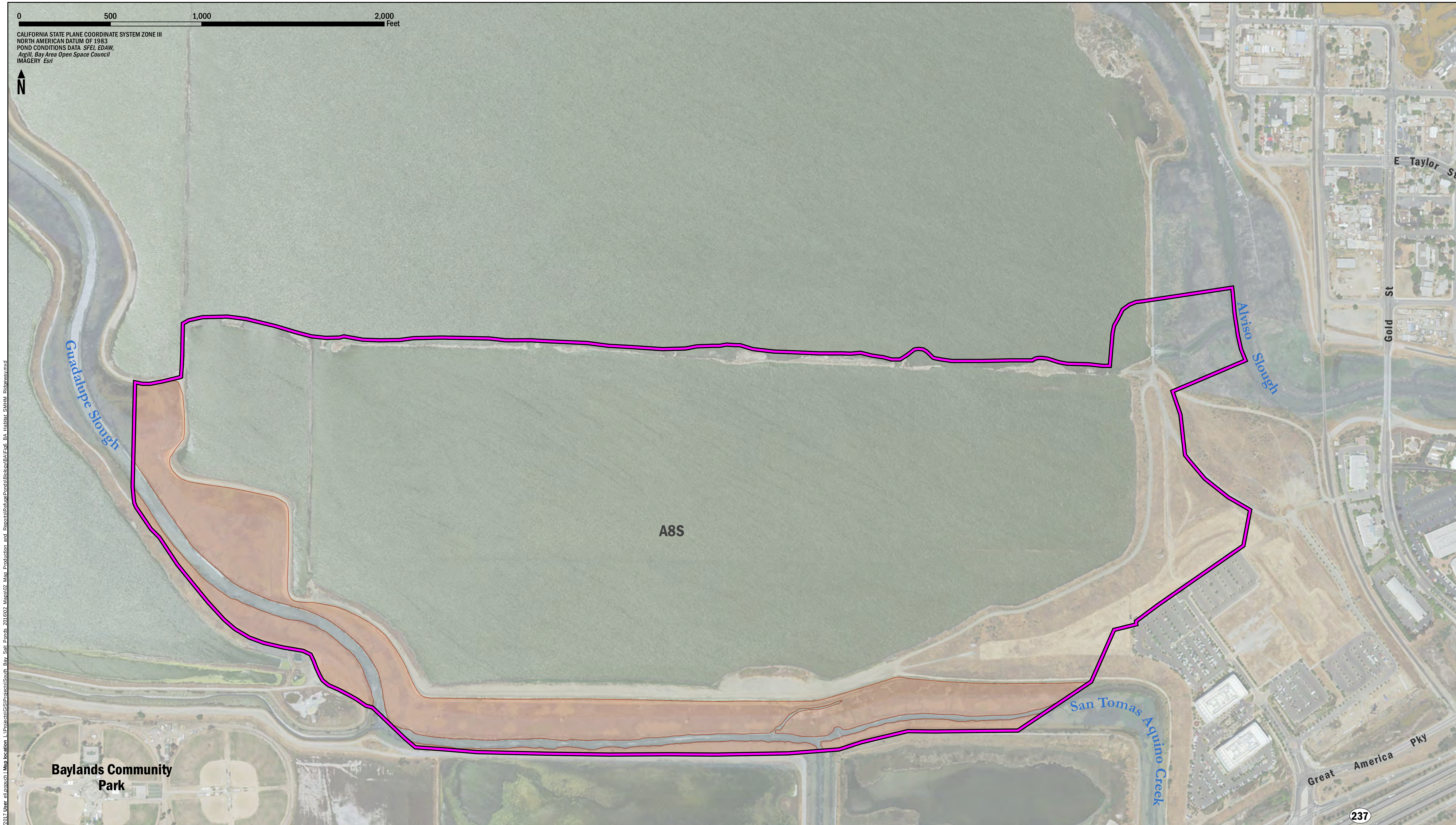
Salt Marsh Harvest Mouse & Ridgway's Rail Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 6a

Salt Marsh Harvest Mouse & Ridgway's Rail Habitat - Alviso Island Ponds



Legend

Phase 2 BA Action Area

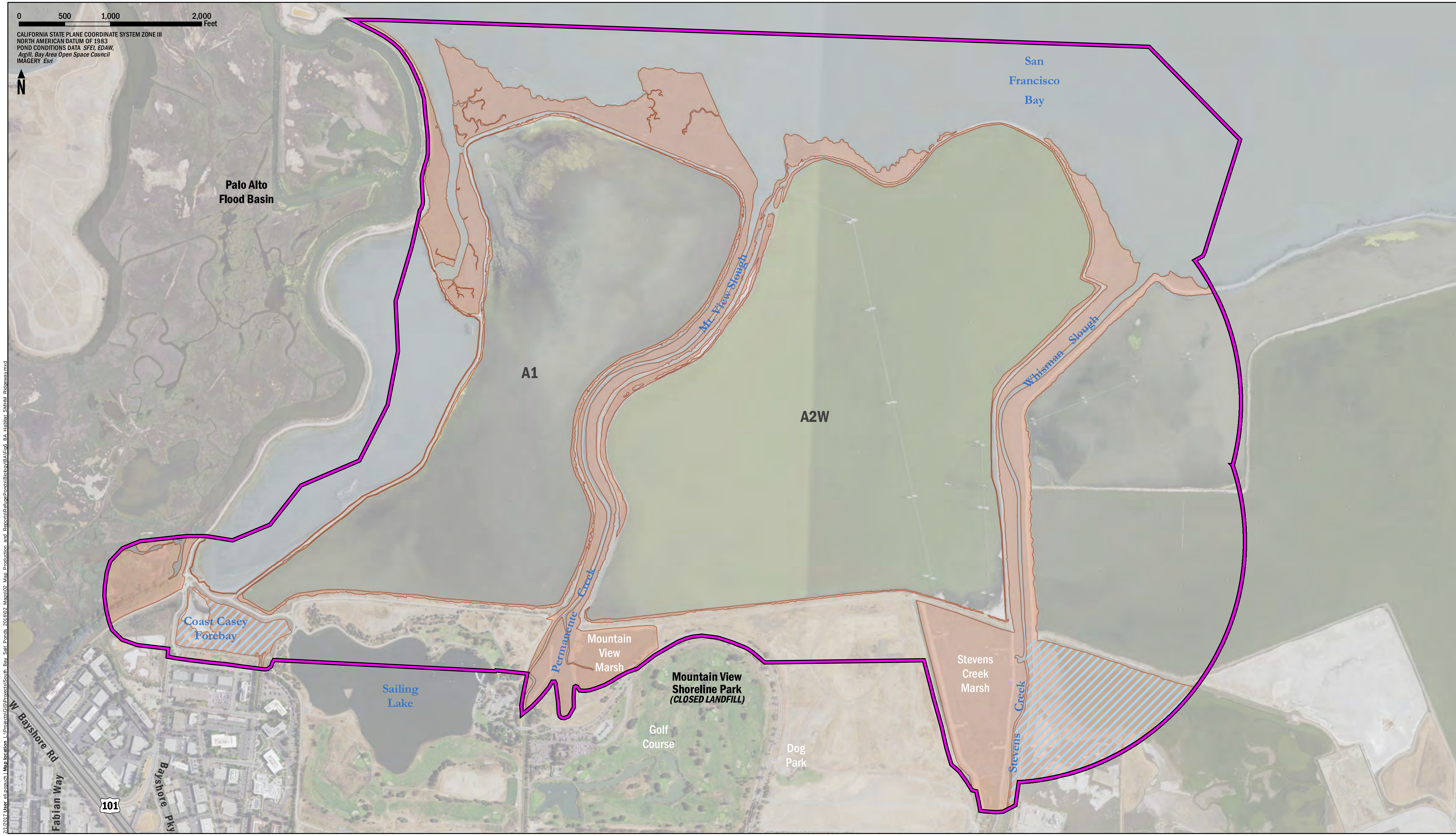
Salt Marsh Harvest Mouse & Ridgway's Rail Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 6b

Salt Marsh Harvest Mouse & Ridgway's Rail Habitat - Alviso A8 Ponds



Legend
- Phase 2 BA Action Area
- Salt Marsh Harvest Mouse & Ridgway's Rail Habitat
- Harvest Mouse Habitat Only (No Ridgway's Rail Habitat Present)

AECOM

South Bay Salt Pond Restoration Project

Figure 6c

Salt Marsh Harvest Mouse & Ridgway's Rail Habitat - Alviso Mountain View Ponds

Legend

Phase 2 BA Action Area

Salt Marsh Harvest Mouse & Ridgway's Rail Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 6d

Salt Marsh Harvest Mouse & Ridgway's Rail Habitat - Ravenswood Ponds

LEGEND

Phase 2 BA Action Area

Snowy Plover Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7c

Snowy Plover Habitat - Alviso Mountain View Ponds

LEGEND

Phase 2 BA Action Area

Snowy Plover Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 7d

Snowy Plover Habitat - Ravenswood Ponds

LEGEND

Phase 2 BA Action Area

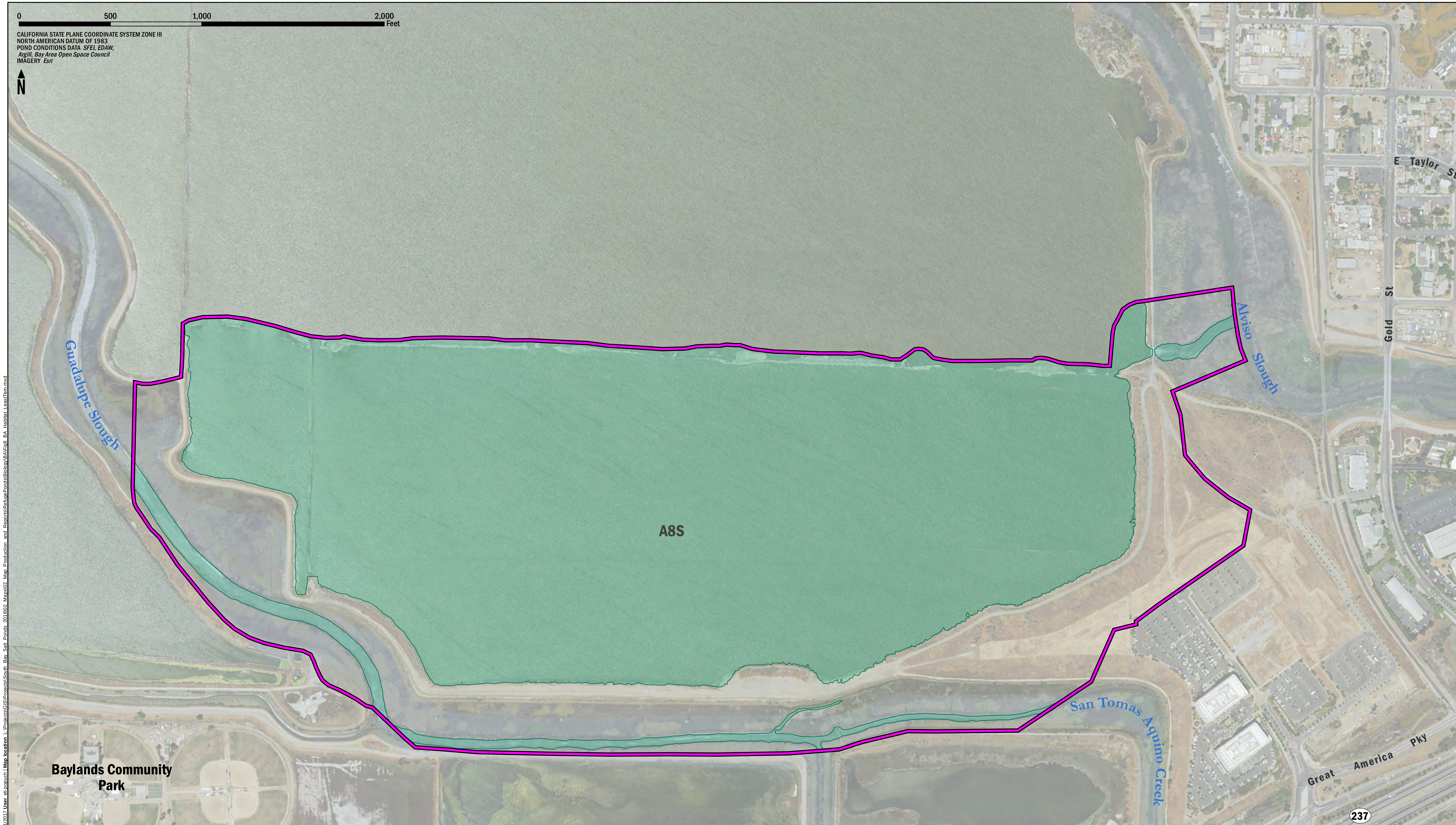
California Least Tern Foraging Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8a

California Least Tern Habitat - Alviso Island Ponds



LEGEND

Phase 2 BA Action Area

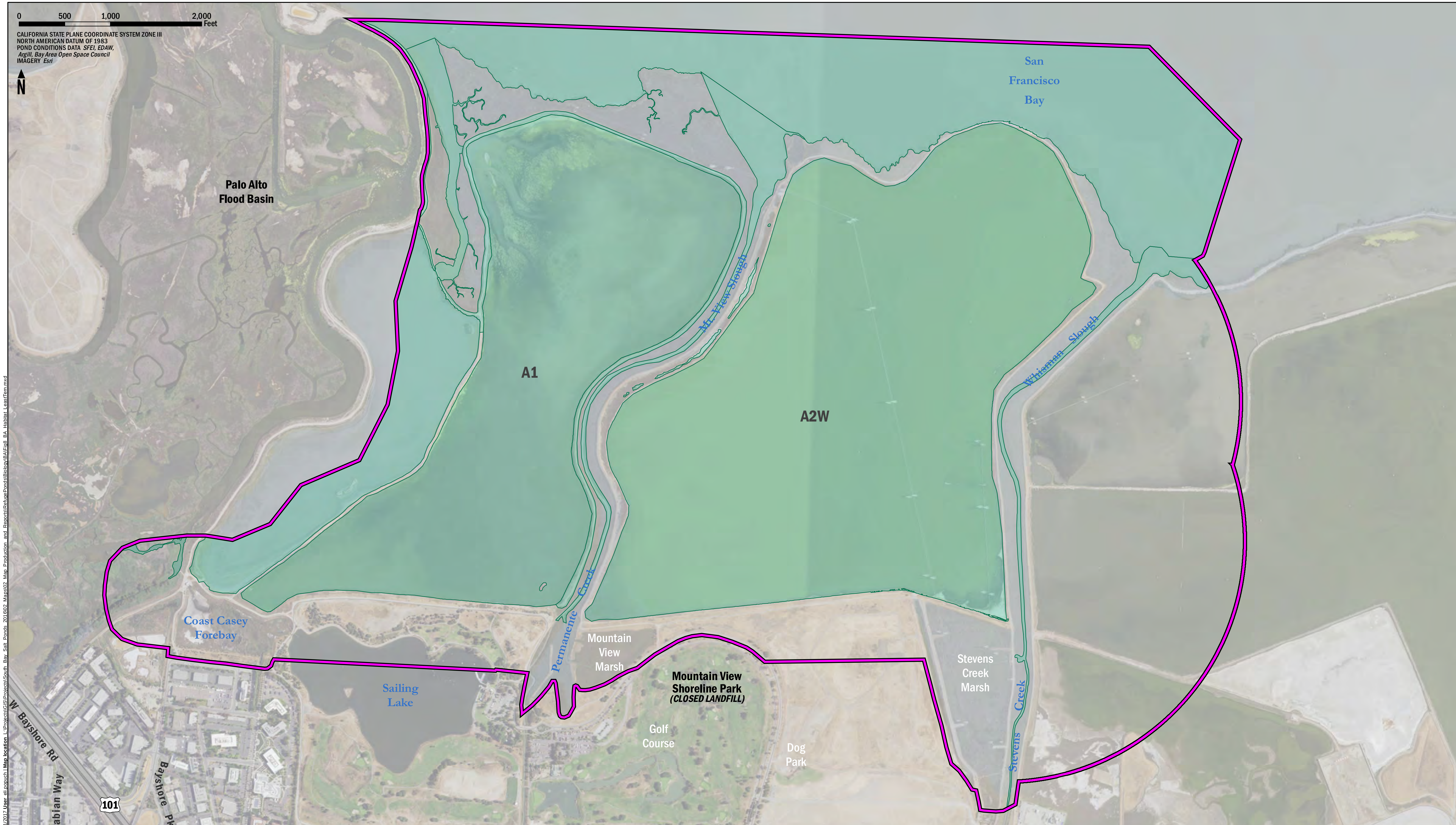
California Least Tern Foraging Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8b

California Least Tern Habitat - Alviso A8 Ponds



LEGEND

Phase 2 BA Action Area

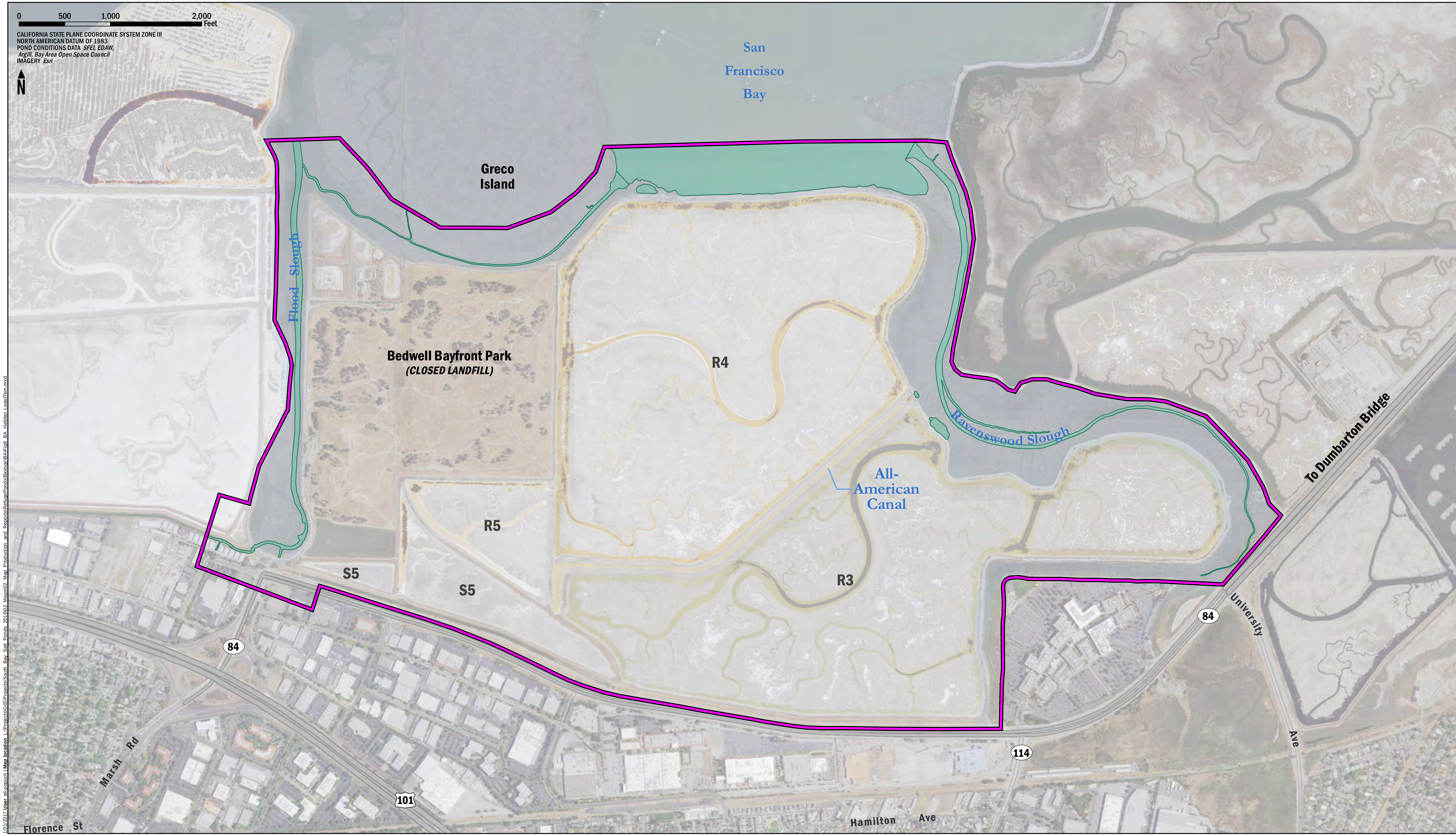
California Least Tern Foraging Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8c

California Least Tern Habitat - Alviso Mountain View Ponds



LEGEND

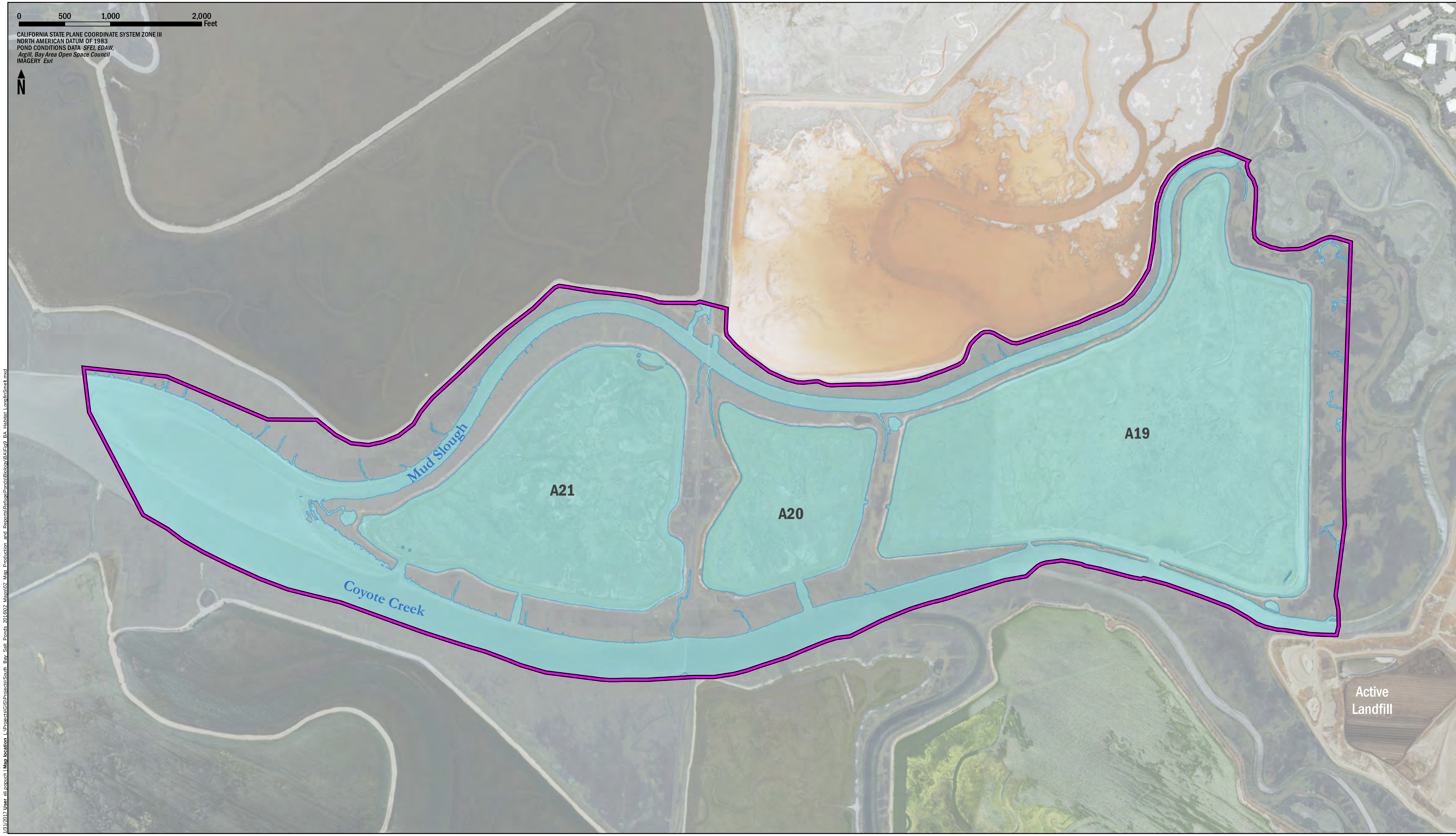
- Phase 2 BA Action Area
- California Least Tern Foraging Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 8d

California Least Tern Habitat - Ravenswood Ponds



1/31/2017 **User** eli.popuch | **Map location** L:\Projects\GIS\Projects\South Bay Salt Ponds 2016\02 Maps\02 Map Production and Reports\RefugePonds\Biology\BA\Fig9 BA Habitat LongfinSmelt.mxd

LEGEND

Phase 2 BA Action Area

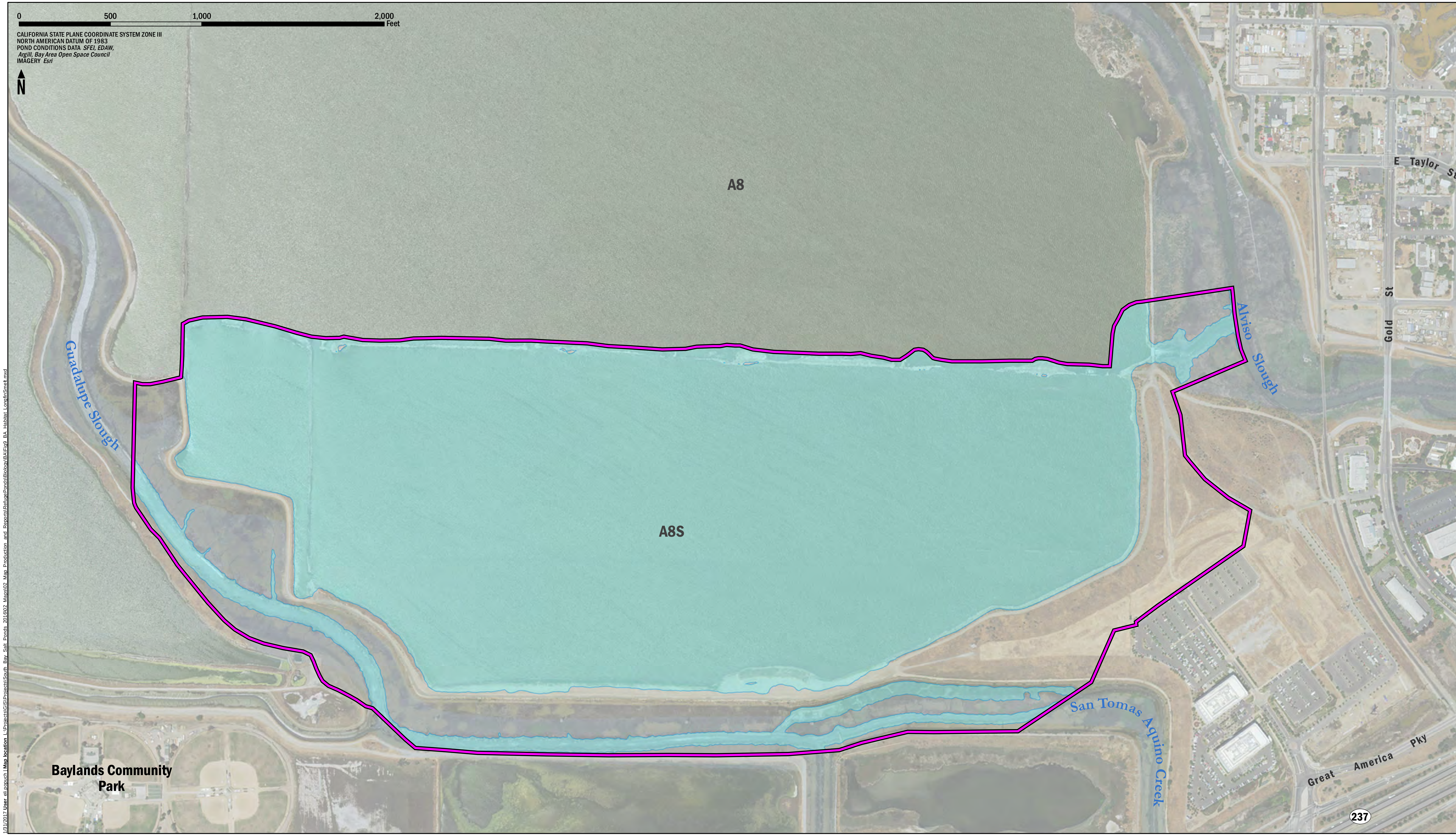
Longfin Smelt Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9a

Longfin Smelt Habitat - Alviso Island Ponds



LEGEND

Phase 2 BA Action Area

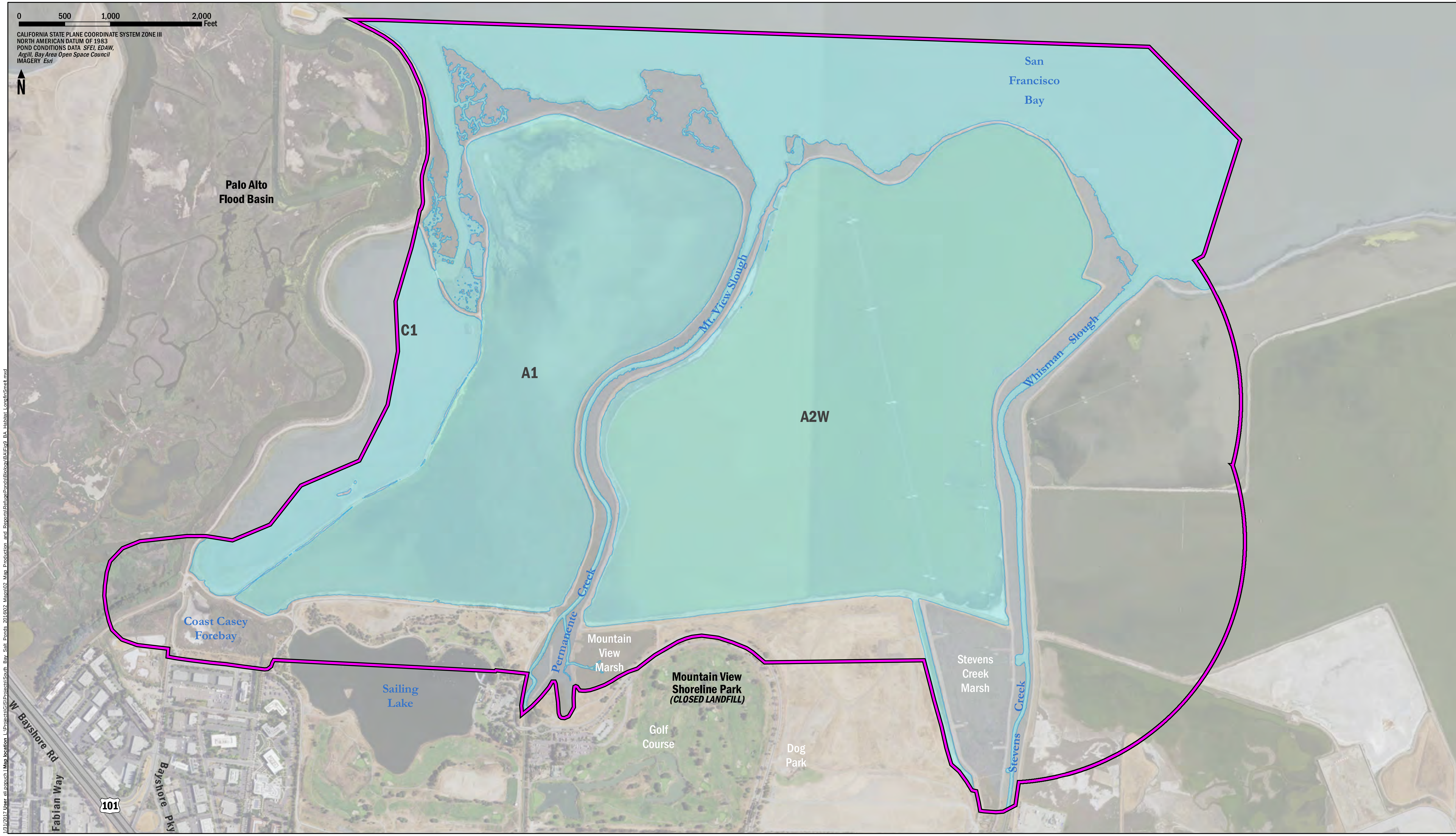
Longfin Smelt Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9b

Longfin Smelt Habitat - Alviso A8 Ponds



LEGEND

Phase 2 BA Action Area

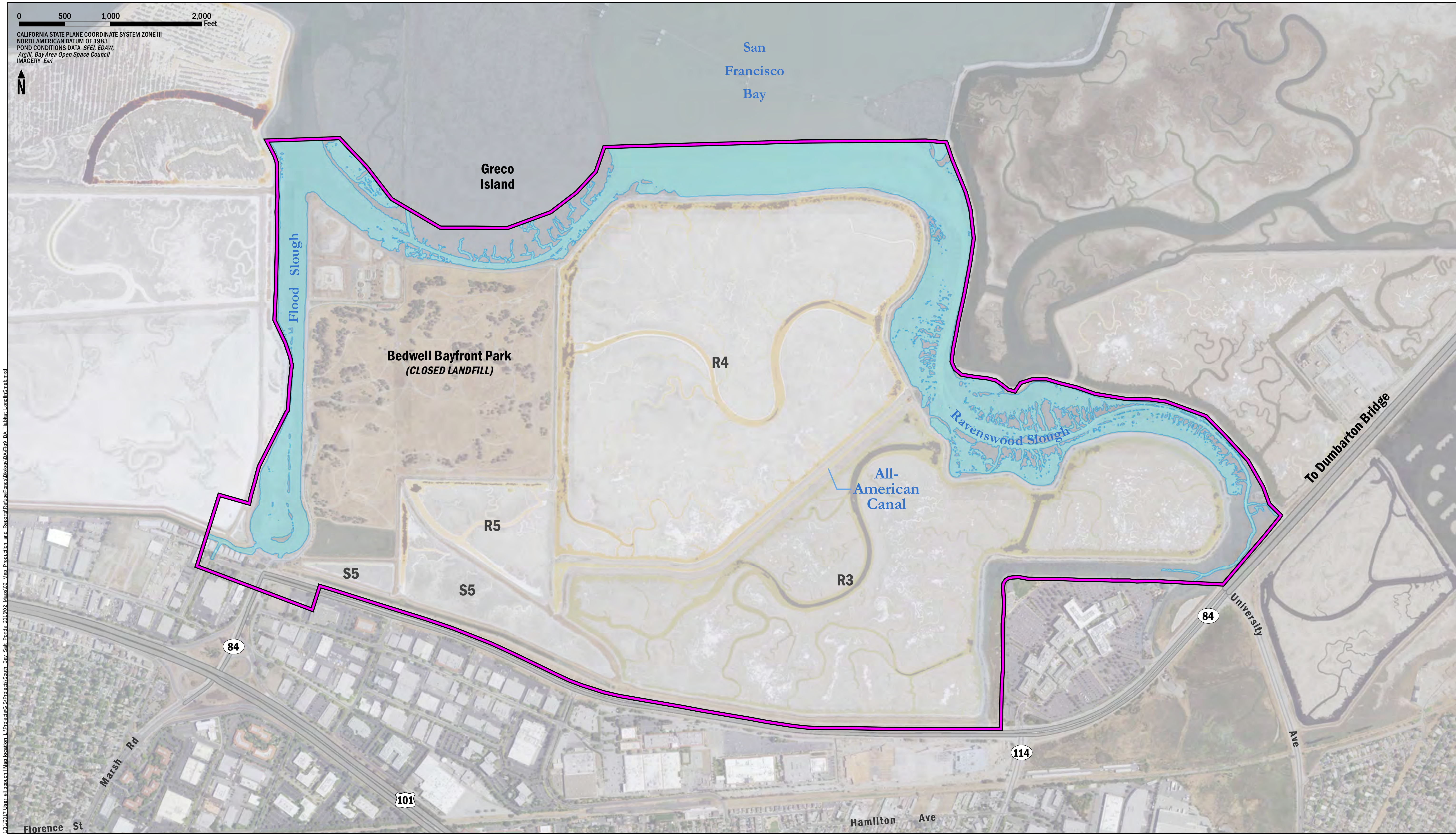
Longfin Smelt Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9c

Longfin Smelt Habitat - Alviso Mountain View Ponds



LEGEND

Phase 2 BA Action Area

Longfin Smelt Habitat

AECOM

South Bay Salt Pond Restoration Project

Figure 9d

Longfin Smelt Habitat - Ravenswood Ponds

9 References

Ackerman, J.T., Herzog, M.P., Hartman, C.A., Watts, T., and Barr, J., 2014, Waterbird egg mercury concentrations in response to wetland restoration in south San Francisco Bay, California: U.S. Geological Survey Open-File Report 2014-1189, 22 p., http://dx.doi.org/10.3133/ofr20141189.

AECOM. 2016. South Bay Salt Pond Restoration Project Final Environmental Impact Statement/Report, Phase 2. Submitted to the U.S. Fish and Wildlife Service, and California State Coastal Conservancy. April. Available online: http://www.southbayrestoration.org/planning/phase2/. [Referred to in text as "Phase 2 EIS/R."]

Albertson, J.D. 1995. Ecology of the California Clapper Rail in South San Francisco Bay. San Francisco, CA: Unpublished Master's Thesis: San Francisco State University. 199 p.

Baxter, R., K. Hieb, S. DeLeon, K. Fleming and J. Orsi (editor). 1999. *Report on the 1980–1995 Fish, Shrimp, and Crab Sampling in the San Francisco Estuary, California*. Interagency Ecological Program for the Sacramento–San Joaquin Estuary. Sacramento, CA: California Department of Fish and Game, 1999.

Bourgeois, J.A. 2017. Personal communication from John Bourgeois, California State Coastal Conservancy, SBSP Executive Project Manager to Dillon Lennebacker (AECOM) provided unpublished data collected by the Refuge for use in this document. January 31, 2017. CDFW (California Department of Fish and Wildlife).

2016a. California Natural Diversity Database (CNDDB). Biogeographic Data Branch, Department of Fish and Game. Available: https://www.wildlife.ca.gov/Data/CNDDB/Data-Updates accessed January 2017

2016b. Monthly Abundance Indices. Available on the Internet at: http://www.dfg.ca.gov/delta/data/fmwt/indices.asp. Accessed April 13, 2016.

Cheng, R.T., V. Casulli, and J.W. Gartner. 1993. Tidal, residual, intertidal mudflat (TRIM) model and its applications to San-Francisco Bay, California. Estuarine, Coastal, and Shelf Science 36(3): 235-280.

DRERIP (Delta Regional Ecosystem Restoration Implementation Plan). (2010). Life History Conceptual Model and Sub-Models for Longfin Smelt, San Francisco Estuary Population.

Donehower, C, K. Tokatlian, C. Robinson-Nilsen, and C. Strong. 2013. Western Snowy Plover Monitoring in the San Francisco Bay Annual Report 2012. Online: http://www.sfbbo.org/docs/RU3_SNPL_Report_2012.pdf

Donehower, C. and K. Tokatlian. 2012. Citizen Science-based Colonial Waterbird Monitoring at the San Francisco Bay Bird Observatory - 2012 Nesting Summary. San Francisco Bay Bird Observatory report prepared for C. Strong and E. Mruz, Don Edwards San Francisco Bay National Wildlife Refuge, and J. Karuse, CDFG, December 29, 2012.

Dooling, Robert J. and Popper, Arthur N. 2007. The Effects of Highway Noise on Birds. Prepared for California Department of Transportation, under Contract 43A0139 for Jones and Stokes Associates.

EDAW, Philip Williams & Associates Ltd., H.T. Harvey & Associates, Brown and Caldwell, and Geomatrix. 2007. South Bay Salt Pond Restoration Project Environmental Impact Statement/Report (Programmatic and Phase 1 document). Submitted to U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and California Department of Fish and Game. March.

ESA-PWA, AMEC, HDR, SCI, and HT Harvey. 2012. Shoreline Regional Park Community Sea Level Rise Study Feasibility Report and Capital Improvement Program. Prepared for City of Mountain View. December.

Evens, J., and G.W. Page. 1983. The ecology of rail populations at Corte Madera Ecological Reserve: with recommendations for management. Report by the Point Reyes Bird Observatory. Stinson Beach, CA. 62 pp.

Fischer, H.B., and G.A. Lawrence. 1983. Currents in South San Francisco Bay. State Water Resources Control Board, California. Report No. UCB/HEL-83/01.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. June 12.

Foxgrover, Amy C., Shawn A. Higgins, Melissa K. Ingraca, Bruce E. Jaffe, and Richard E. Smith. 2004. *Deposition, Erosion, and Bathymetric Change in South San Francisco Bay: 1858-1983*. U.S. Geologic Survey Open-File Report 2004-1192, 2004, 25 pp.

Foxgrover, A.C., B.E. Jaffe, G.T. Hovis, C.A. Martin, J.R. Hubbard, M.R. Samant, and S.M Sullivan. 2007. 2005 Hydrographic Survey of South San Francisco Bay, California, U.S. Geological Survey Open-File Report 2007-1169, 113 pp.

Gill, R.J. 1977. “Breeding Avifauna of the South San Francisco Bay Estuary.” *Western Birds* 8(1): 1-12.

Goals Project. 1999. *Baylands Ecosystem Habitat Goals*. A Report of Habitat Recommendations. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. First Reprint. San Francisco/Oakland, CA: U.S. Environmental Protection Agency/San Francisco Bay Regional Water Quality Control Board, June 2000.

Goals Project. 2000. *Baylands Ecosystem Species and Community Profiles: Life Histories and Environmental Requirements of Key Plants, Fish and Wildlife*. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project, P.R. Olofson, ed. Oakland, CA: San Francisco Bay Regional Water Quality Control Board, 2000.

Goals Project. 2015. The Baylands and Climate Change: What We Can Do. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

Grenier, L., M. Marvin-DiPasquale, D. Drury, J. Hunt, A. Robinson, S. Bezalel, A. Melwani, J. Agee, E. Kakouros, L. Kieu, L. Windham-Myers, and J. Collins. 2010. South Baylands Mercury Project. Final Report. Prepared for the California State Coastal Conservancy by San Francisco Estuary Institute, U.S. Geological Survey, and Santa Clara Valley Water District, February 10, 2010. 97 pp.

Hobbs, J., P. Moyle, and N. Buckmaster. 2012 Monitoring the Response of Fish Communities to Salt Pond Restoration: Final Report. Online: http://www.southbayrestoration.org/documents/technical/110712_Final%20Report_Monitoring%20the%20Respons%20of%20Fish%20Assemblages.pdf

H. T. Harvey & Associates, Philip William and Associates, EDAW, and Brown and Caldwell. 2005. Biology and Habitats Existing Conditions Report. March 2005. Online: http://www.southbayrestoration.org/pdf_files/Biology_Habitats_Existing_Conditions.3.25.05.pdf

H. T. Harvey & Associates. 2006. Marsh Studies in South San Francisco Bay: 2005-2008. California Clapper Rail and Salt Marsh Harvest Mouse Survey Report, 2006. Project No. 477-28. San Jose, California: Prepared for City of San Jose.

Hurt, R. 2004. (USFWS) email message to S. Rottenborn and L. Henkel, dated 6 August 2004. As cited in the SPSP Programmatic BA.

Krone, R.B. 1996. "Recent Sedimentation in the San Francisco Bay System." J.T. Hollibaugh, editor. San Francisco Bay: The Ecosystem: Pacific Division of the American Association for the Advancement of Science.

Liu, L., M. Herzog, N. Nur, P. Abbaspour, A. Robinson, and N. Warnock. 2005. *San Francisco Bay Tidal Marsh Project Annual Report 2005. Distribution, Abundance, and Reproductive Success of Tidal Marsh Birds*. Prepared by Point Reyes Bird Observatory (PRBO) Conservation Science, December 31, 2005.

Mejia, F., M.K. Saiki, and J.Y. Takekawa. 2008. Relation between species assemblages of fishes and water quality in salt ponds and sloughs in South San Francisco Bay. The Southwestern Naturalist 53(3):335-345. Moyle, P. B. 2002. Inland Fishes of California. University of California Press. Chapter: Smelts, Osmeridae. p.234-239.

Monsen, N.E., J.E. Cloem, and L.V. Lucas. 2002. A comment on the use of flushing time, residence time, and age as transport time scales. Limnol Oceanogr 47(5):1545-1553.

Olofson Environmental, Inc. 2015. California Ridgway's Rail Surveys for the San Francisco Estuary Invasive Spartina Project 2015. Online: http://www.spartina.org/documents/RIRA_Report_2015_FINAL(sm).pdf.

Page, G.W., L.E. Stenzel, and J.E. Kjelmyr. 1999. "Overview of Shorebird Abundance and Distribution in Wetlands of the Pacific Coast of the Contiguous United States." *The Condor* 101(no. 3): 461–471.

Pearl, B., K. Tokatlian, and J. Scullen. 2015. Western Snowy Plover Monitoring in the San Francisco Bay Annual Report 2015. Online: http://www.sfbbo.org/docs/RU3_SNPL_Report_2015.pdf.

Powell, T., J. Cloern, and L. Huzzey. 1989. Spatial and temporal variability in South San Francisco Bay (USA). Horizontal distributions of salinity, suspended sediments, and phytoplankton biomass and productivity. Estuarine Coastal and Shelf Science 28(6):583–597.

Rosenfield, J.A. and R.D. Baxter. 2007. Population Dynamics and Distribution Patterns of Longfin Smelt in the San Francisco Estuary. Transaction of America Fisheries Society, 136: 1557-1592.

Ryan, T.P. and J.L. Parkin. 1998. The Western Snowy Plover in southern San Francisco Bay: summary of detections made during colonial waterbird monitoring surveys from 1981 to 1997. Alviso, CA: San Francisco Bay Bird Observatory. 19 p. SCVWD (Santa Clara Valley Water District) and U.S. Fish and Wildlife Service, Don Edwards National Wildlife Refuge, J. C. Callaway, L.M. Schile, and E.R. Herbert. 2010. Island Ponds Mitigation Monitoring and Reporting, Year 4 – 2009. January 2010.

SCVWD (Santa Clara Valley Water District) and U.S. Fish and Wildlife Service, Don Edwards National Wildlife Refuge.2016. Island Ponds Mitigation Monitoring and Reporting, Year 10 – 2015. Online:http://www.southbayrestoration.org/monitoring/Island%20Ponds%20Year%2010%20Monitoring%20Report.pdf.

Schoellhamer, D.H. 1996. *Factors affecting suspended solids concentrations in South San Francisco Bay, California*. Journal of Geophysical Research Vol. 100, No. C5, 12.087–12.095.

Shellenbarger, G.G., S.A. Wright, and D.H. Schoellhamer. 2013. *A sediment budget for the southern reach in San Francisco Bay, CA: Implications for habitat restoration*. Marine Geology 345 (2013) 281–293.

Shellenbarger, Gregory G., Maureen A. Downing-Kunz, and David H. Schoellhamer. 2014. "Suspended-Sediment Dynamics in the Tidal Reach of a San Francisco Bay Tributary." In: *Proceedings of the 17th Physics of Estuaries and Coastal Seas (PECS) Conference*, Porto de Galinhas, Pernambuco, Brazil, 19–24 October 2014.

Schemel, L.E. 1995. Measurements of salinity, temperature, and tides in South San Francisco Bay, California, at Dumbarton Bridge: 1990-1993 water years. U.S. Geological Survey. Report No. Open-File Report 98-650.

Shuford, W.D., and T. Gardali, eds. 2008. *California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California*. Studies of Western Birds No. 1. Western Field Ornithologists. Camarillo, CA, and Sacramento, CA: California Department of Fish and Game, 4 February 2008.

Siegel, S.W., and P.A.M. Bachand. 2002. *Feasibility Analysis: South Bay Salt Pond Restoration*. San Rafael, CA: Wetlands and Water Resources, 2002, 228 pp.

Strong C.M. and R. Dakin R. 2004. Western Snowy Plover breeding season surveys for 2003. Unpubl. report. Alviso: San Francisco Bay Bird Observatory, Alviso, California.

Strong, C. M., N. Wilson, and J. D. Albertson. 2004. Western Snowy Plover numbers, nesting success and avian predator surveys in the San Francisco Bay, 2004. Unpublished report. San Francisco Bay Bird Observatory, Alviso, CA.

Tokatlian, K., J. Scullen, C. Burns. 2014. Western Snowy Plover Monitoring in the San Francisco Bay Annual Report 2014. Online: http://www.sfbbo.org/docs/RU3_SNPL_Report_2014.pdf.

Trulio, L.A., J.C. Callaway, E.S. Gross, J.R. Lacy, F.H. Nichols, and J.Y. Takekawa. 2004. *South Bay Salt Pond Restoration Project Science Strategy: A Framework for Guiding Scientific Input into the Restoration Process*. Unpublished Report to the State Coastal Conservancy, Oakland, CA, April 4, 2004.

URS. 2013. Delineation of Jurisdictional Wetlands for SBSP Restoration Project Phase 2.

USFWS (U.S. Fish and Wildlife Service). 1984. Salt marsh harvest mouse and California Clapper Rail Recovery Plan. Portland: U. S. Fish and Wildlife Service. 141 pp.

USFWS (U.S. Fish and Wildlife Service). 2008. 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). Online: http://www.southbayrestoration.org/pdf_files/SBSP%20FWS%20BO%20to%20Corps.pdf. [Referred to in text as "Programmatic Biological Opinion."]

USFWS (U.S. Fish and Wildlife Service). 2009. Endangered and Threatened Wildlife and Plants: 12-Month Finding on a Petition to List the San Francisco Bay-Delta Population of the Longfin Smelt (Spirinchus thaleichthys) as Endangered. Federal Register 74(67). 16169-16175. April 9, 2009:

USFWS (U.S. Fish and Wildlife Service). 2010. 5-Year Review: Summary and Review, *Suaeda californica* (California sea-blite). Ventura Fish and Wildlife Office. U. S. Fish and Wildlife Service. February 2010. Online: http://ecos.fws.gov/docs/five_year_review/doc3227.pdf

USFWS (U.S. Fish and Wildlife Service). 2012a. Formal Consultation for the Proposed San Francisco Estuary Invasive Spartina Project: *Spartina* (ISP) Control Program and Restoration for 2012 on 188 sites; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties. Sacramento Fish and Wildlife Office. U. S. Fish and Wildlife Service. August 2012. Online: http://www.spartina.org/project_documents/2012_Spartina_BO_web.pdf

USFWS (U.S. Fish and Wildlife Service). 2012b. Endangered and Threatened Wildlife and Plants; 12-month Finding on a Petition to List the San Francisco Bay-Delta Population of the Longfin Smelt as Endangered or Threatened. San Francisco Bay-Delta Fish and Wildlife Office, Sacramento, CA.

USFWS (U.S. Fish and Wildlife Service). 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California, vol. 1. Online: https://www.fws.gov/sfbaydelta/documents/tidal_marsh_recovery_plan_v1.pdf.

USFWS (U.S. Fish and Wildlife). 2016a. Sacramento Fish and Wildlife Office Species Profiles. Online: http://www.fws.gov/sacramento/es_species/Lists/es_species_lists-form.cfm

USFWS (U.S. Fish and Wildlife). 2016b. Guidance for Preparing a Biological Assessment. Online: https://www.fws.gov/midwest/endangered/section7/ba_guide.html.

USFWS, USACOE and CDFG (United States Fish and Wildlife Service, United States Army Corps of Engineers, and California Department of Fish Game). 2007. South Bay Salt Pond Restoration Project Draft Biological Assessment. Online: http://www.southbayrestoration.org/documents/permit-related/

USFWS and CDFG (United States Fish and Wildlife Service and California Department of Fish Game). 2003. South Bay Salt Ponds Initial Stewardship Plan. Prepared by Life Science! June 2003.

Valoppi, Laura. 2016. Personal communication from Laura Valoppi, U.S. Geological Survey; SBSP Restoration Project Science Team Leader. Provided as-yet unpublished data for use in this document. April 12, 2016.

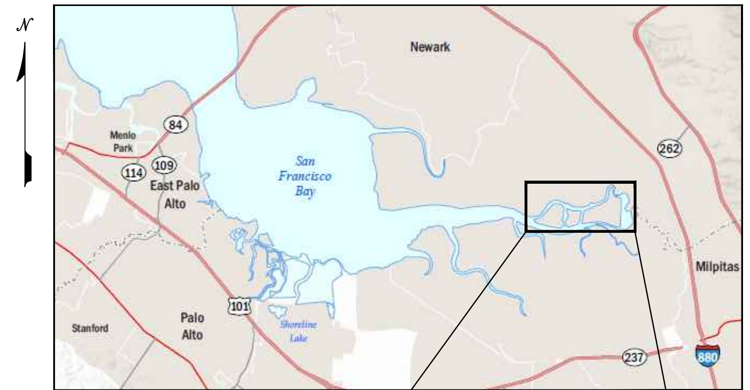
Walters, R.A., R.T. Cheng, and T.J. Conomos. 1985. "Time Scales of Circulation and Mixing Processes of San Francisco Bay Waters." *Hydrobiologia* 129: 13–36.

Wetlands Research Associates. 1994. Biological evaluation for dredge lock use and levee maintenance. Prepared by Wetland Research Associates for the U.S. Army Corps of Engineers.

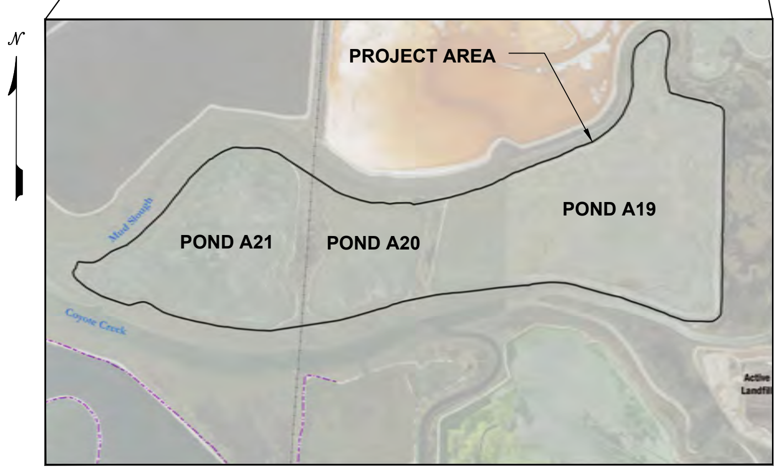
Appendix A.
Engineering Designs

SOUTH BAY SALT POND RESTORATION PROJECT

ISLAND PONDS
NEAR ALVISO, CALIFORNIA



VICINITY MAP
NTS



LOCATION MAP
NTS

PROJECT AREA PHOTO

Dec 14, 2016 - 4:37pm
C:\pwworking\aecom_na\chandrasekaran\dms75825\IP_T-1.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE ISLAND PONDS TITLE SHEET

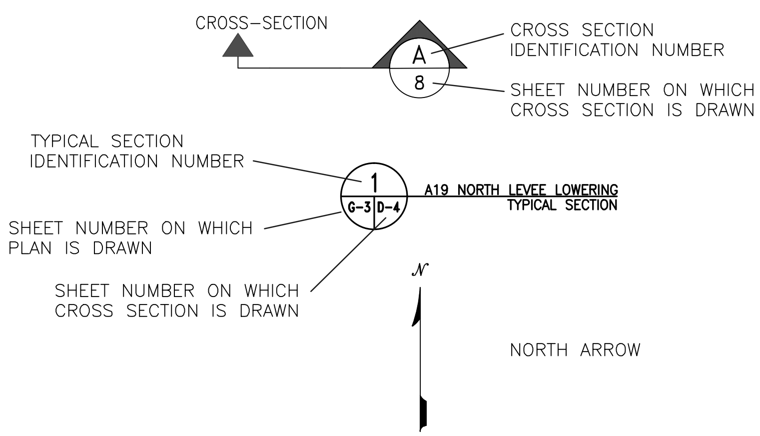
SHEET NO. SHT. 1 OF 23 SHTS.
REV
DWG NO. T-1

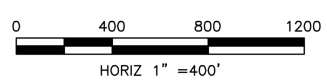
LEGEND

LINETYPES

- ALIGNMENT CENTERLINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DAYLIGHT LINE
- CREW VEHICLE ACCESS ROUTE
- CONSTRUCTION EQUIPMENT ACCESS ROUTE
- PROPOSED EARTHWORK CUT
- STAGING AREA

SYMBOLS





SCALE BAR

ABBREVIATIONS

℄	CENTERLINE
EL	ELEVATION
FT	FEET
HORIZ.	HORIZONTAL
NTS	NOT TO SCALE
STA	STATION
TYP	TYPICAL
VERT.	VERTICAL

GENERAL NOTES

1. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM ARE AS FOLLOWS:
   COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 3
   VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
2. PROJECT SITE TOPOGRAPHY IS BASED ON LIDAR DATA OBTAINED FROM AIRBORNE1 IN U.S. SURVEY FEET, DATED JUNE–NOVEMBER 2010. BATHYMETRY DATA FOR COYOTE CREEK AND MUD SLOUGH IS FROM THE 2005 HYDROGRAPHIC STUDY OF SOUTH SAN FRANCISCO BAY.
3. PROPOSED TOPOGRAPHIC CONTOUR INFORMATION IS SHOWN AT 1–FOOT CONTOUR INTERVALS, UNLESS OTHERWISE STATED.
4. ALL CONSTRUCTION AND CONSTRUCTION MATERIAL SHALL BE IN ACCORDANCE WITH THESE PLANS.
5. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BE KNOWLEDGEABLE ABOUT AND OBEY ALL PERMIT REQUIREMENTS WHILE PERFORMING THE WORK ON THESE PLANS.
6. THE CONTRACTOR SHALL PRACTICE SAFETY AT ALL TIMES AND SHALL FURNISH, ERECT, AND MAINTAIN SUCH FENCES, BARRICADES, LIGHTS, AND SIGNS NECESSARY TO GIVE ADEQUATE PROTECTION TO THE PUBLIC AT ALL TIMES.
7. THE CONTRACTOR SHALL HAVE COPIES OF THE APPROVED PLANS AND SPECIFICATIONS FOR THIS PROJECT AT ALL TIMES AND SHALL BE FAMILIAR WITH ALL APPLICABLE STANDARDS AND SPECIFICATIONS.
8. THE CONTRACTOR IS RESPONSIBLE FOR SETTING ONSITE SURVEY CONTROL FOR CONSTRUCTION STAKING IN PROJECT COORDINATE SYSTEM AND VERTICAL DATUM.
9. UNDERGROUND FACILITIES AND SUB–STRUCTURES SHOWN IN THESE PLANS WERE OBTAINED FROM THE BEST AVAILABLE SOURCES. HOWEVER, SINCE SOME INFORMATION WAS OBTAINED FROM OTHERS, AECOM CANNOT GUARANTEE SAID INFORMATION AS BEING ACCURATE. PRIOR TO BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY THE DEPTH AND LOCATION OF ALL EXISTING UTILITIES, EQUIPMENT, AND SUB–STRUCTURES. IN THE EVENT OF DAMAGE TO EXISTING UTILITIES, EQUIPMENT, OR SUB–STRUCTURES, THE CONTRACTOR SHALL PERFORM ALL REPAIRS AT THEIR EXPENSE.
10. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY OF ALL EXCAVATIONS.

EARTHWORK SUMMARY

LEVEE REMOVAL	8,900 CY (CUT, BANK–MEASURE)
LEVEE LOWERING	12,700 CY (CUT, BANK–MEASURE)
BREACH EXCAVATION	3,900 CY (CUT, BANK–MEASURE)
DITCH BLOCKS	11,000 CY (FILL, ASSUMING NO SHRINKAGE)
DITCH FILL	14,500 CY (FILL, ASSUMING NO SHRINKAGE)

Dec 02, 2016 - 12:14pm C:\pwworking\aecom_na\chandrasekaranl\dms75825\IP_T-2.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY AECOM 300 Lakeside Drive, Suite 400 Oakland, CA 94612 Tel: (510) 893-3600 aecom.com

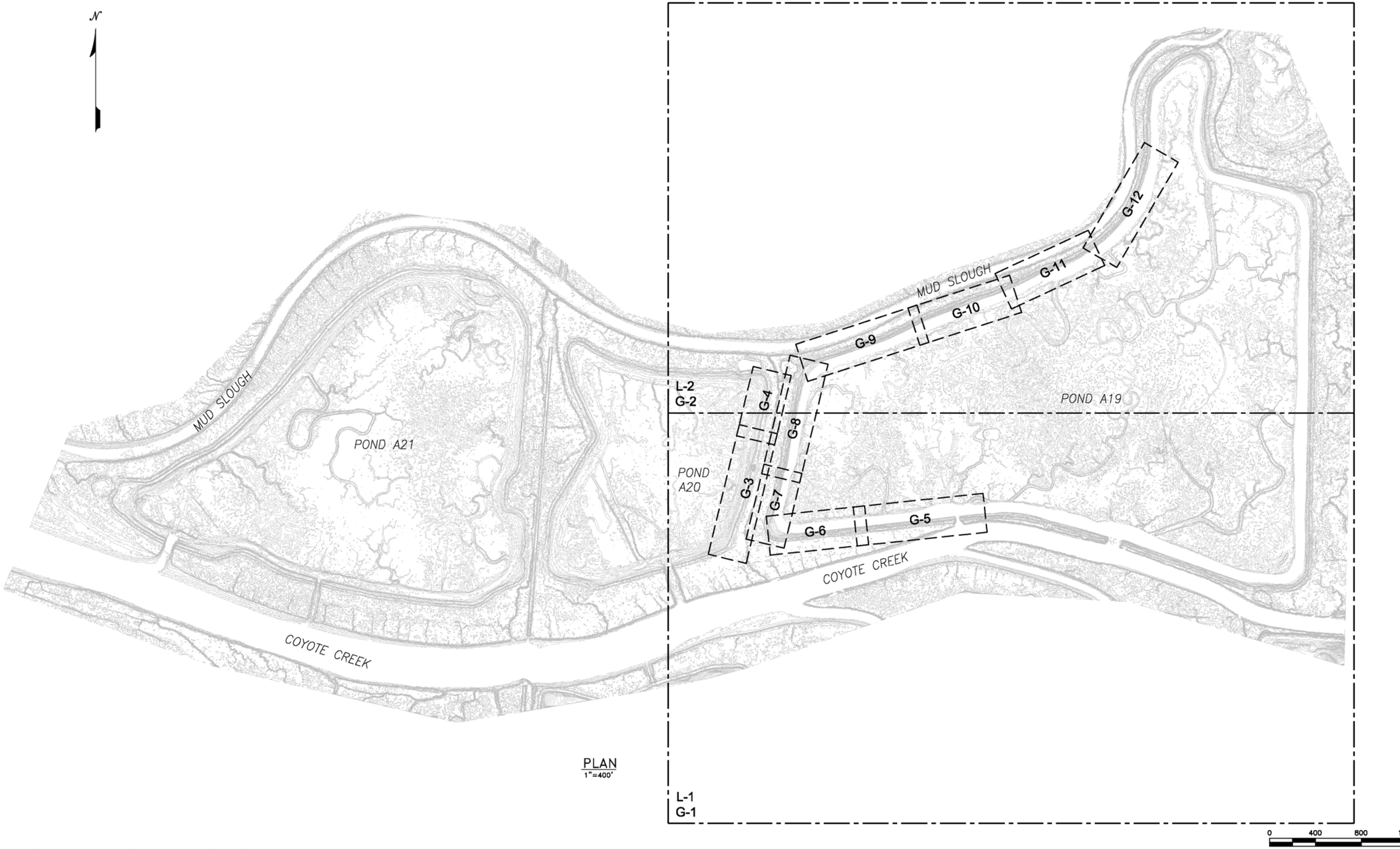
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 11-30-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE ISLAND PONDS NOTES AND LEGEND

SHEET NO. SHT. 2 OF 23 SHTS. REV
DWG NO. T-2



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

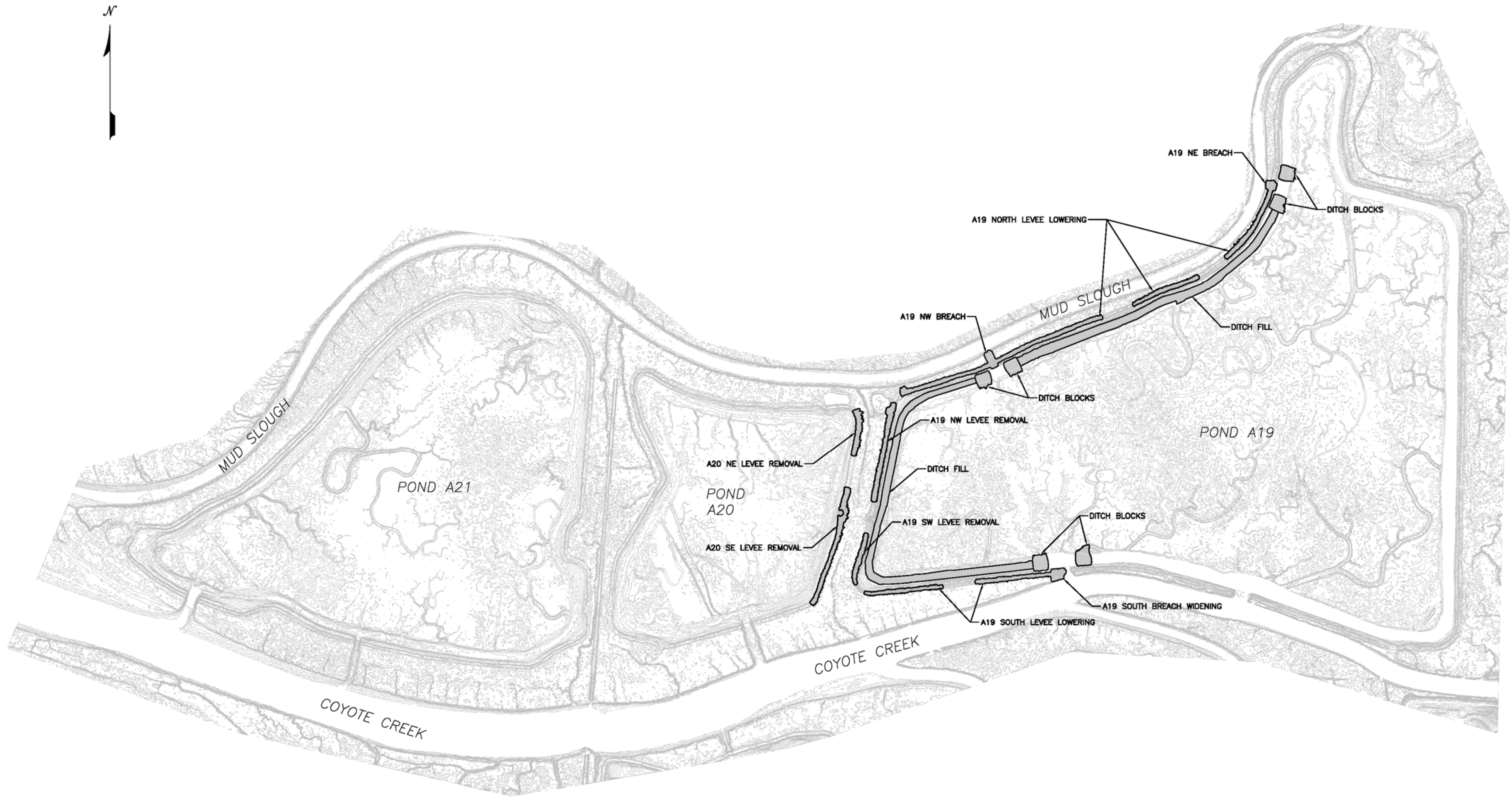
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
KEY MAP

SHEET NO. SHT. 3 OF 23 SHTS.
REV
DWG NO. T-3



PLAN
1"=400'

0 400 800 1200
HORIZ 1" = 400'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
GENERAL ARRANGEMENT PLAN

SHEET NO. SHT. 4 OF 23 SHTS.
REV
DWG NO. T-4

Dec 02, 2016 - 12:34pm

N

NOTES

1. THE CREW VEHICLE ACCESS ROUTE FROM THE FREMONT BOULEVARD EXIT OFF OF INTERSTATE 88 IS NOT SUITABLE FOR HEAVY CONSTRUCTION EQUIPMENT AND IS TO BE USED ONLY FOR CREW VEHICLES.
2. CONSTRUCTION EQUIPMENT WOULD BE OFFLOADED INTO MUD SLOUGH AT CUSHING PARKWAY AND FLOATED ACROSS THE SLOUGH, PER THE INDICATED CONSTRUCTION EQUIPMENT ACCESS ROUTE.
3. THE CONTRACTOR MAY LOCATE VEHICLES AND CONSTRUCTION EQUIPMENT WITHIN THE INDICATED STAGING AREA. EXTENT OF STAGING AREA TO BE NEGOTIATED.

PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

Dec 08, 2016 - 11:52am
C:\pwworking\aecom_na\lchandrasekaran\dms75825\IP_T-5.dwg

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

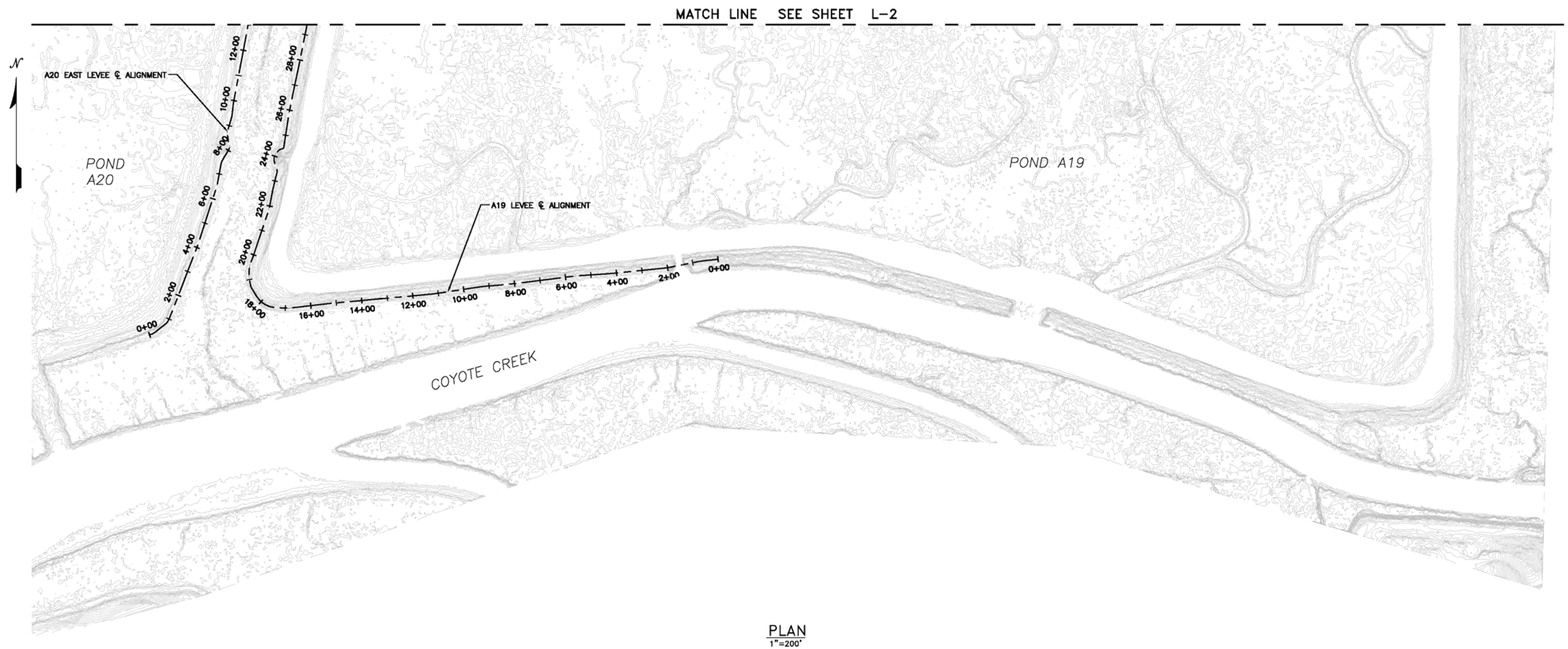
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

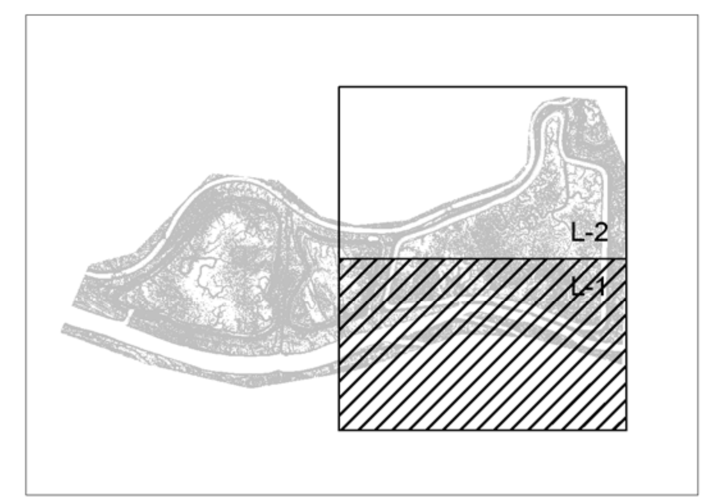
PROJECT No. 60422372
DATE 11-30-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE ISLAND PONDS ACCESS ROUTE & STAGING PLAN

SHEET NO. SHT. 5 OF 23 SHTS.
REV
DWG NO. T-5



PLAN
1"=200'



0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

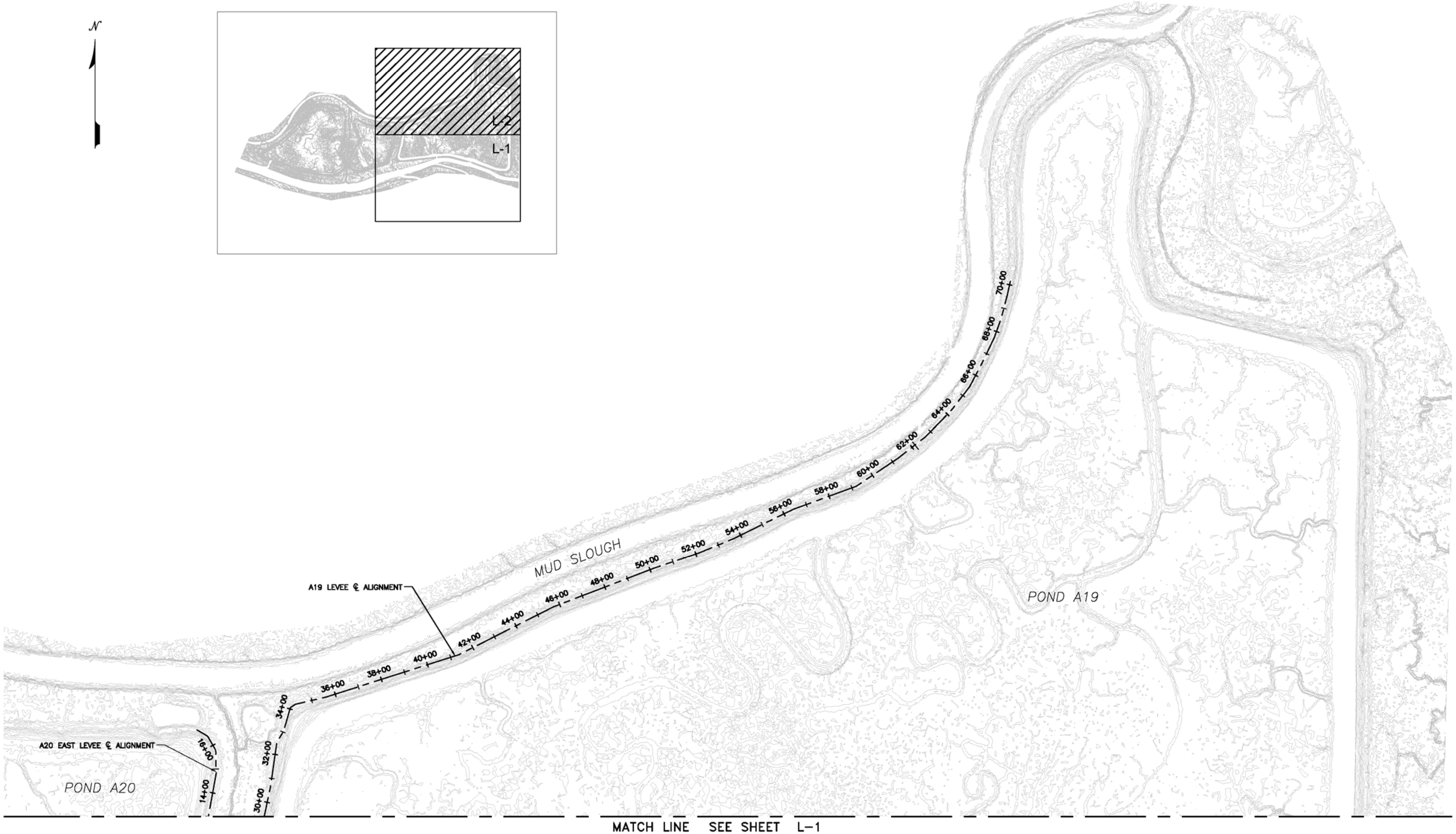
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
LAYOUT PLAN
SHEET 1 OF 2

SHEET NO. SHT. 6 OF 23 SHTS.
REV
DWG NO. L-1



PLAN
1"=200'

0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

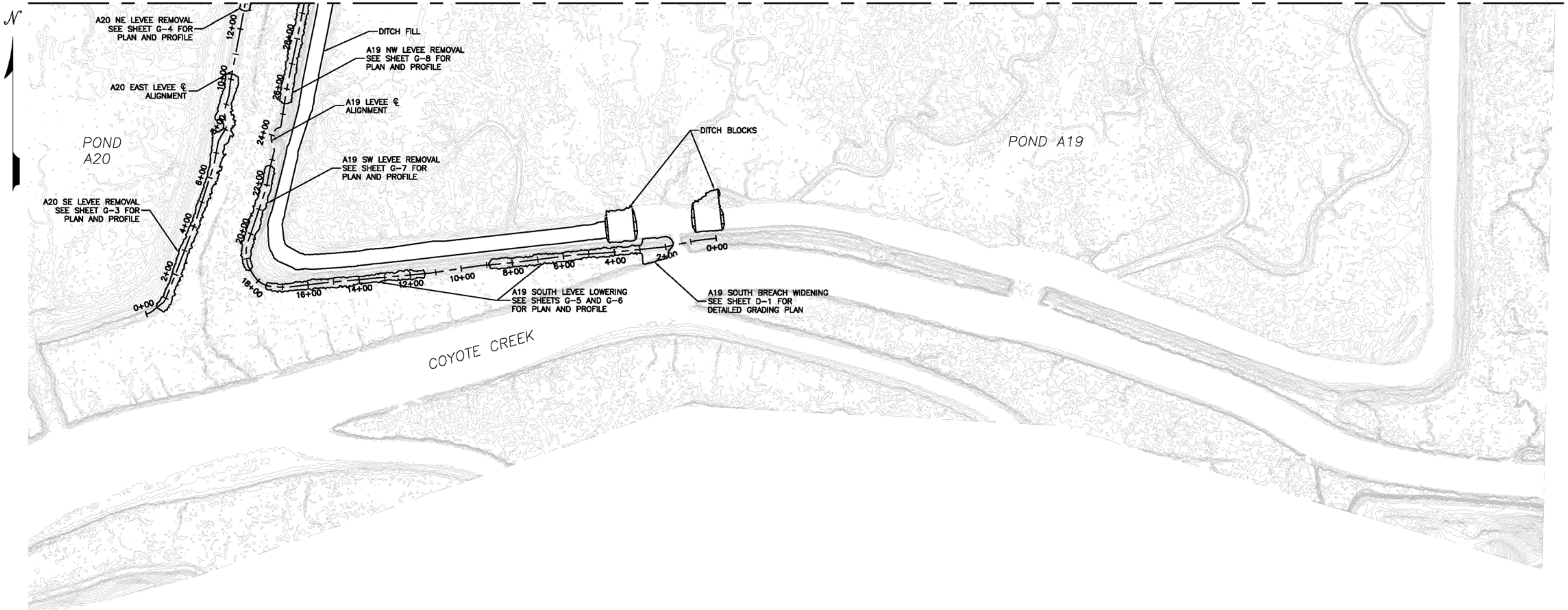
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
LAYOUT PLAN
SHEET 2 OF 2

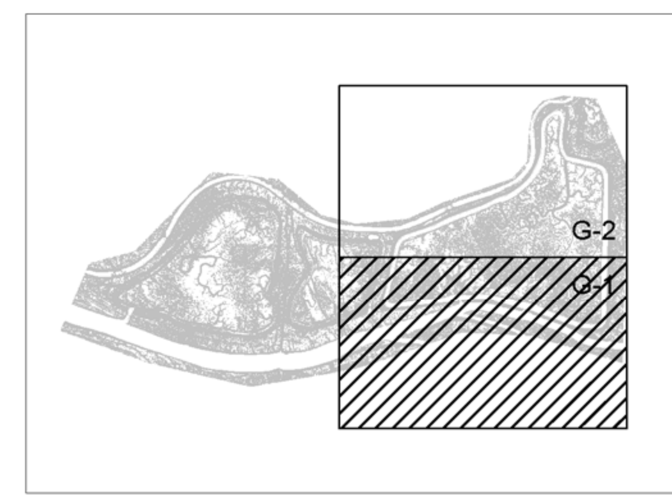
SHEET NO. SHT. 7 OF 23 SHTS.
REV
DWG NO. L-2

Dec 09, 2016 - 9:51am

MATCH LINE SEE SHEET G-2



PLAN
1"=200'



0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

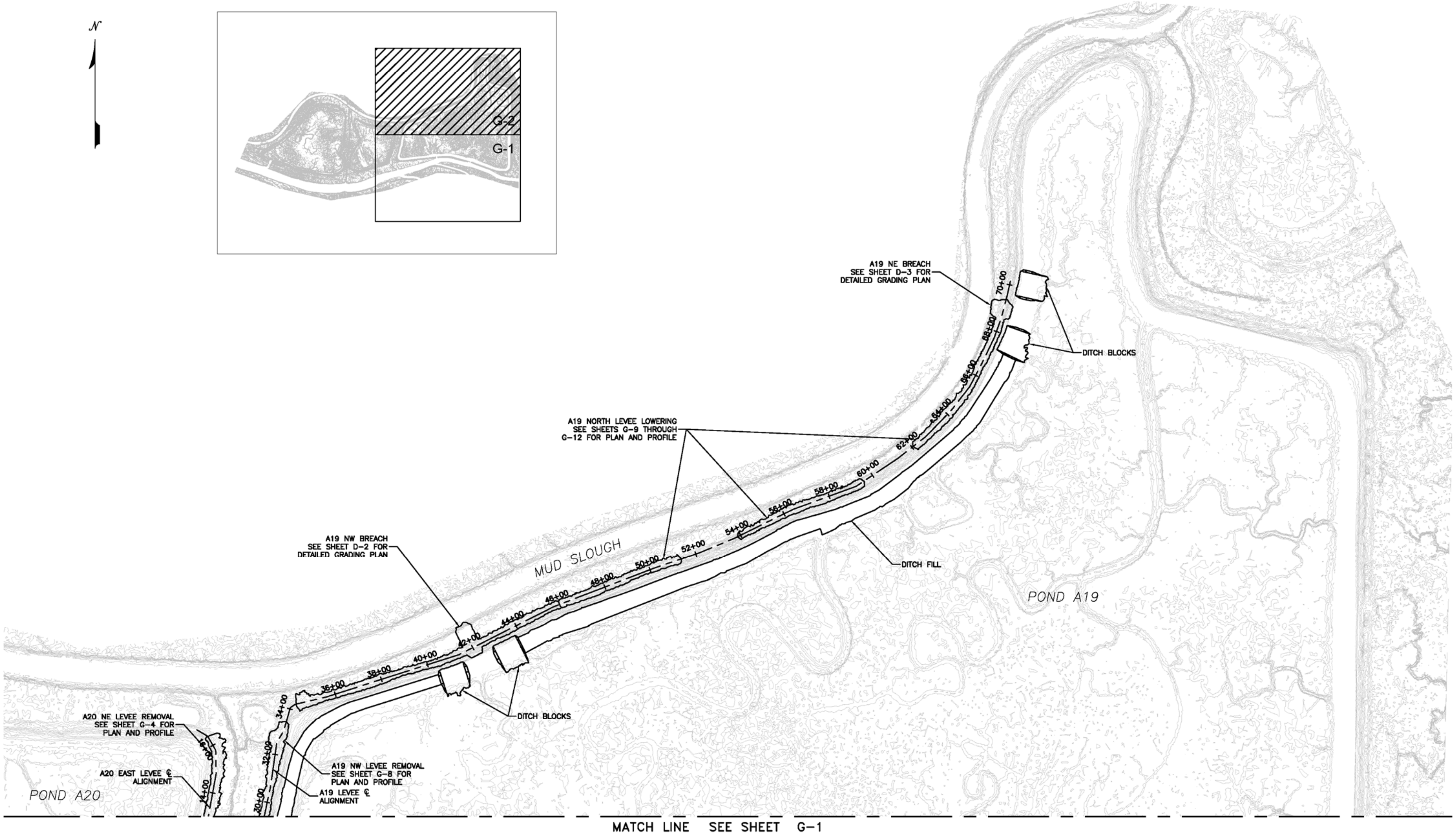
PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE: ISLAND PONDS GRADING PLAN SHEET 1 OF 2

SHEET NO. SHT 8 OF 23 SHTS

REV

DWG NO. G-1



PLAN
1"=200'

0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

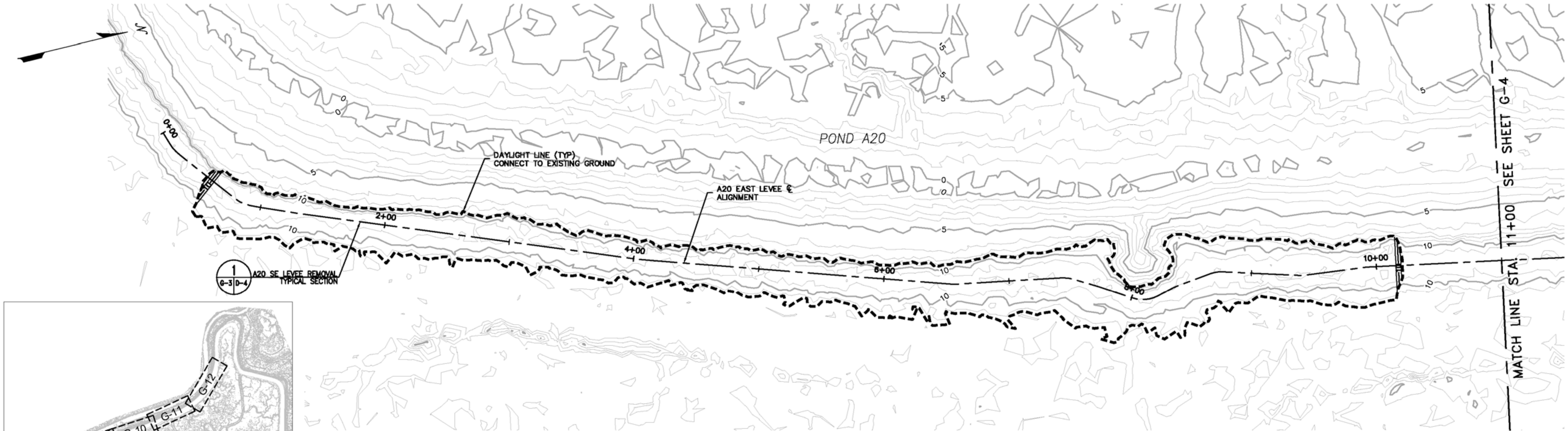
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
GRADING PLAN
SHEET 2 OF 2

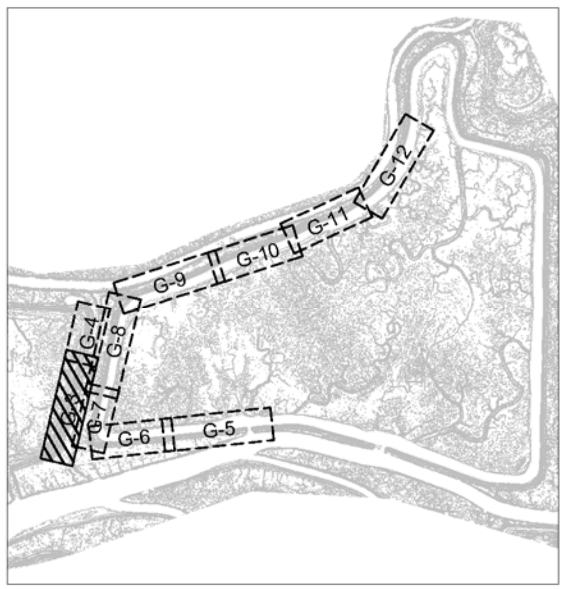
SHEET NO.
SHT. 9 OF 23 SHTS.
REV

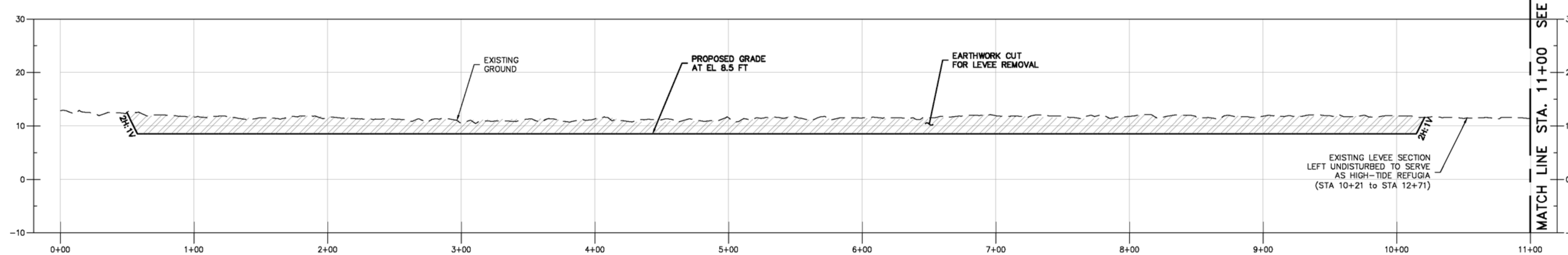
DWG NO.
G-2

Dec 02, 2016 - 2:56pm



PLAN
1"=40'





A20 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

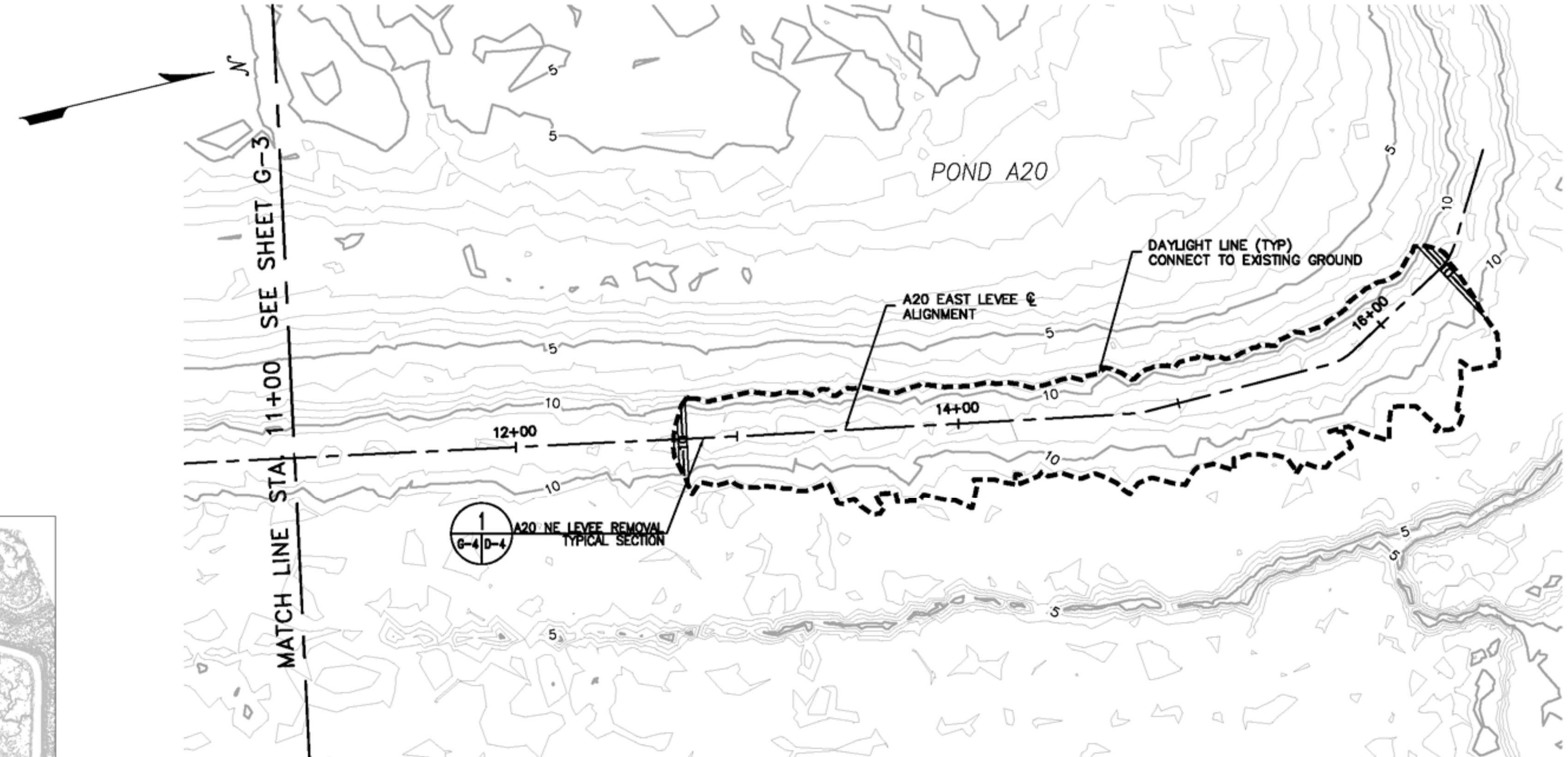
PROJECT No. 60422372 DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

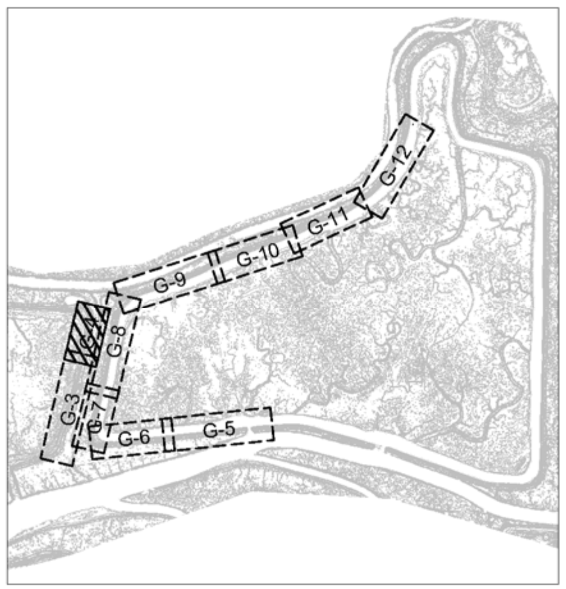
SHEET TITLE
ISLAND PONDS
POND A20 SOUTHEAST LEVEE REMOVAL
PLAN AND PROFILE

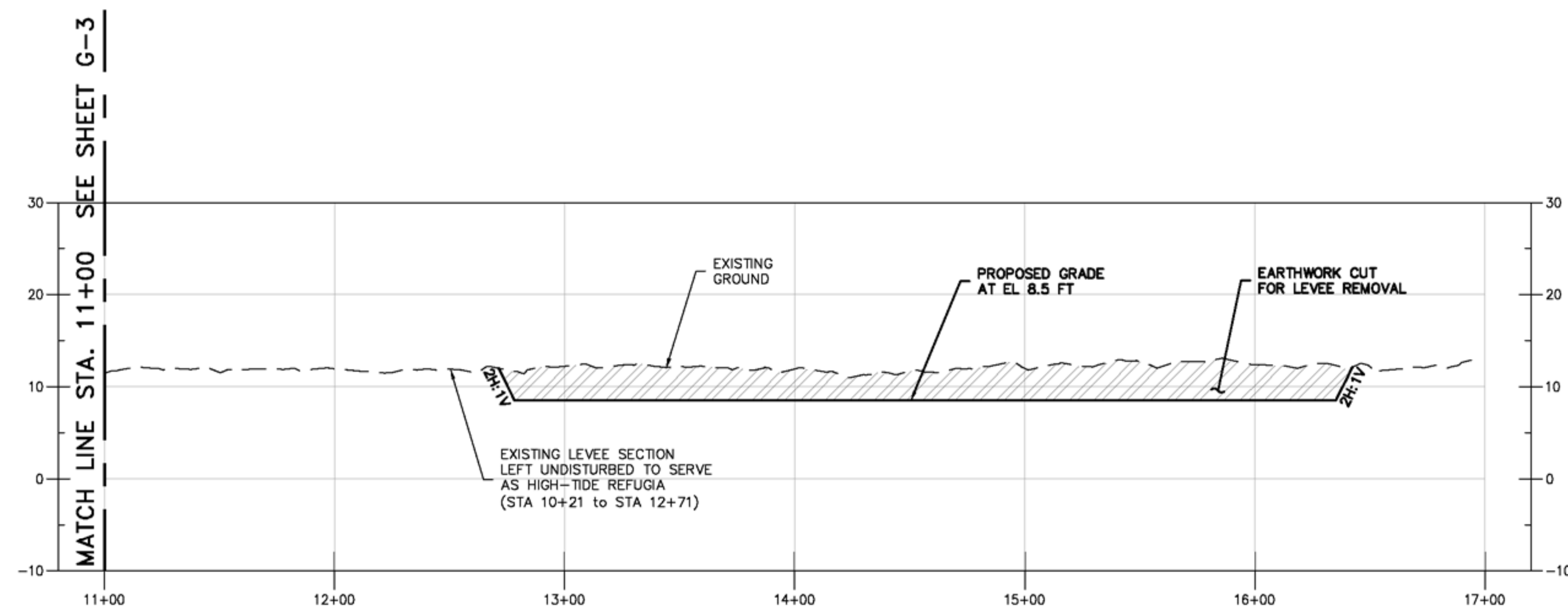
SHEET NO. SHT. 10 OF 23 SHTS.
REV
DWG NO. G-3

Dec 02, 2016 - 3:06pm
C:\pwworking\aecom_na\lchandrasekaran\dms75825\P_G-3.dwg



PLAN
1"=40'





A20 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

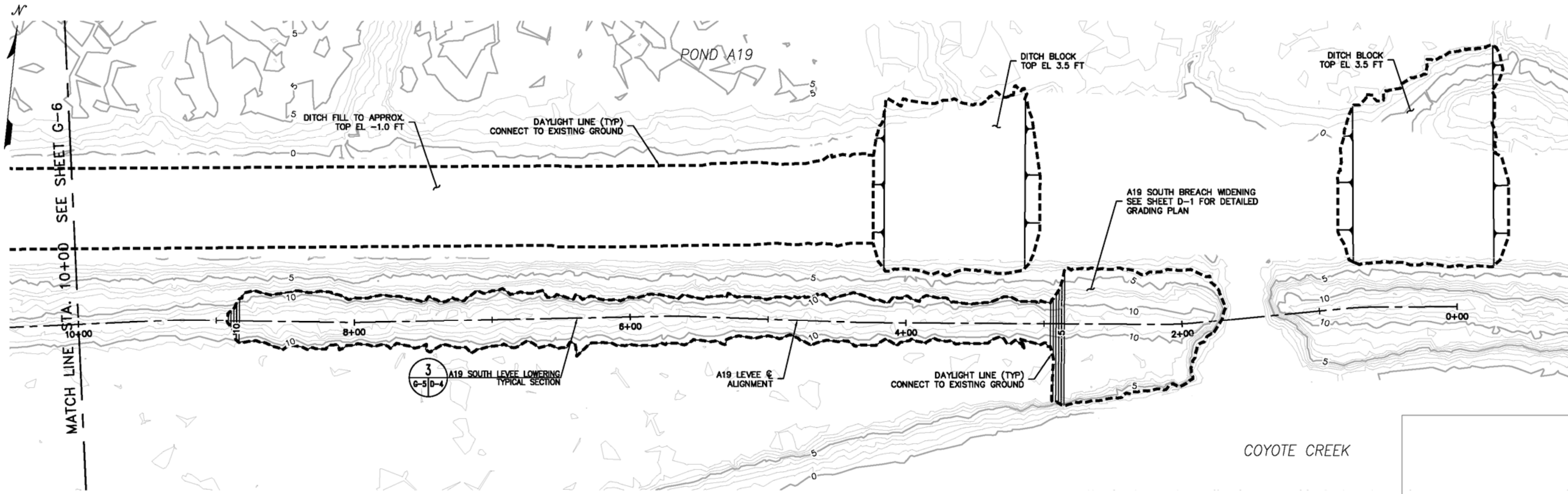
PROJECT No. 60422372
DATE 11-30-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

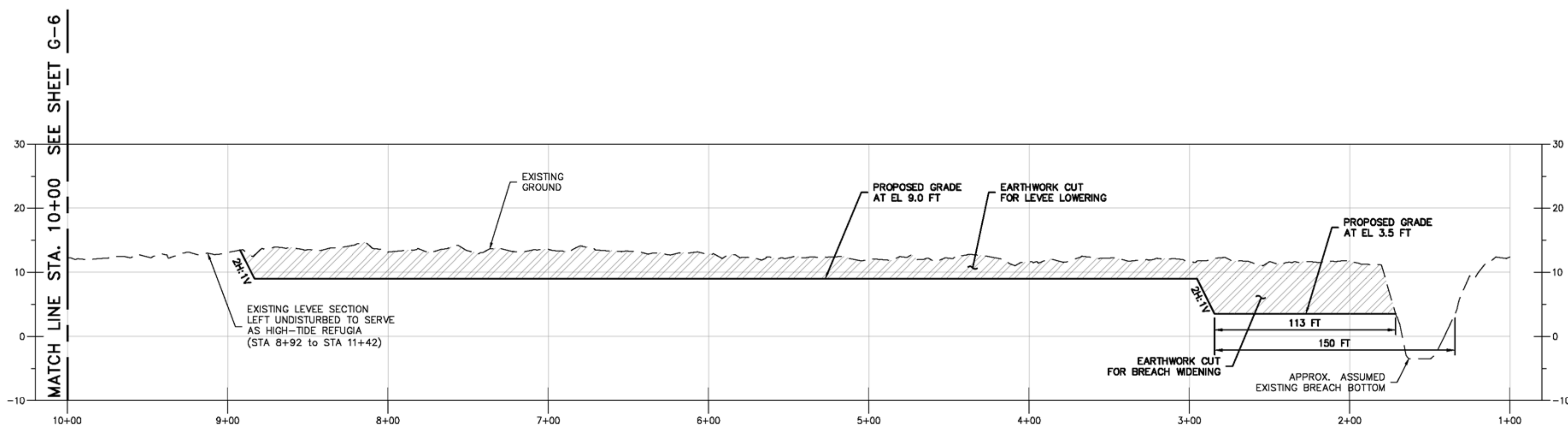
SHEET TITLE: ISLAND PONDS
POND A20 NORTHEAST LEVEE REMOVAL
PLAN AND PROFILE

SHEET NO. SHT. 11 OF 23 SHTS.
REV
DWG NO. G-4

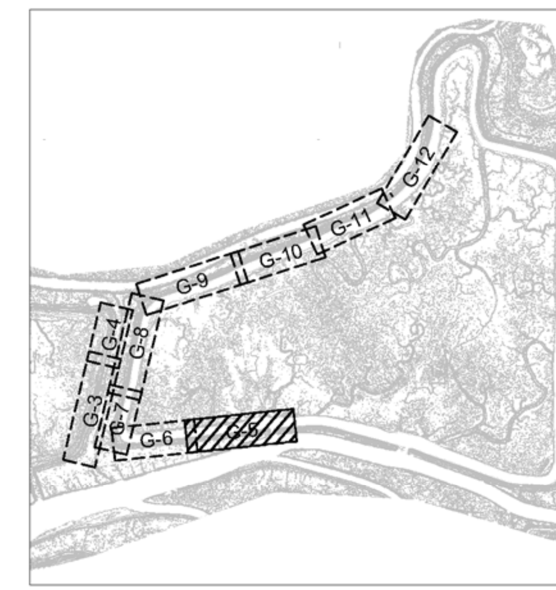
Dec 02, 2016 - 3:13pm
C:\pwworking\aecom_na\chandrasekaranl\dms75825\IP_G-4.dwg



PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'



HORIZ 1" = 40' (0, 40, 80, 120)
VERT 1" = 10' (0, 10, 20, 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: AECOM, 300 Lakeside Drive, Suite 400, Oakland, CA 94612, Tel: (510) 893-3600, aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

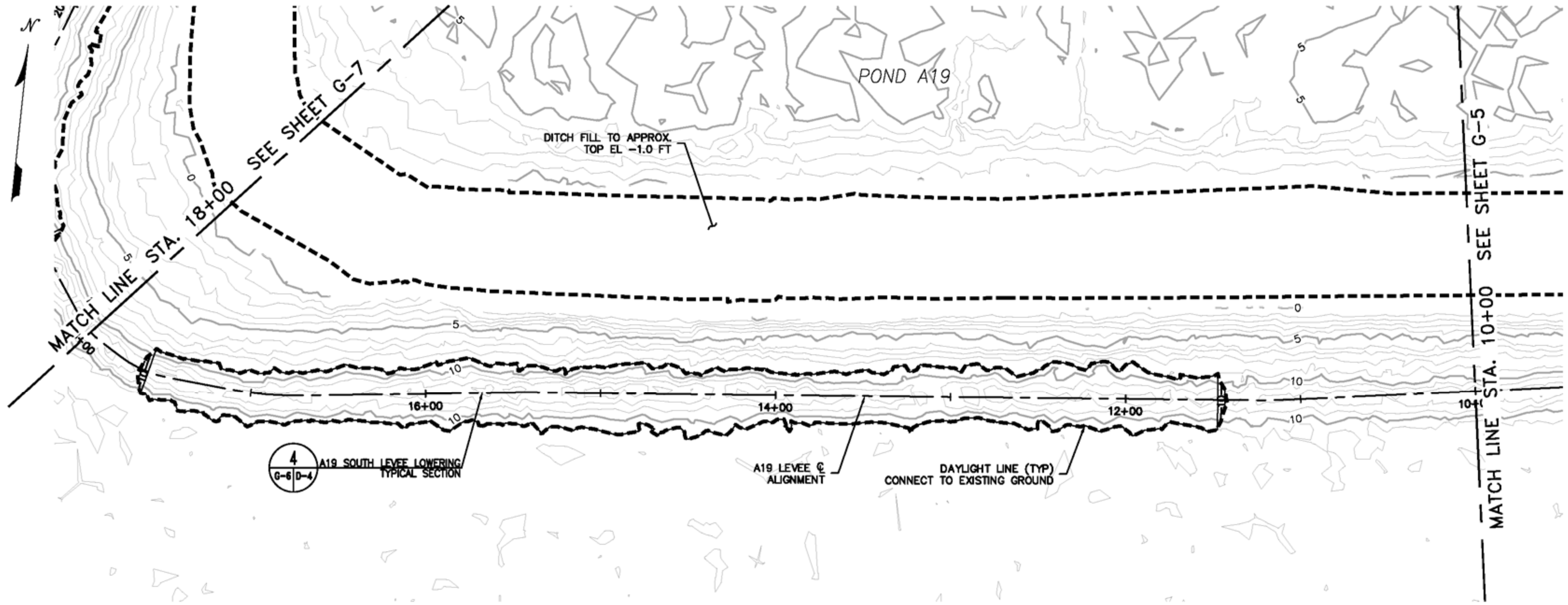
PROJECT No. 60422372 DATE 11-30-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

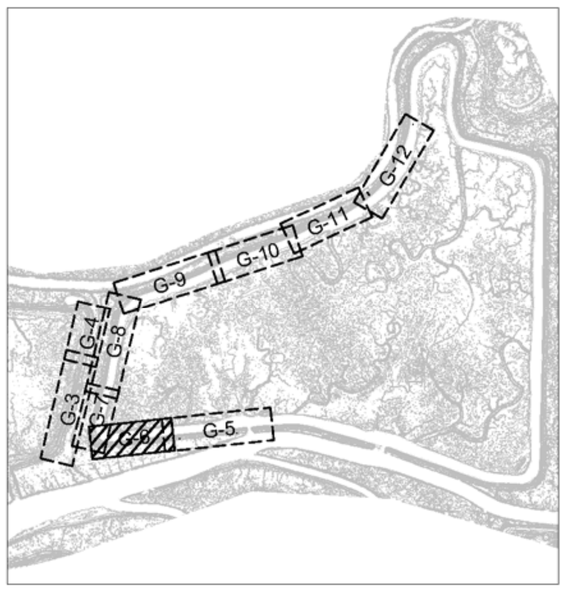
SHEET TITLE: ISLAND PONDS
POND A19 SOUTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 1 OF 2

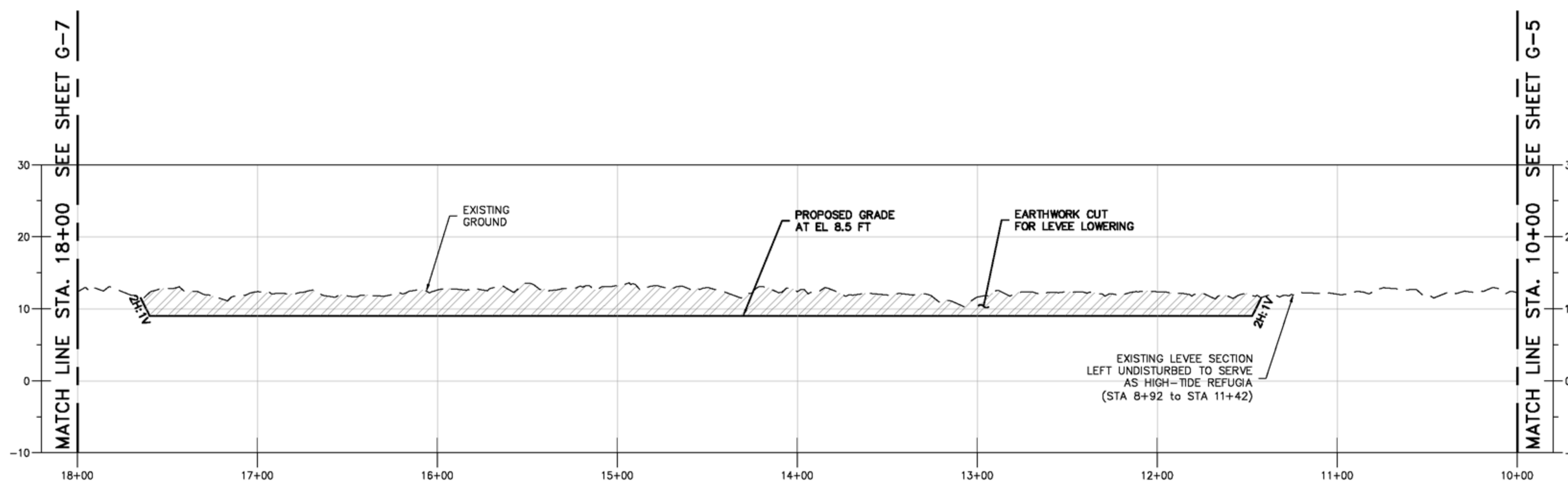
SHEET NO. SHT. 12 OF 23 SHTS.
DWG NO. G-5

Dec 09, 2016 - 10:05am C:\pwworking\aecom_na\chandrasekaranl\dms75825\IP_G-5.dwg



PLAN
1"=40'





A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

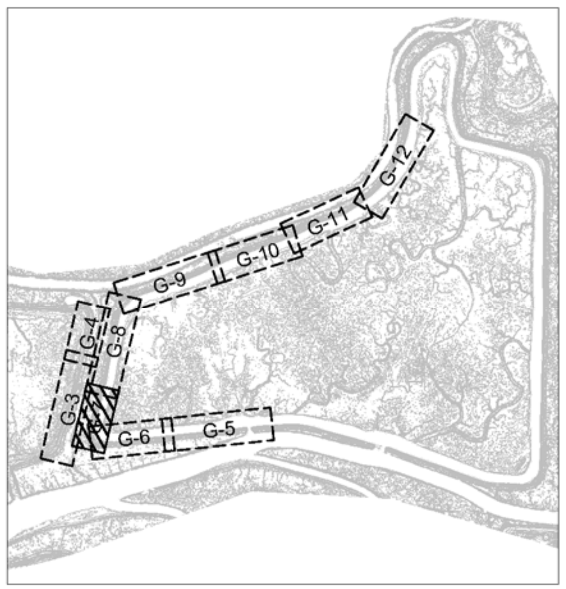
PROJECT No. 60422372
DATE 11-30-2016

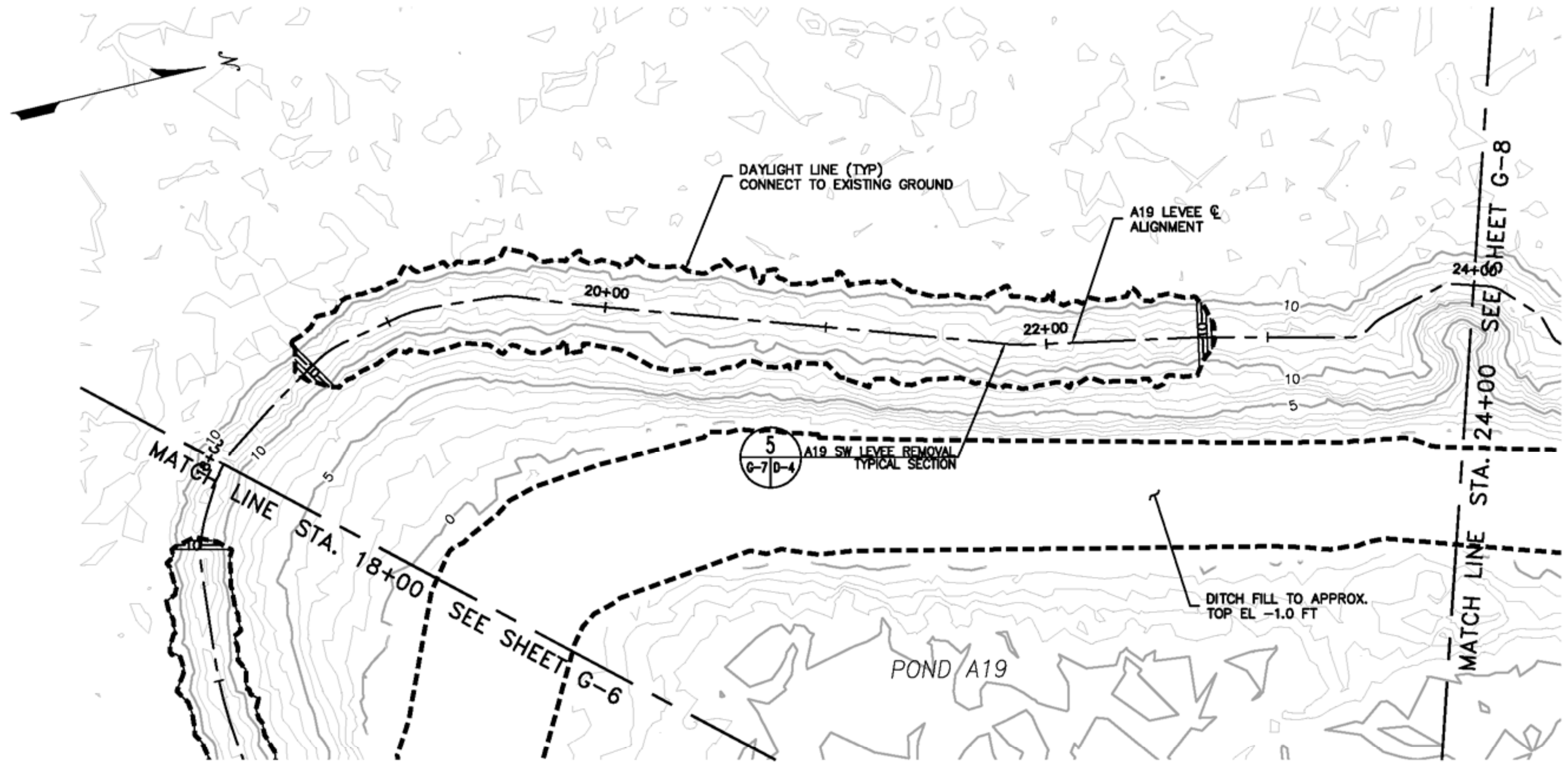
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
POND A19 SOUTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 2 OF 2

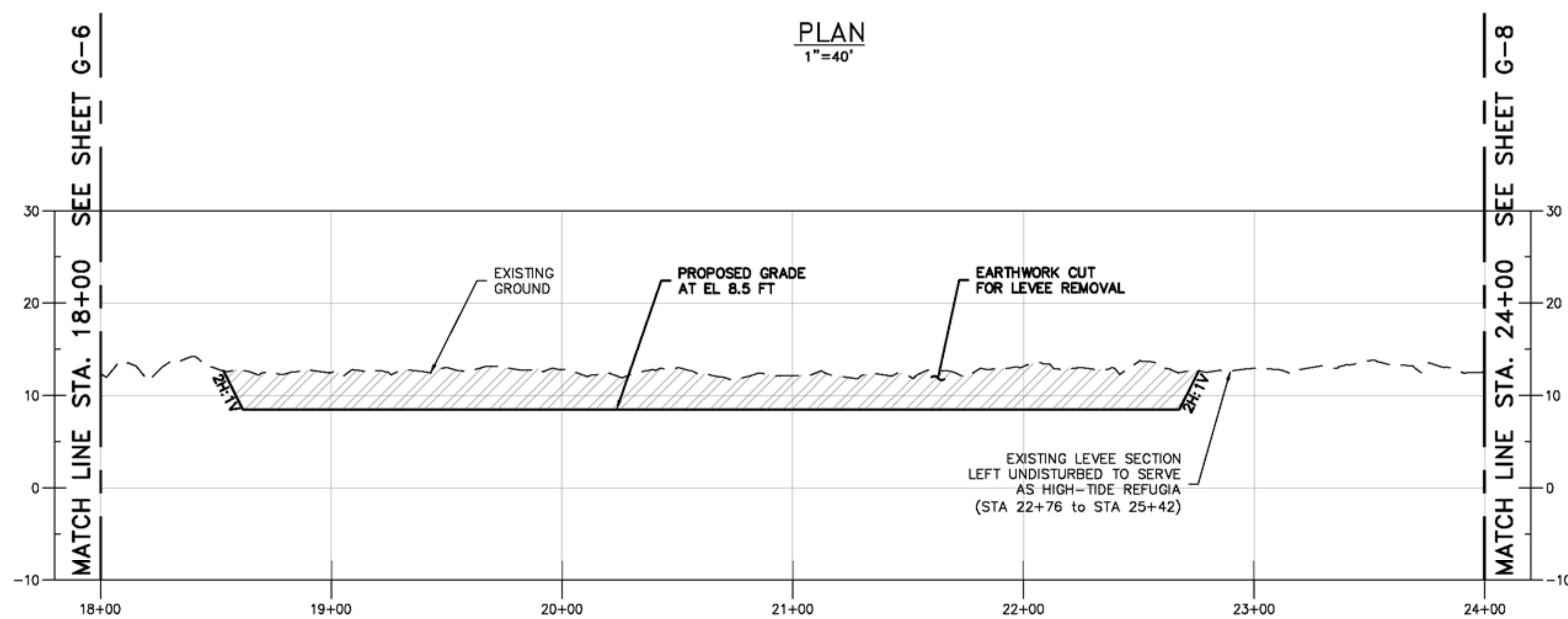
SHEET NO. SHT. 13 OF 23 SHTS.
DWG NO. G-6
REV

Dec 04, 2016 - 5:30pm
C:\pwworking\aecom_na\chandrasekaranl\dms75825\P_G-6.dwg





PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'

0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

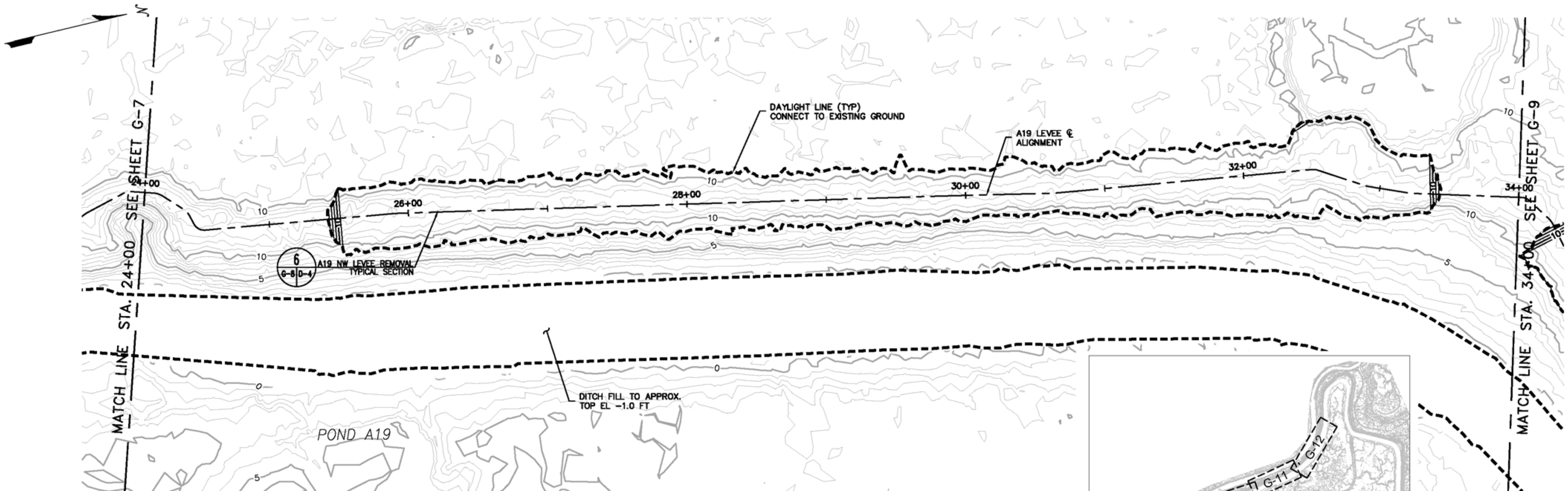
PROJECT No. 60422372
DATE 11-30-2016

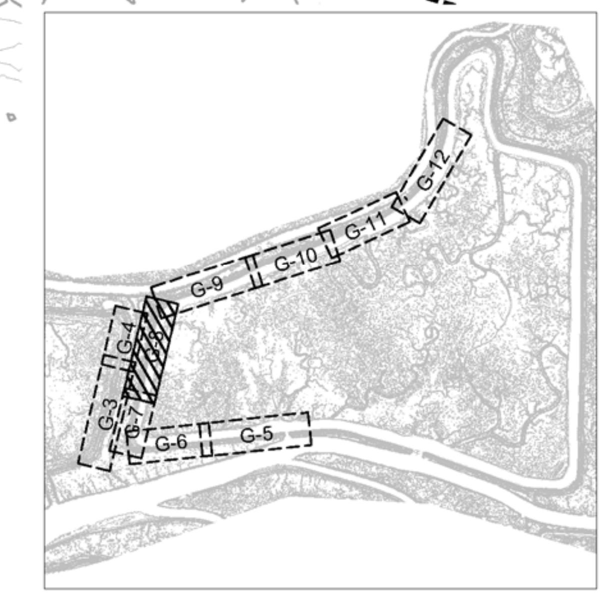
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
POND A19 SOUTHWEST LEVEE REMOVAL
PLAN AND PROFILE

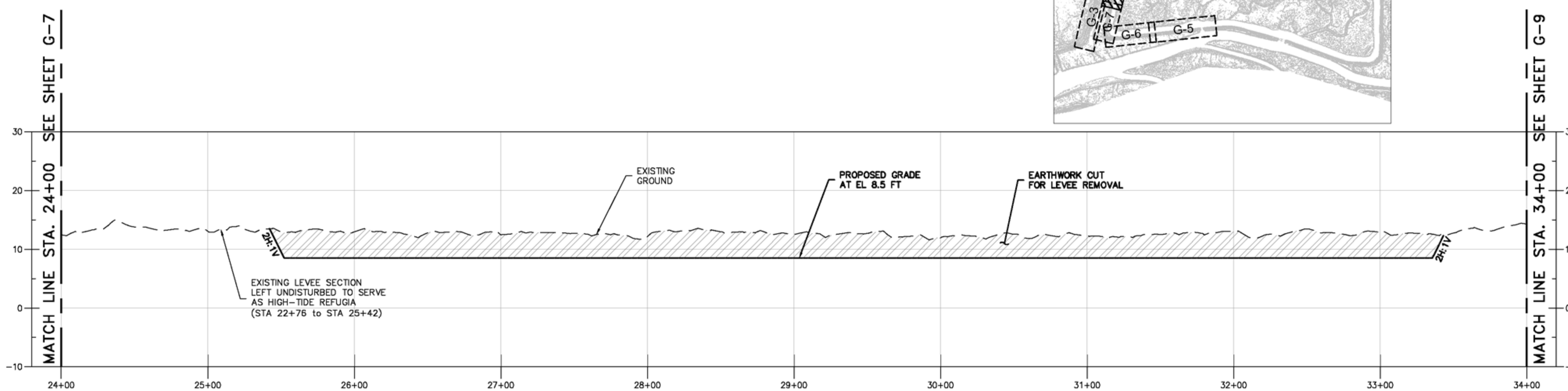
SHEET NO. SHT. 14 OF 23 SHTS.
REV
DWG NO. G-7

Dec 02, 2016 - 3:51pm C:\pwworking\aecom_na\chandrasekaranl\dms75825\P_G-7.dwg





PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

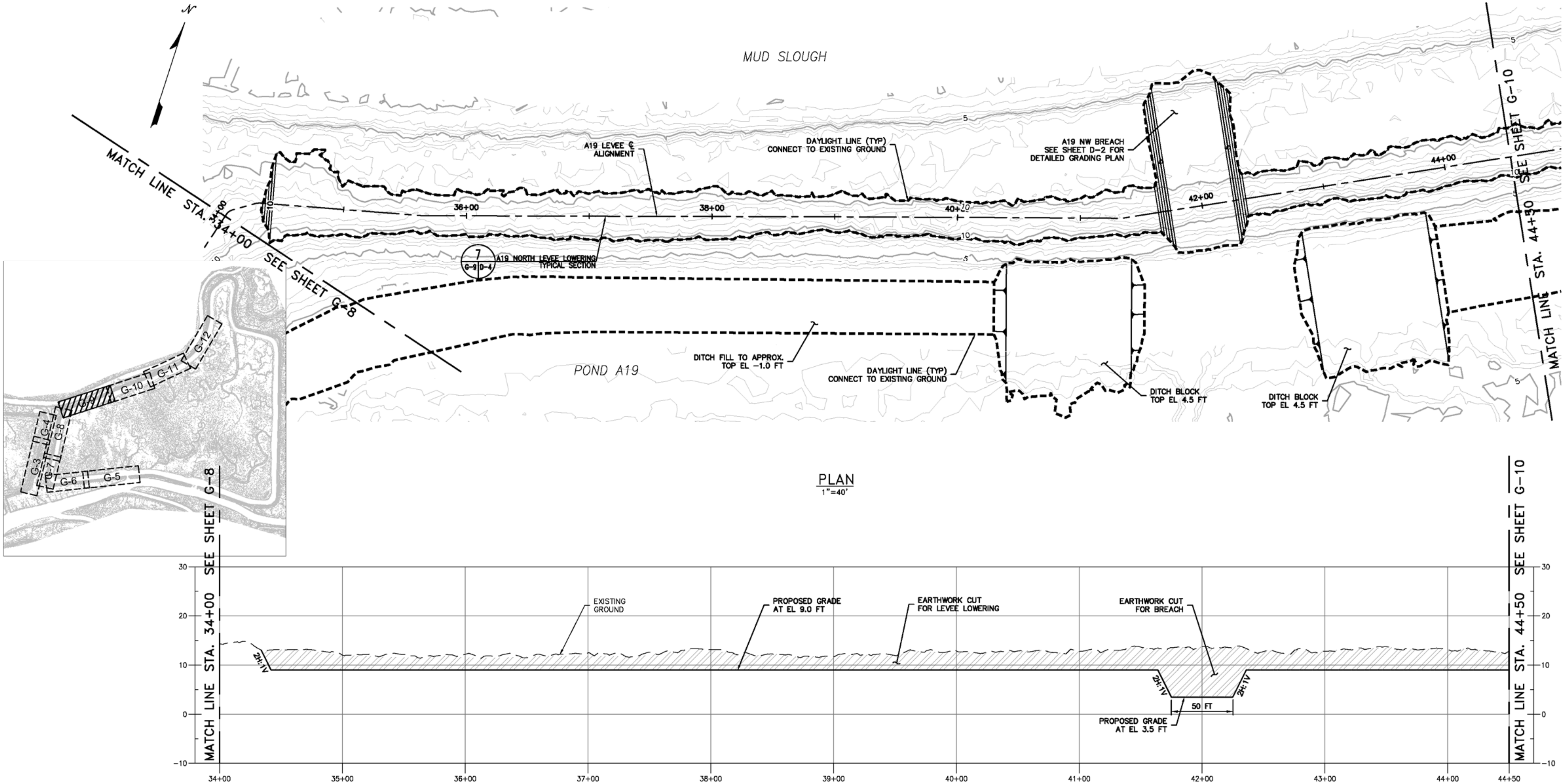
PROJECT No. 60422372 DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
POND A19 NORTHWEST LEVEE REMOVAL
PLAN AND PROFILE

SHEET NO. SHT. 15 OF 23 SHTS.
REV
DWG NO. G-8

Dec 04, 2016 - 5:34pm
C:\pwworking\aecom_na\chandrasekaranl\dms75825\IP_G-8.dwg



A19 LEVEE ℄ ALIGNMENT PROFILE

HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40'

VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

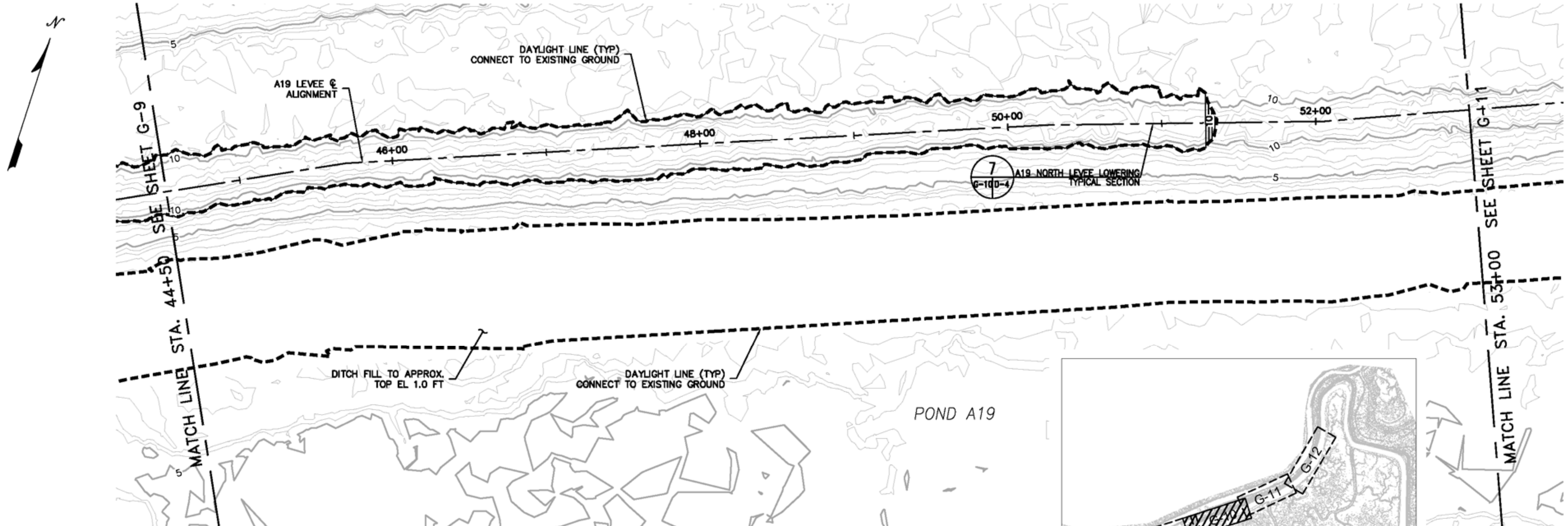
PROJECT No. 60422372
DATE 11-30-2016

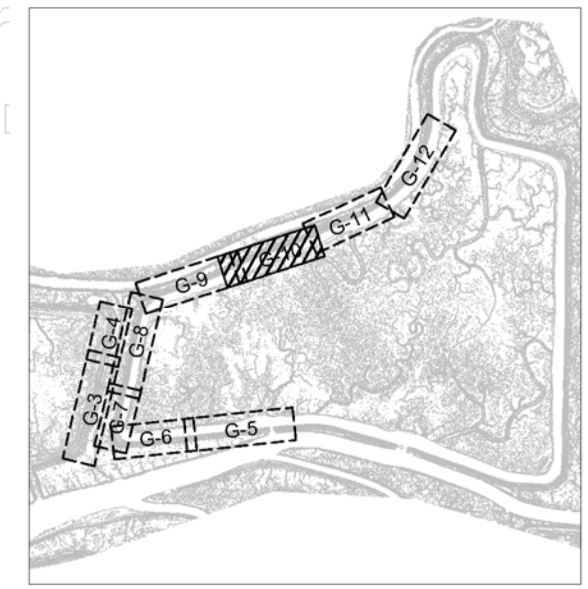
PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE ISLAND PONDS
POND A19 NORTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 1 OF 4

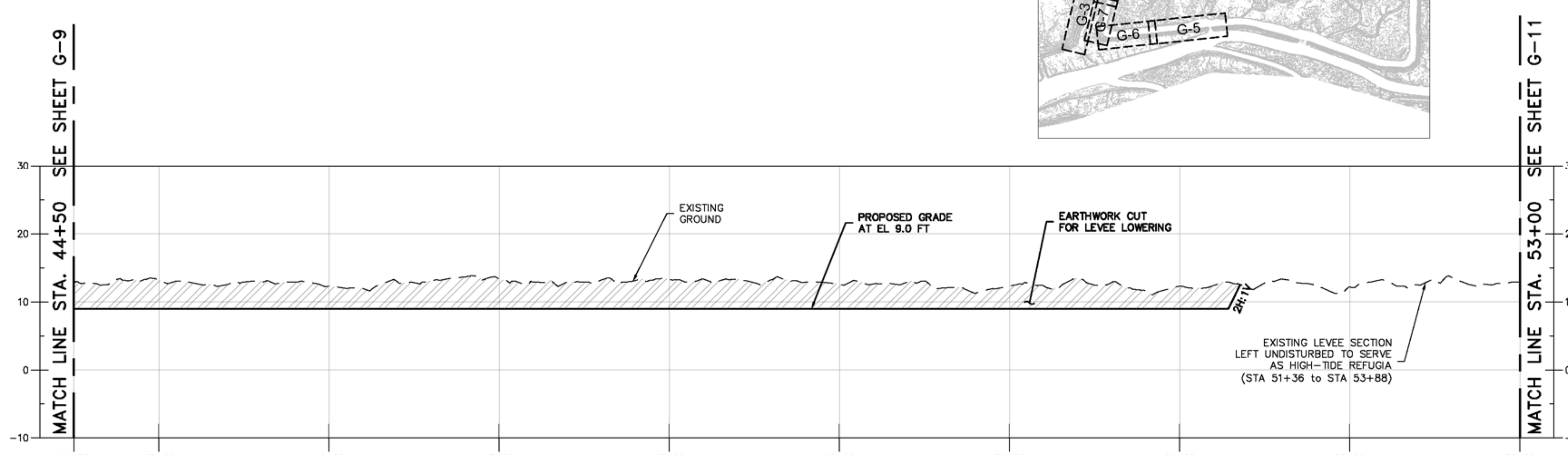
SHEET NO. SHT. 16 OF 23 SHTS.
DWG NO. G-9

Dec 02, 2016 - 5:25pm





PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40' (0 40 80 120)

VERT 1" = 10' (0 10 20 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

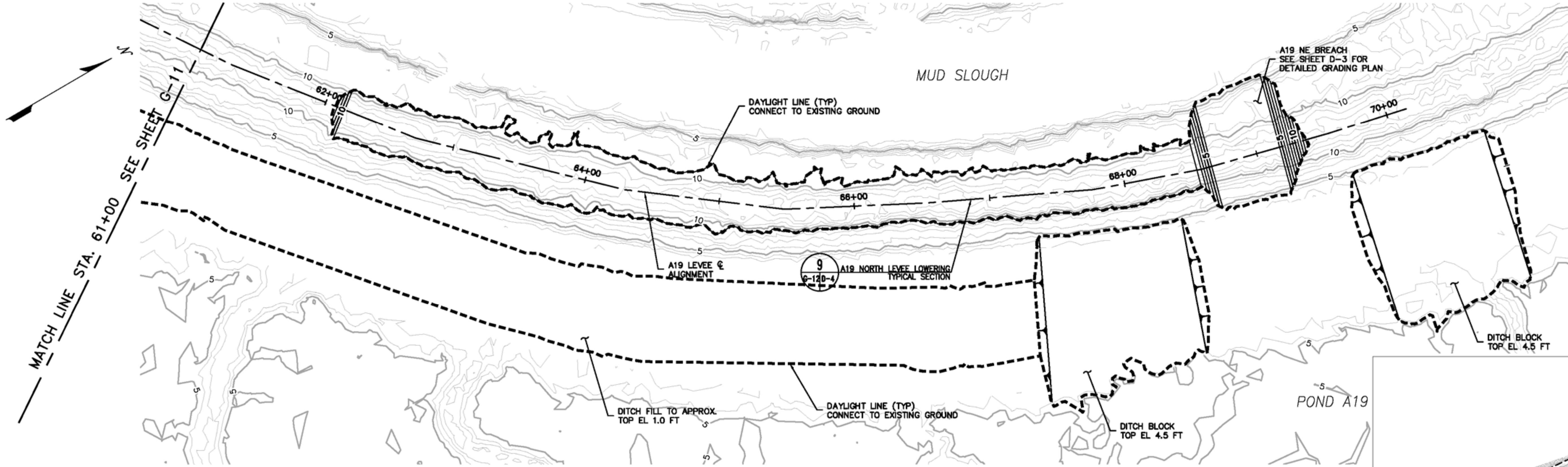
SHEET TITLE: ISLAND PONDS
POND A19 NORTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 2 OF 4

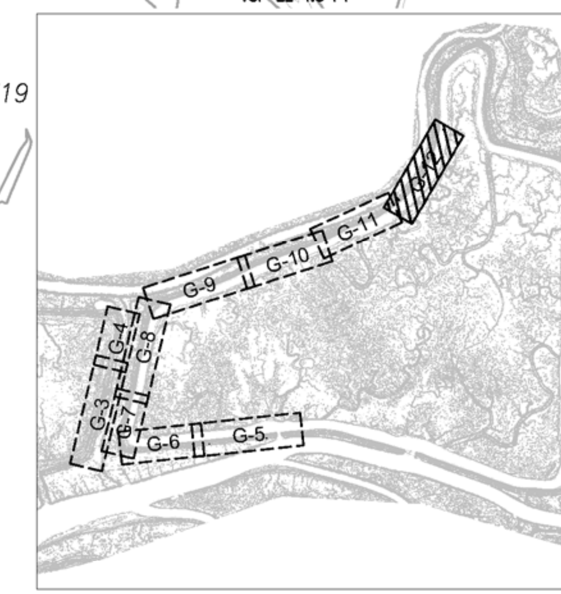
SHEET NO. SHT. 17 OF 23 SHTS.

DWG NO. G-10

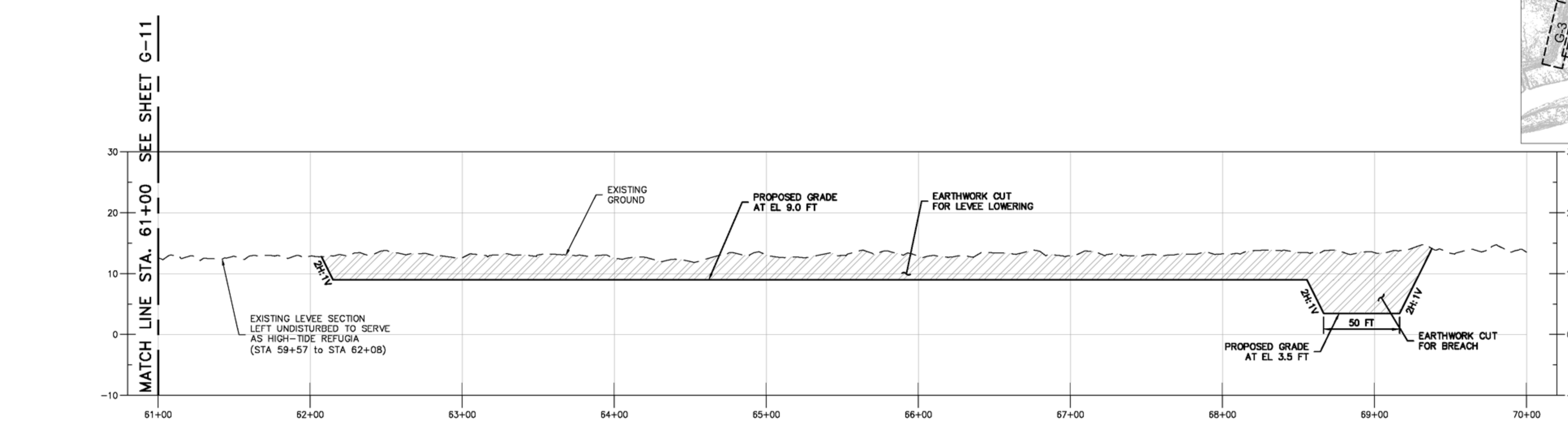
REV

Dec 02, 2016 - 5:00pm
C:\pwworking\aecom_na\lchandrasekaranl\dms75825\P_G-10.dwg





PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'
0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

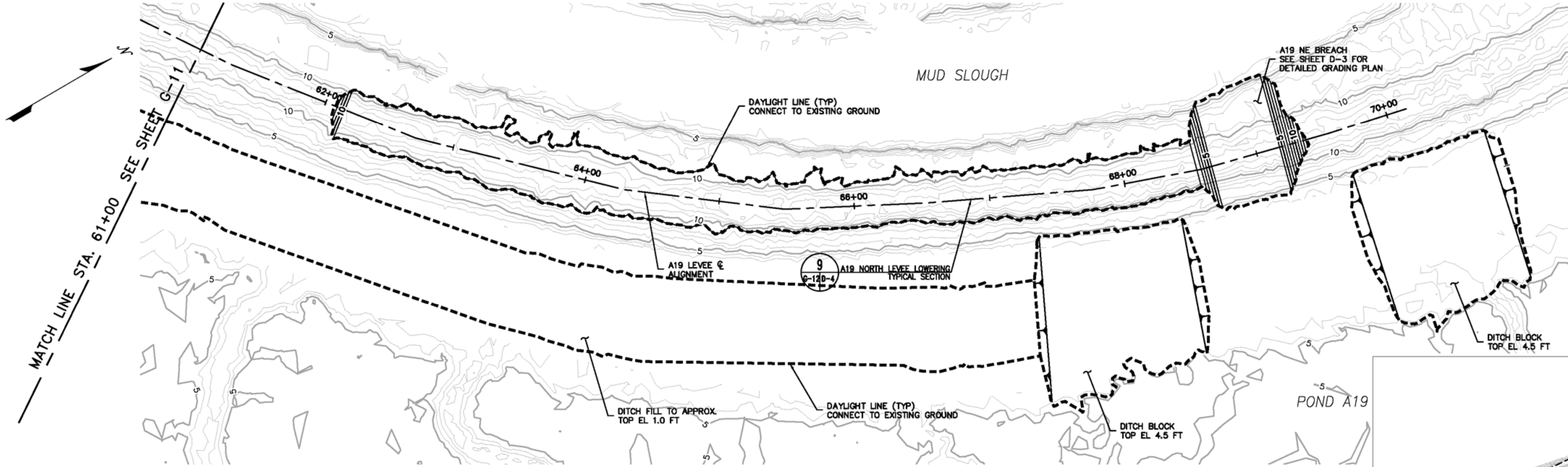
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

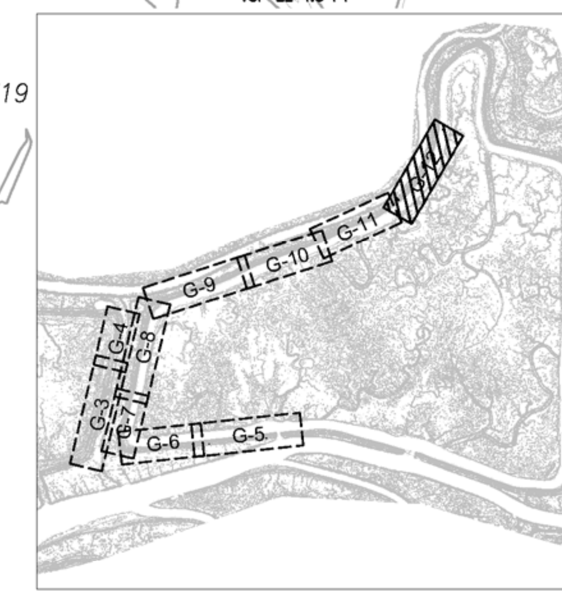
STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
ISLAND PONDS
POND A19 NORTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 4 OF 4

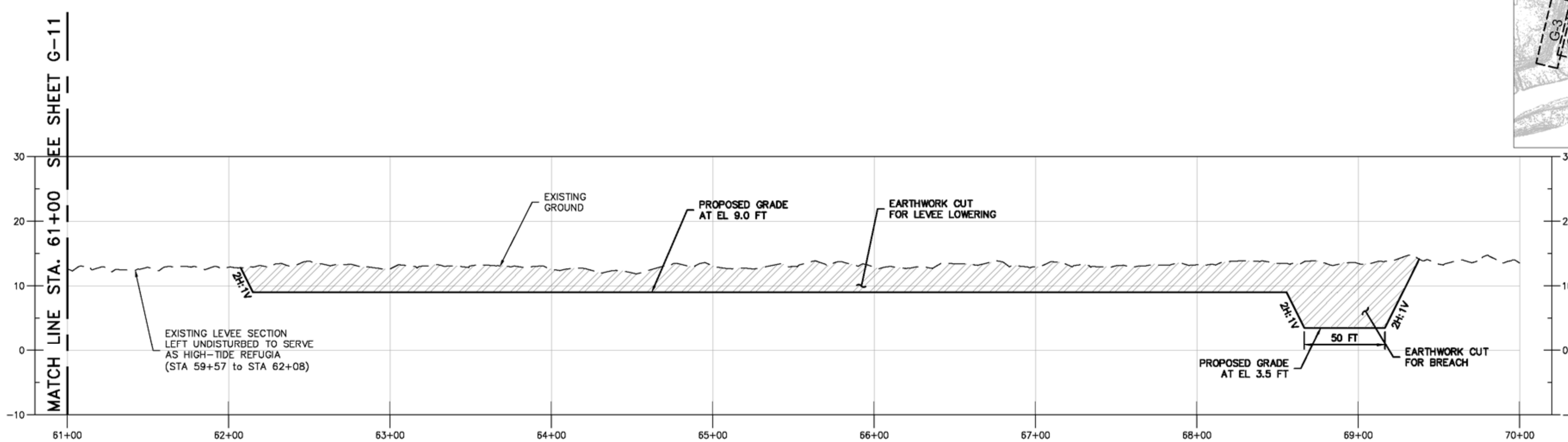
SHEET NO. SHT 19 OF 23 SHTS
DWG NO. G-12
REV

Dec 02, 2016 - 5:50pm





PLAN
1"=40'



A19 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

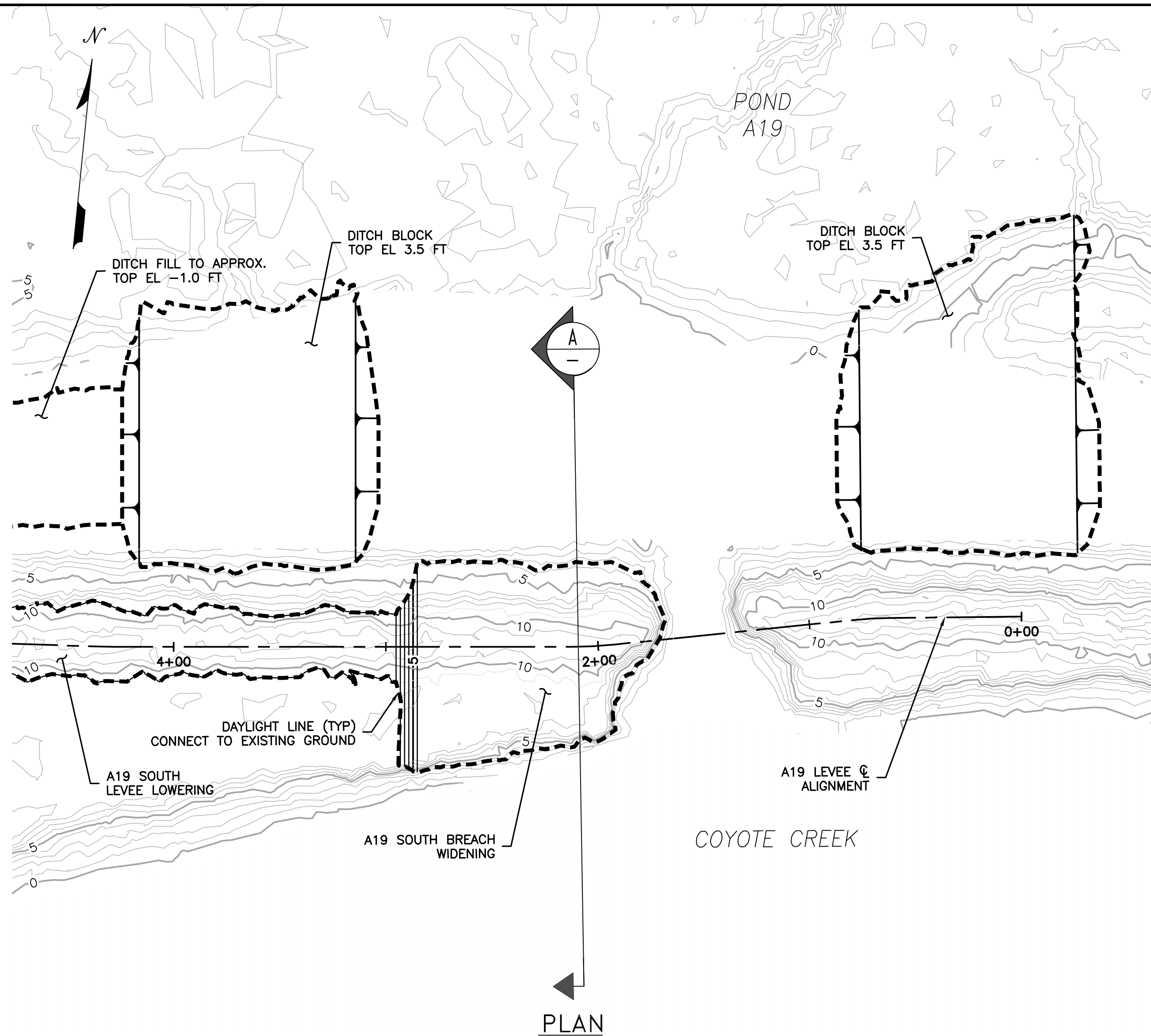
PROJECT No. 60422372 DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

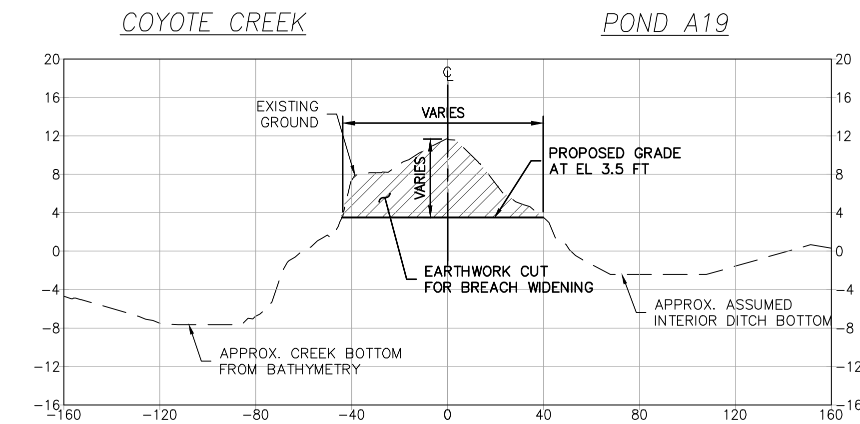
SHEET TITLE
ISLAND PONDS
POND A19 NORTH LEVEE LOWERING
PLAN AND PROFILE - SHEET 4 OF 4

SHEET NO. SHT 19 OF 23 SHTS
DWG NO. G-12
REV

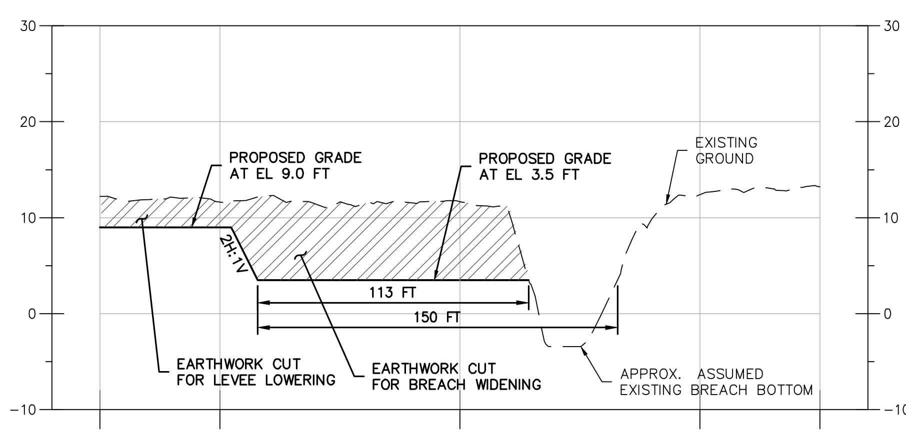
Dec 02, 2016 - 5:50pm
C:\pwworking\aecom_na\lchandrasekaran\dms75825\P_G-12.dwg



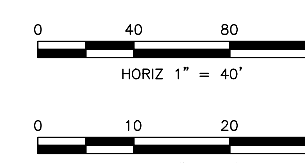
PLAN
1"=40'



A19 SOUTH BREACH WIDENING – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A19 SOUTH BREACH WIDENING – PROFILE
HORIZ 1"=40', VERT 1"=10'



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

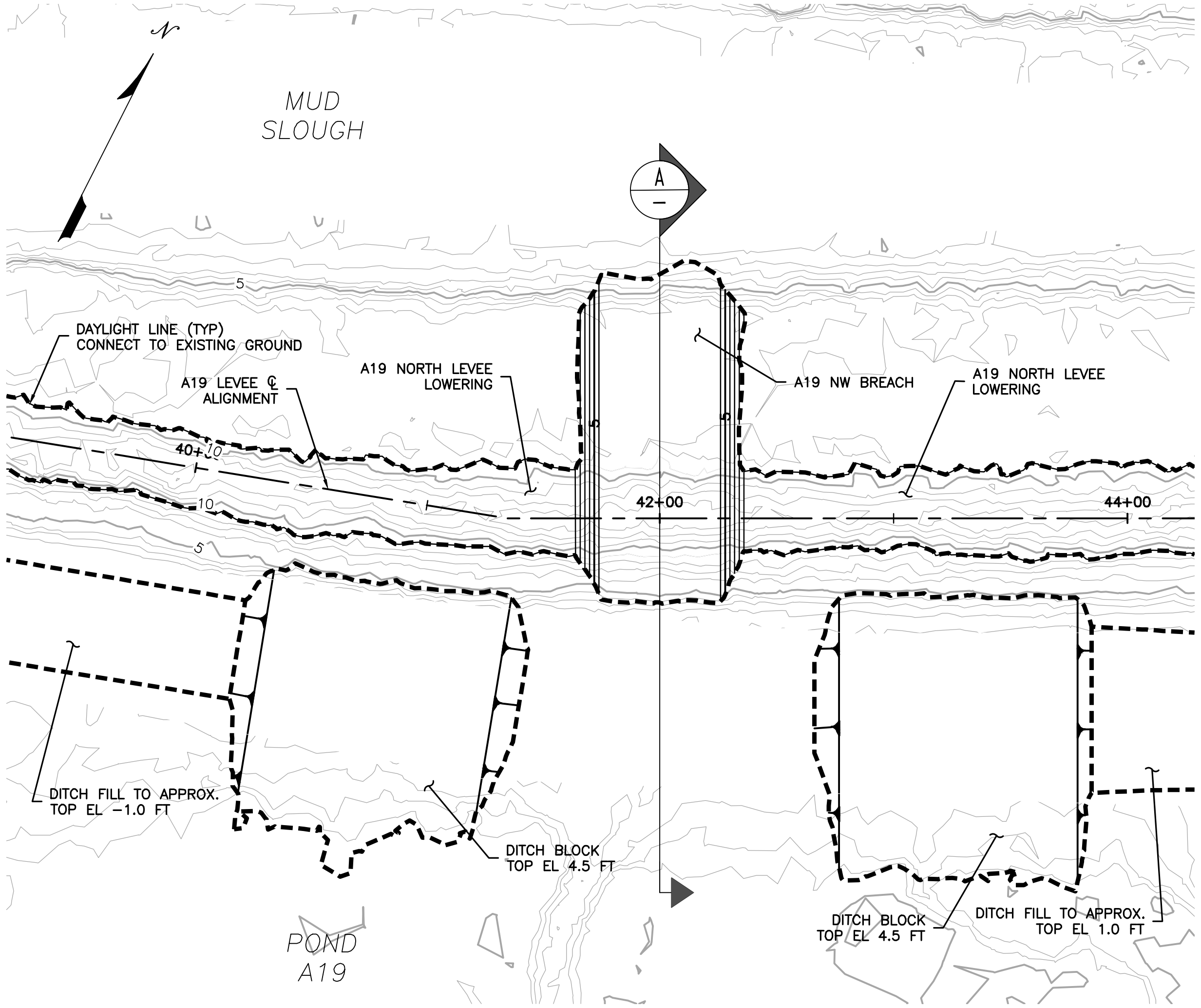
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

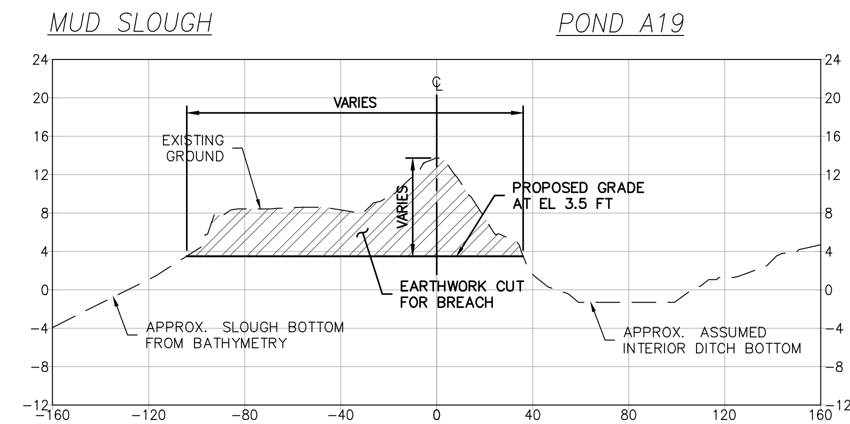
SHEET TITLE
ISLAND PONDS
POND A19 SOUTH BREACH WIDENING
DETAILED GRADING PLAN

SHEET NO. SHT. 20 OF 23 SHTS.
REV
DWG NO. D-1

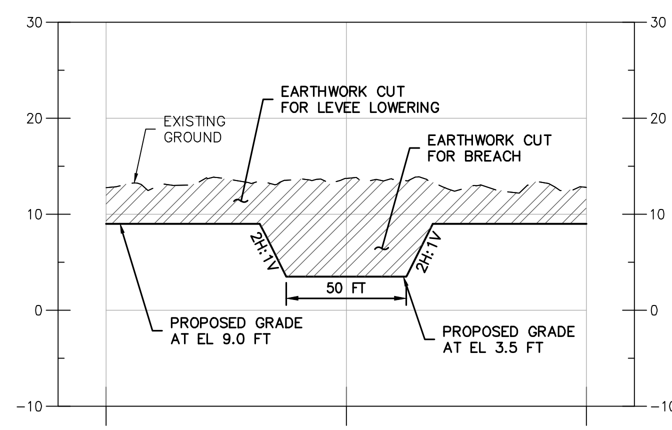
Dec 09, 2016 - 10:01am
C:\pwworking\aecom_na\chandrasekaranl\dms75825\P_D-1.dwg



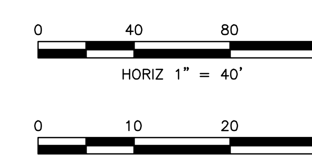
PLAN
1"=40'



A19 NW BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A19 NW BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

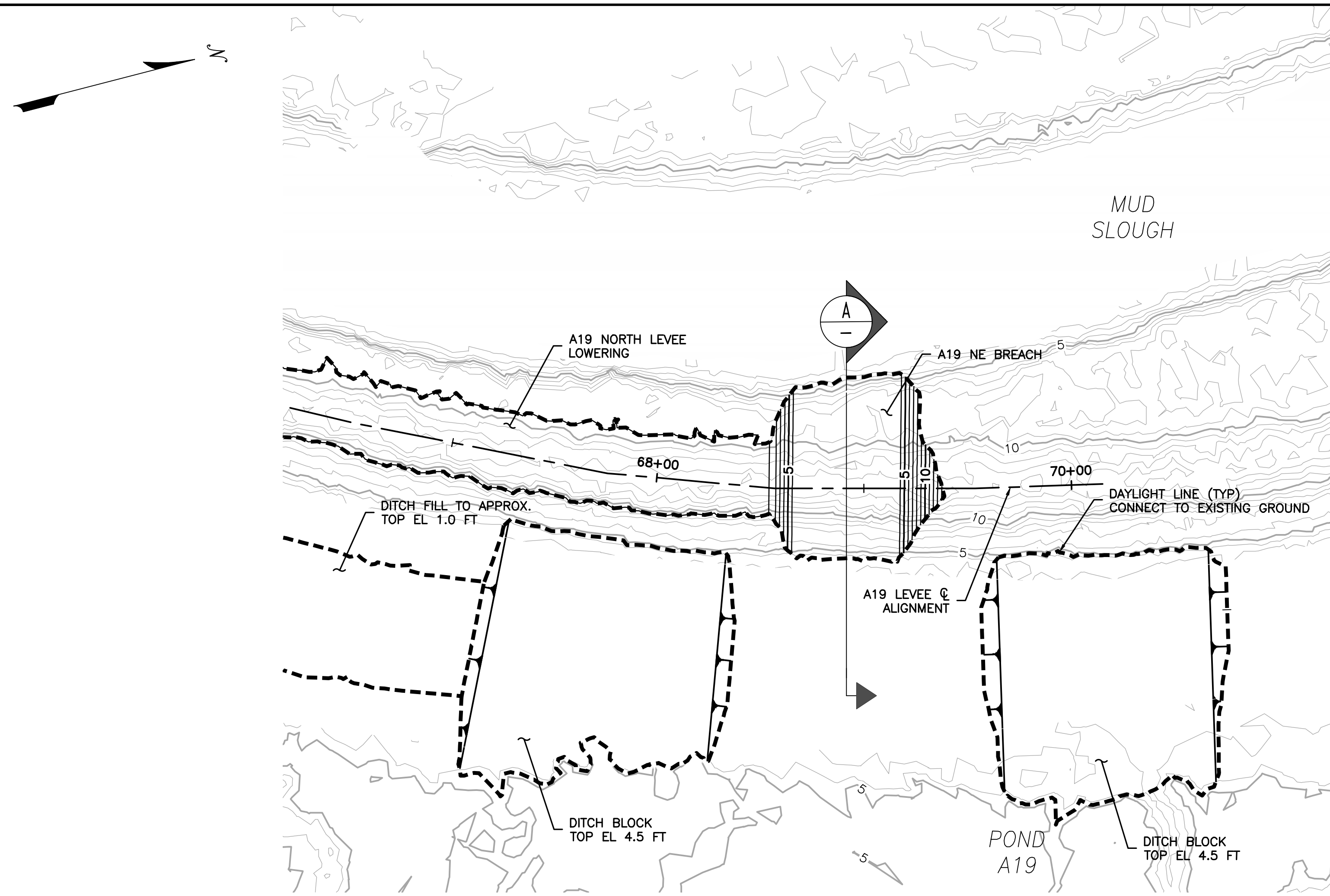
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

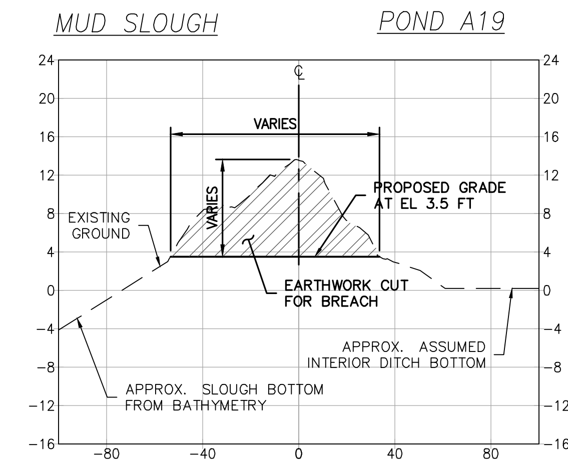
SHEET TITLE
ISLAND PONDS
POND A19 NORTHWEST BREACH
DETAILED GRADING PLAN

SHEET NO. SHT. 21 OF 23 SHTS.
REV
DWG NO. D-2

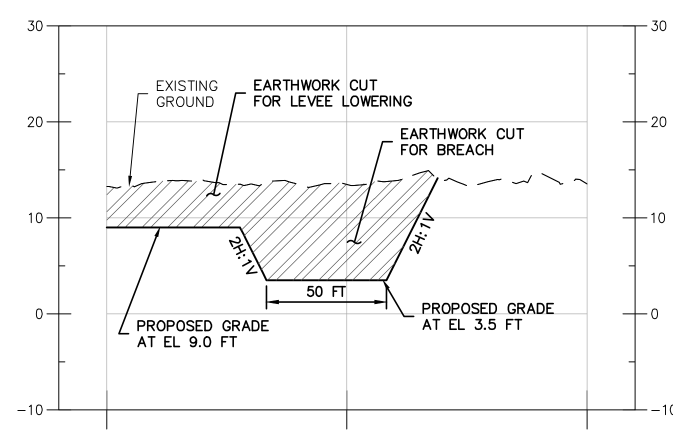
Dec 02, 2016 - 6:25pm
C:\pwworking\aecom_na\chandrasekaranl\dms75825\P_D-2.dwg



PLAN
1"=40'



A — A19 NE BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A19 NE BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

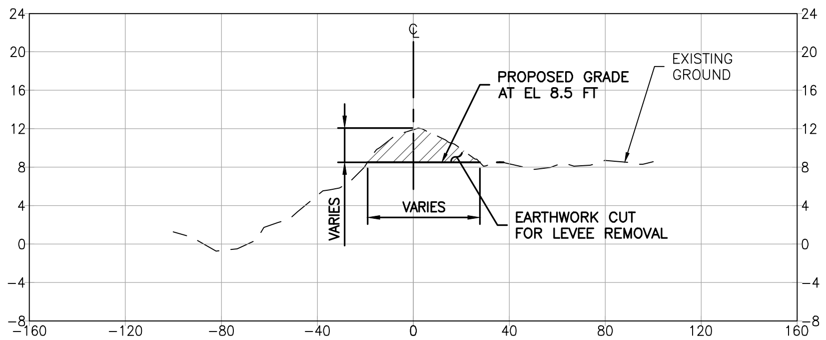
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
POND A19 NORTHEAST BREACH
DETAILED GRADING PLAN

SHEET NO. SHT. 22 OF 23 SHTS.
REV
DWG NO. D-3

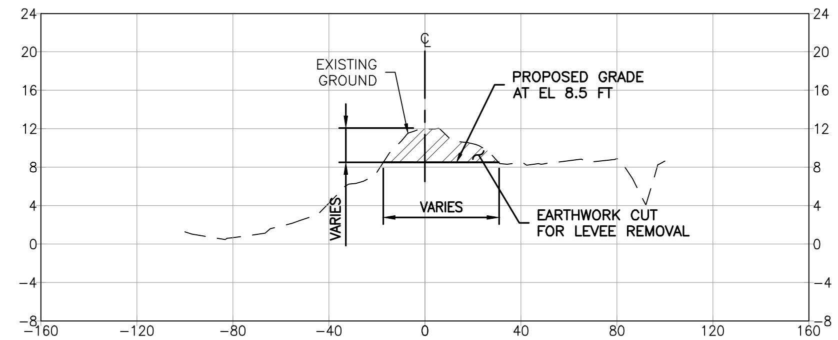
Dec 02, 2016 - 6:42pm
C:\pwworking\aecom_na\lchandrasekaran\dms75825\P_D-3.dwg

POND A20



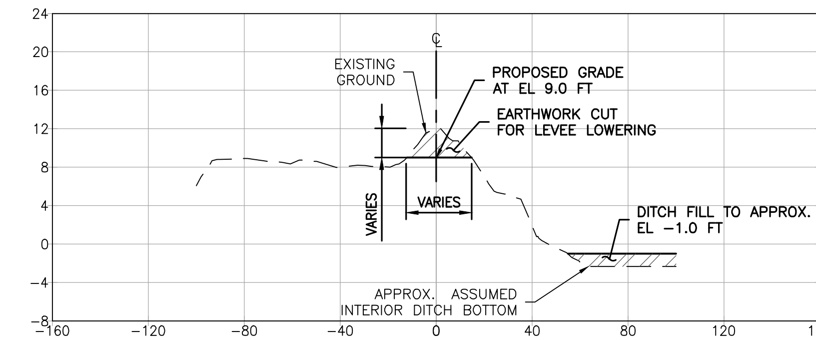
1 G-3 D-4 A20 SOUTHEAST LEVEE REMOVAL – TYPICAL SECTION
STA 0+50 TO 10+21
HORIZ 1"=40', VERT 1"=10'

POND A20



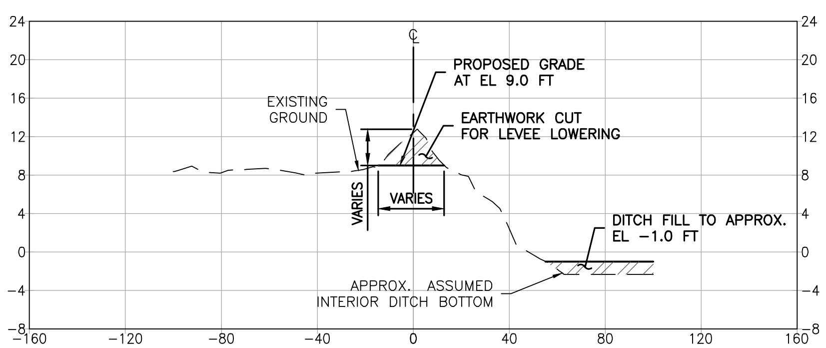
2 G-4 D-4 A20 NORTHEAST LEVEE REMOVAL – TYPICAL SECTION
STA 12+71 TO 16+42
HORIZ 1"=40', VERT 1"=10'

POND A19



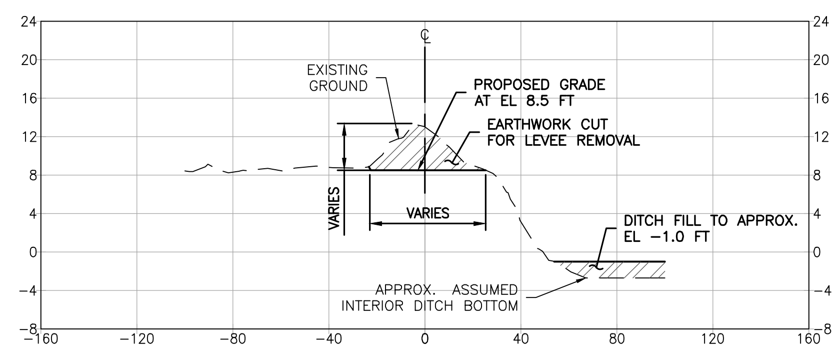
3 G-5 D-4 A19 SOUTH LEVEE LOWERING – TYPICAL SECTION
STA 2+95 TO 8+92
HORIZ 1"=40', VERT 1"=10'

POND A19



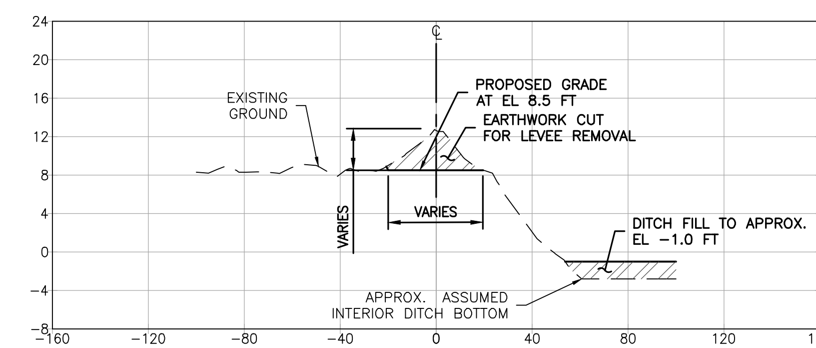
4 G-6 D-4 A19 SOUTH LEVEE LOWERING – TYPICAL SECTION
STA 11+42 TO 17+65
HORIZ 1"=40', VERT 1"=10'

POND A19



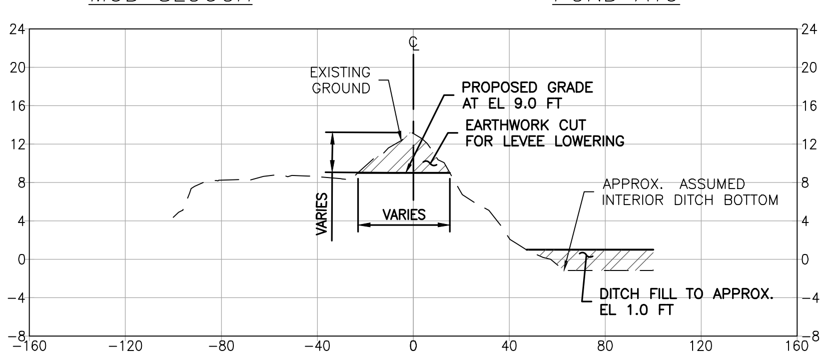
5 G-7 D-4 A19 SOUTHWEST LEVEE REMOVAL – TYPICAL SECTION
STA 18+53 TO 22+76
HORIZ 1"=40', VERT 1"=10'

POND A19



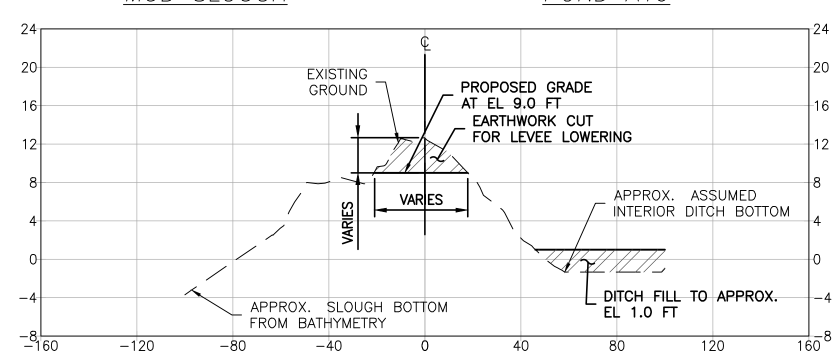
6 G-8 D-4 A19 NORTHWEST LEVEE REMOVAL – TYPICAL SECTION
STA 25+42 TO 33+43
HORIZ 1"=40', VERT 1"=10'

MUD SLOUGH POND A19



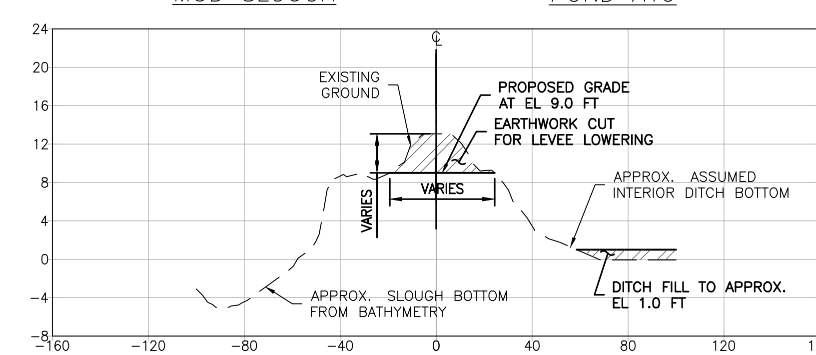
7 G-10 G-9 D-4 A19 NORTH LEVEE LOWERING – TYPICAL SECTION
STA 34+34 TO 41+64, STA 42+36 TO 51+36
HORIZ 1"=40', VERT 1"=10'

MUD SLOUGH POND A19



8 G-11 D-4 A19 NORTH LEVEE LOWERING – TYPICAL SECTION
STA 53+88 TO 59+57
HORIZ 1"=40', VERT 1"=10'

MUD SLOUGH POND A19



9 G-12 D-4 A19 NORTH LEVEE LOWERING – TYPICAL SECTION
STA 62+07 TO 68+55
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

Dec 04, 2016 - 6:07pm
C:\pwworking\aecom_na\chandrasekarandms75825\P_D-4.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

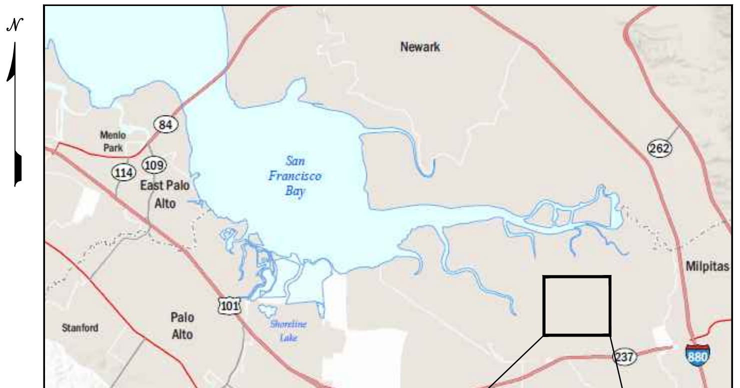
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
ISLAND PONDS
TYPICAL GRADING SECTIONS

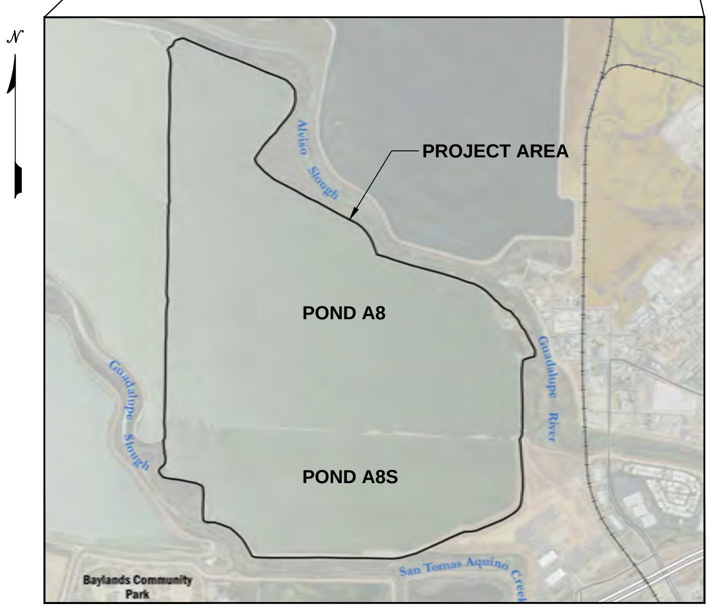
SHEET NO. SHT. 23 OF 23 SHTS.
REV
DWG NO. D-4

SOUTH BAY SALT POND RESTORATION PROJECT

A8 PONDS
NEAR ALVISO, CALIFORNIA



VICINITY MAP
NTS



LOCATION MAP
NTS

PROJECT AREA PHOTO

SHEETS

T–1	TITLE SHEET
T–2	NOTES AND LEGEND
T–3	KEY MAP
T–4	GENERAL ARRANGEMENT PLAN
T–5	ACCESS ROUTE AND STAGING PLAN

LAYOUT PLAN SHEETS

L–1	LAYOUT PLAN – SHEET 1 OF 2
L–2	LAYOUT PLAN – SHEET 2 OF 2

GRADING PLAN SHEETS

G–1	POND A8S WEST HTZ GRADING PLAN
G–2	POND A8S EAST HTZ GRADING PLAN

Nov 30, 2016 - 12:12pm
C:\pwworking\aecom_na\lchandrasekaran\dms75826\A8_T-1.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE: A8 PONDS TITLE SHEET
SHEET NO. SHT. 1 OF 9 SHTS.
REV
DWG NO. T-1

LEGEND

LINETYPES

Linetype
ALIGNMENT CENTERLINE
EXISTING CONTOUR
PROPOSED MAJOR CONTOUR
PROPOSED MINOR CONTOUR
PROPOSED DAYLIGHT LINE
CONSTRUCTION ACCESS ROUTE
EXISTING TRAIL

PROPOSED EARTHWORK FILL

STAGING AREA

SYMBOLS

CROSS–SECTION

A
8

CROSS SECTION IDENTIFICATION NUMBER

SHEET NUMBER ON WHICH CROSS SECTION IS DRAWN

N

NORTH ARROW

0 100 200 300

HORIZ 1" = 100'

SCALE BAR

ABBREVIATIONS

℄	CENTERLINE
EL	ELEVATION
FT	FEET
HORIZ.	HORIZONTAL
HTZ	HABITAT TRANSITION ZONE
NTS	NOT TO SCALE
STA	STATION
TYP	TYPICAL
VERT.	VERTICAL

GENERAL NOTES

1. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM ARE AS FOLLOWS:
   COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 3
   VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
2. TOPOGRAPHY FROM LIDAR DATA OBTAINED FROM AIRBORNE1 IN U.S. SURVEY FEET, DATED JUNE–NOVEMBER 2010.
3. PROPOSED TOPOGRAPHIC CONTOUR INFORMATION IS SHOWN AT 1–FOOT CONTOUR INTERVALS, UNLESS OTHERWISE STATED.
4. ALL CONSTRUCTION AND CONSTRUCTION MATERIAL SHALL BE IN ACCORDANCE WITH THESE PLANS.
5. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BE KNOWLEDGEABLE ABOUT AND OBEY ALL PERMIT REQUIREMENTS WHILE PERFORMING THE WORK ON THESE PLANS.
6. THE CONTRACTOR SHALL PRACTICE SAFETY AT ALL TIMES AND SHALL FURNISH, ERECT, AND MAINTAIN SUCH FENCES, BARRICADES, LIGHTS, AND SIGNS NECESSARY TO GIVE ADEQUATE PROTECTION TO THE PUBLIC AT ALL TIMES.
7. THE CONTRACTOR SHALL HAVE COPIES OF THE APPROVED PLANS AND SPECIFICATIONS FOR THIS PROJECT AT ALL TIMES AND SHALL BE FAMILIAR WITH ALL APPLICABLE STANDARDS AND SPECIFICATIONS.
8. THE CONTRACTOR IS RESPONSIBLE FOR SETTING ONSITE SURVEY CONTROL FOR CONSTRUCTION STAKING IN PROJECT COORDINATE SYSTEM AND VERTICAL DATUM.
9. UNDERGROUND FACILITIES AND SUB–STRUCTURES SHOWN IN THESE PLANS WERE OBTAINED FROM THE BEST AVAILABLE SOURCES. HOWEVER, SINCE SOME INFORMATION WAS OBTAINED FROM OTHERS, AECOM CANNOT GUARANTEE SAID INFORMATION AS BEING ACCURATE. PRIOR TO BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY THE DEPTH AND LOCATION OF ALL EXISTING UTILITIES, EQUIPMENT, AND SUB–STRUCTURES. IN THE EVENT OF DAMAGE TO EXISTING UTILITIES, EQUIPMENT, OR SUB–STRUCTURES, THE CONTRACTOR SHALL PERFORM ALL REPAIRS AT THEIR EXPENSE.

EARTHWORK SUMMARY

HABITAT TRANSITON ZONES	184,300 CY (FILL, INCLUDES 3% FOR SHRINKAGE)

Dec 08, 2016 - 12:00pm C:\pwworking\aecom_na\chandrasekaranl\dms75826\A8_T-2.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

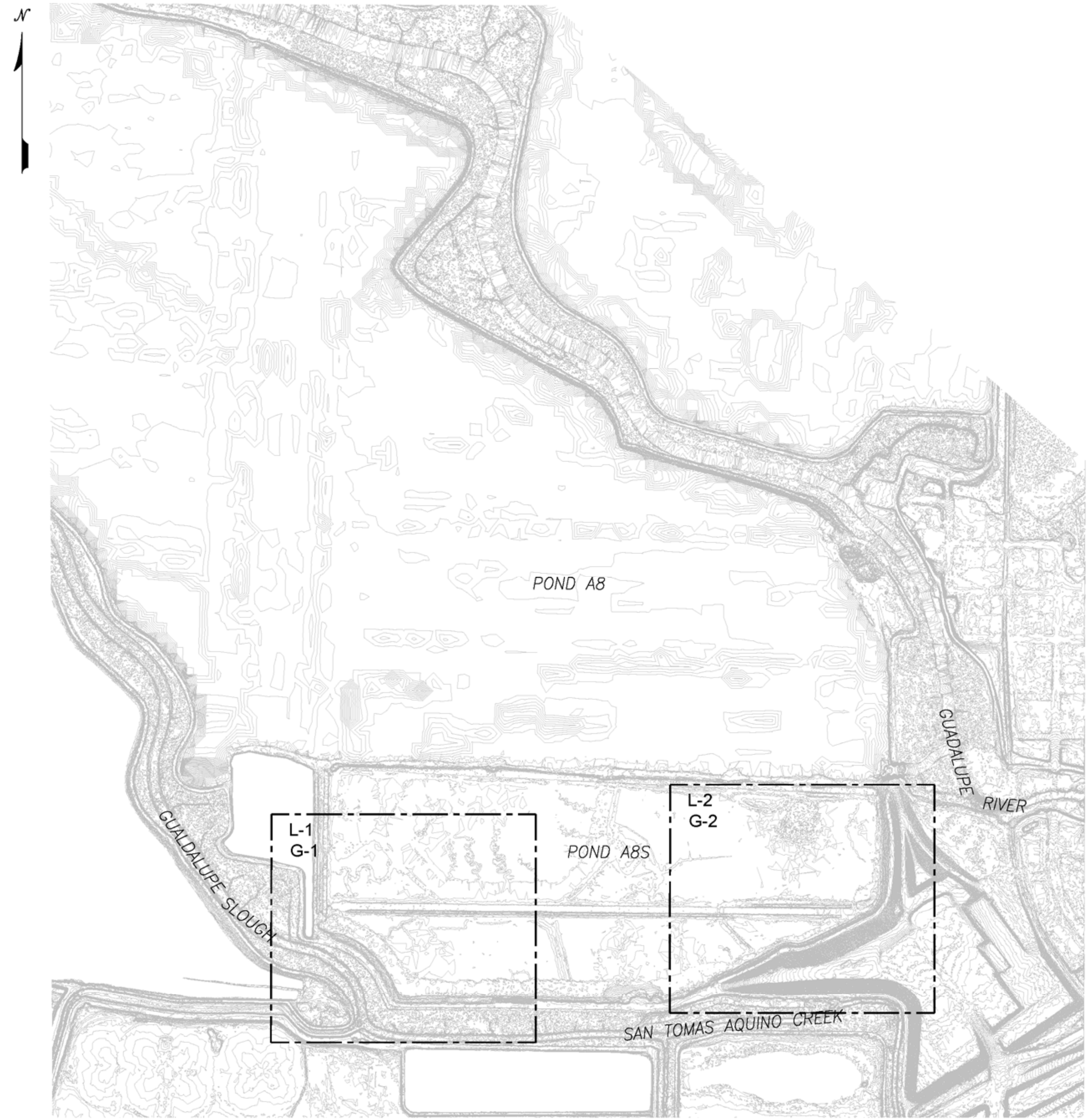
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE A8 PONDS NOTES AND LEGEND

SHEET NO. SHT. 2 OF 9 SHTS.
REV
DWG NO. T-2



PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

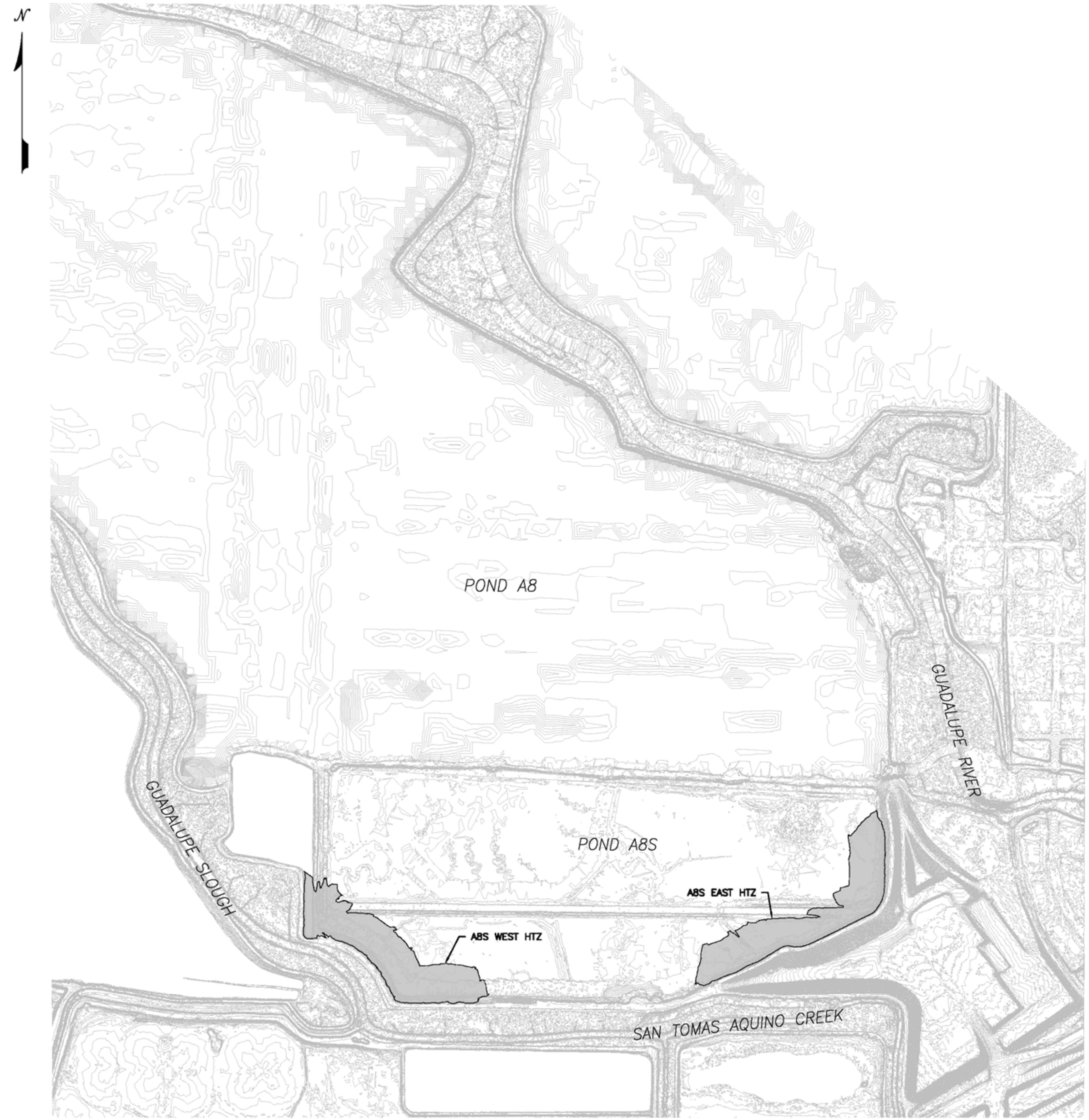
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
KEY MAP

SHEET NO.
SHT. 3 OF 9 SHTS.
REV

DWG NO.
T-3



PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

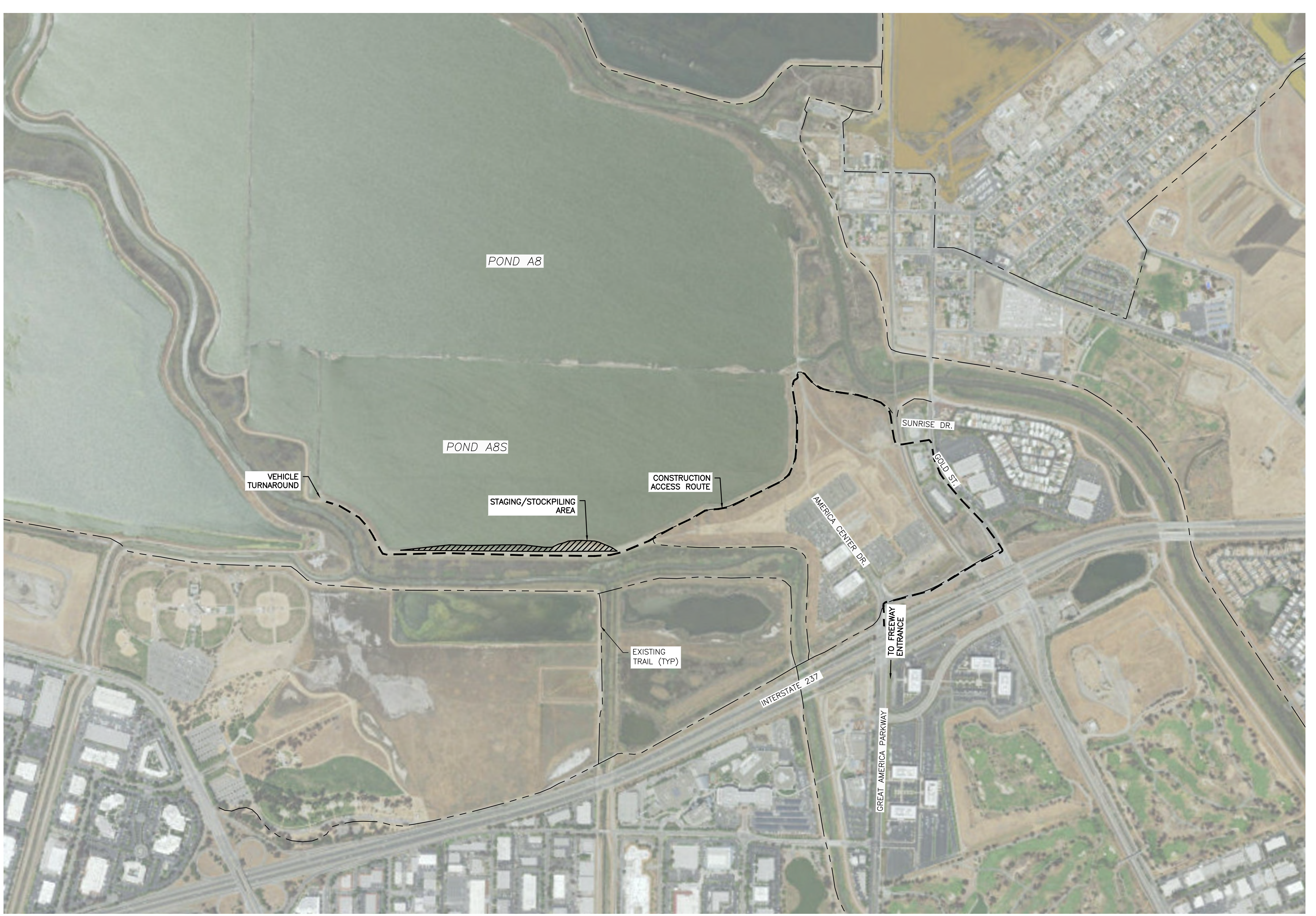
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
GENERAL ARRANGEMENT PLAN

SHEET NO.
SHT. 4 OF 9 SHTS.
REV

DWG NO.
T-4

Nov 30, 2016 - 3:03pm
C:\pwworking\aecom_na\chandrasekaranl\dms75826\A8_T-4.dwg



NOTES

1. THE ACCESS ROUTES ARE PRELIMINARY AND INTENDED FOR PLANNING AND IMPACT ANALYSIS PURPOSES ONLY.
2. THE CONTRACTOR MAY LOCATE FILL MATERIAL WITHIN THE INDICATED STOCKPILING AREA.

PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

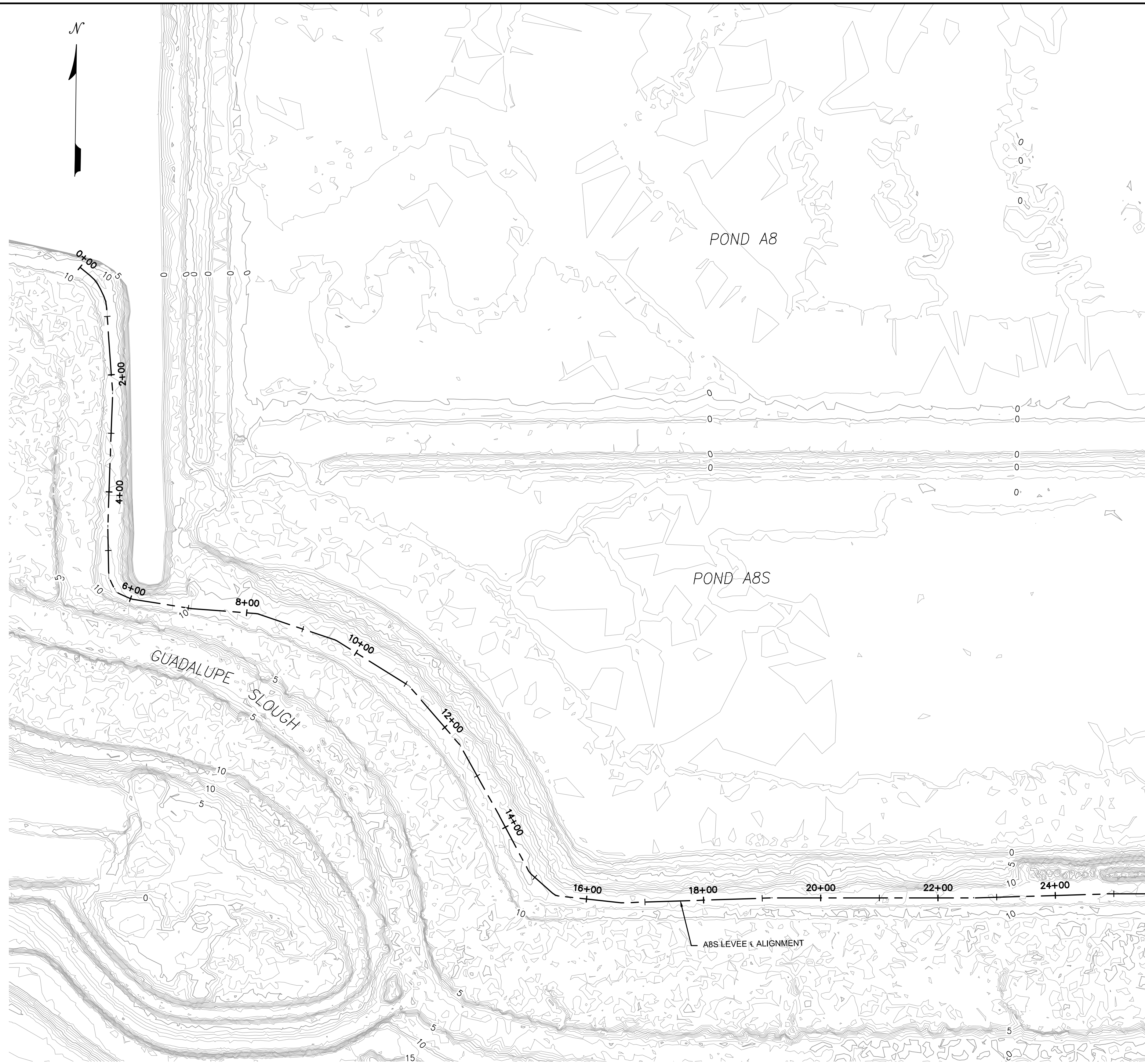
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
ACCESS ROUTE & STAGING PLAN

SHEET NO. SHT. 5 OF 9 SHTS.
REV
DWG NO. T-5

Dec 08, 2016 - 11:44am
C:\pwworking\aecom_na\chandrasekaranl\dms75826\A8_T-5.dwg



PLAN
1"=100'

0 100 200 300
HORIZ 1" = 100'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

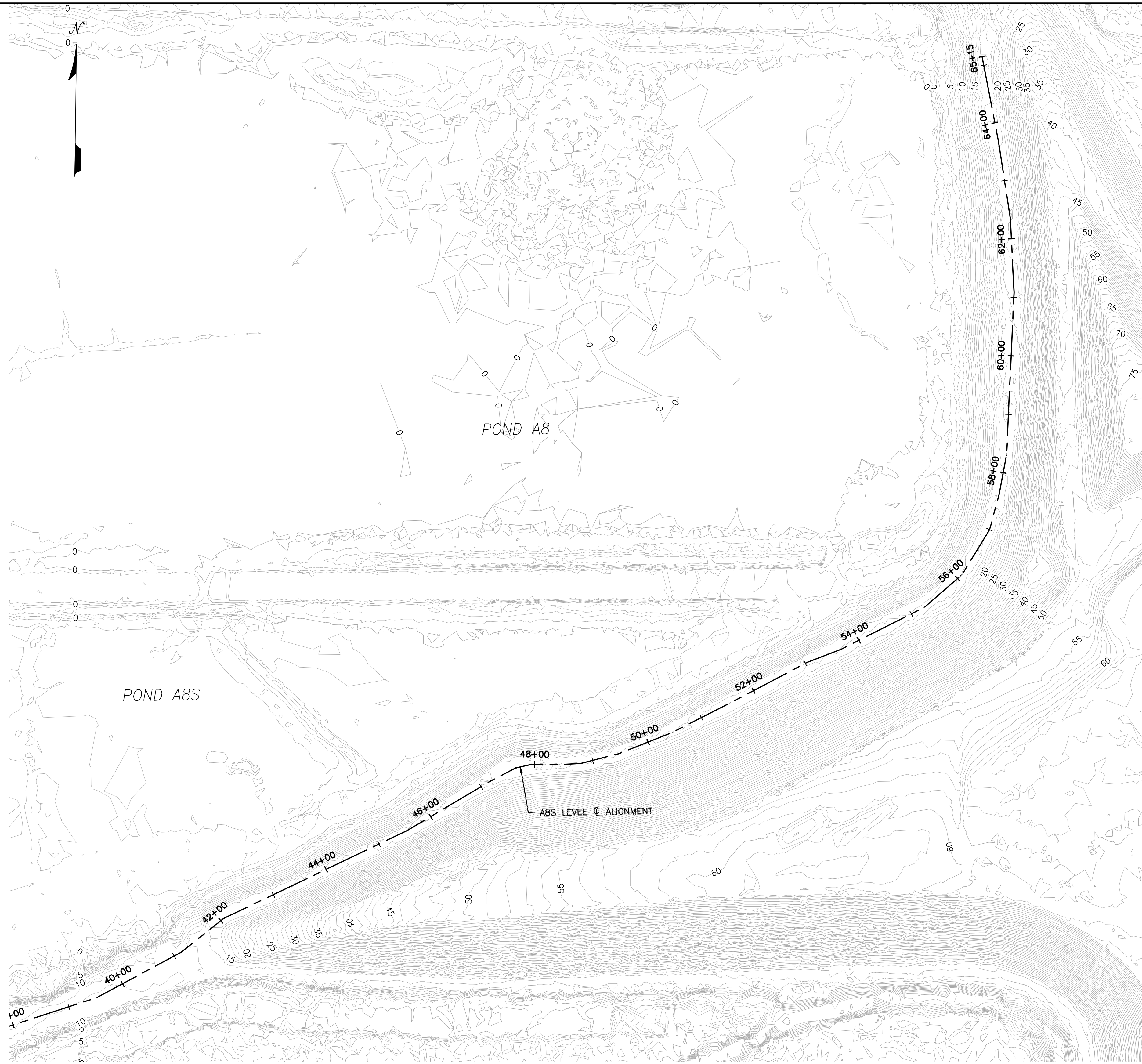
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
LAYOUT PLAN - SHEET 1 OF 2

SHEET NO. SHT. 6 OF 9 SHTS.
REV
DWG NO. L-1

Dec 01, 2016 - 9:32am
C:\pwworking\aecom_na\lchandrasekaran\dms75826\A8_L-1.dwg



PLAN
1"=100'

0 100 200 300
HORIZ 1" = 100'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

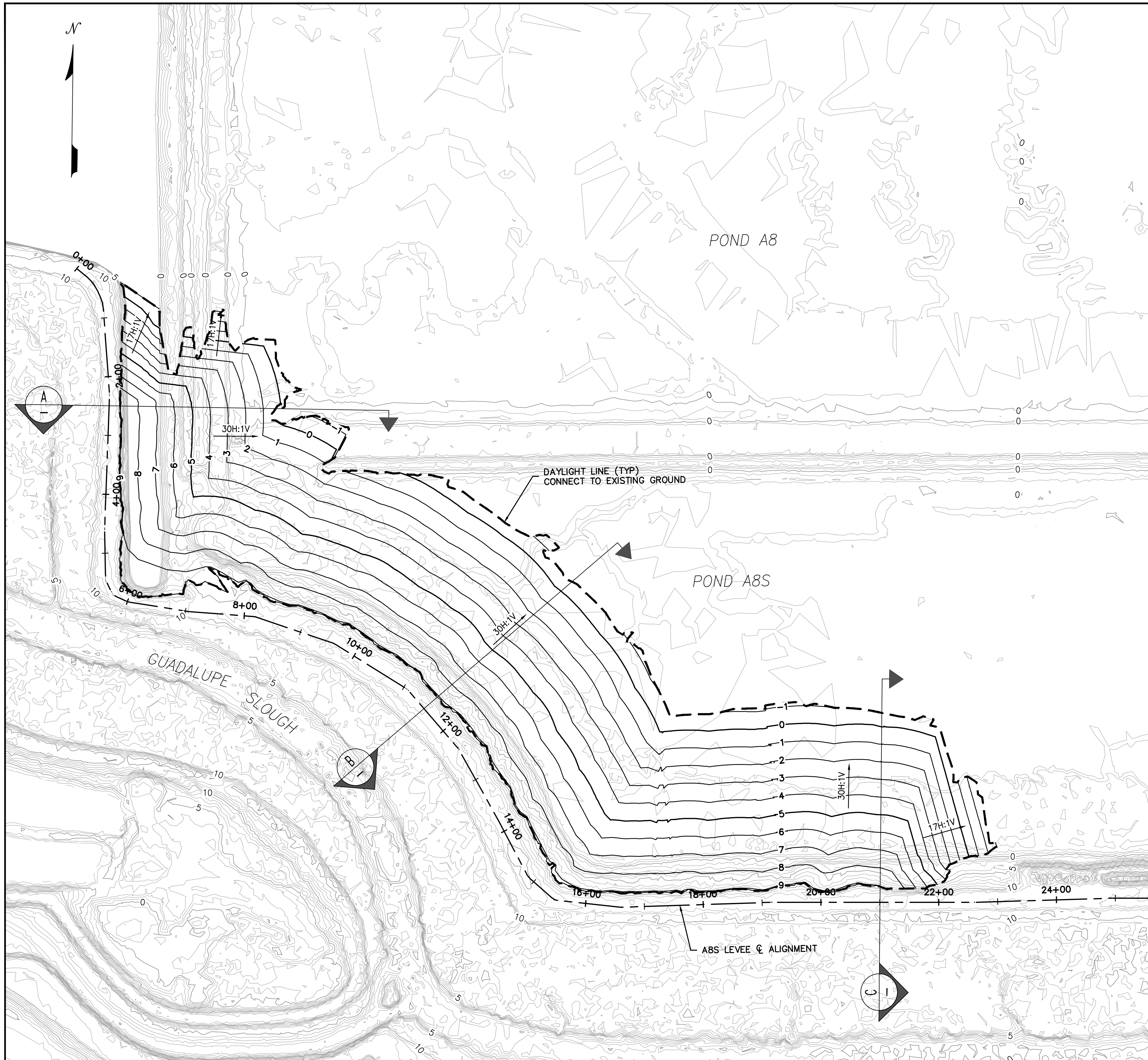
PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
LAYOUT PLAN - SHEET 2 OF 2

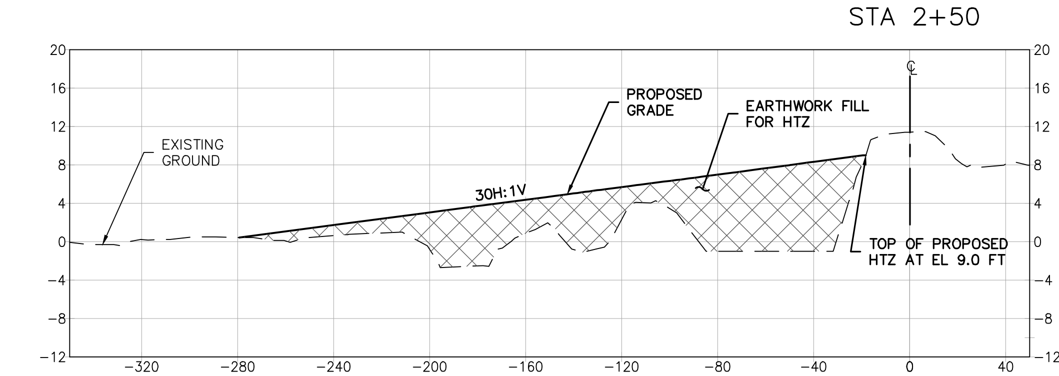
SHEET NO. SHT. 7 OF 9 SHTS.
REV
DWG NO. L-2

Dec 01, 2016 - 8:53am
C:\pwworking\aecom_na\lchandrasekaran\dms75826\A8_L-2.dwg

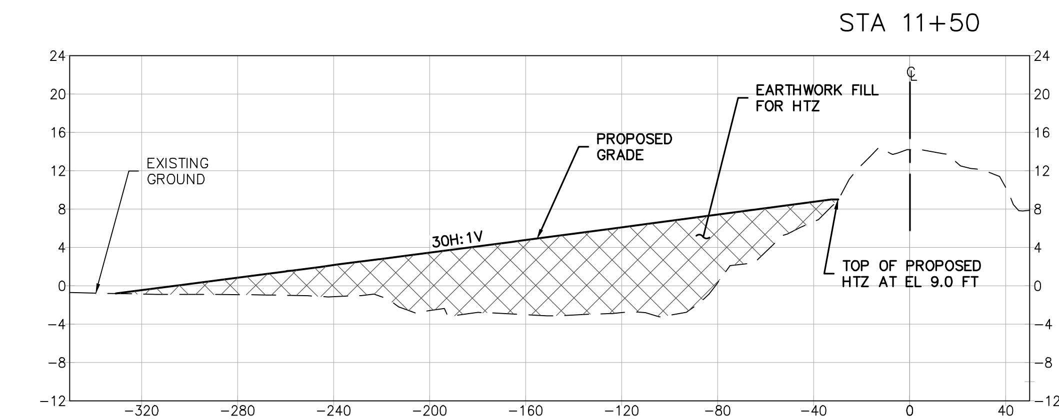


PLAN
1"=100'

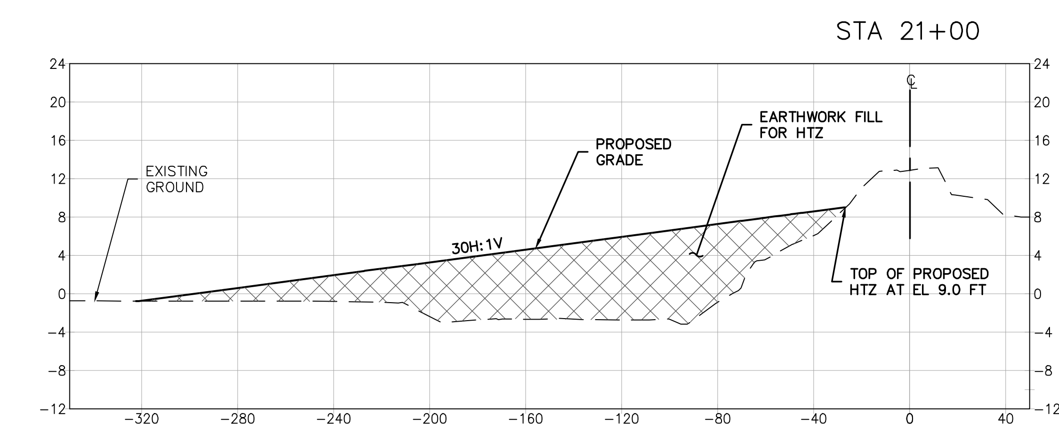
0 100 200 300
HORIZ 1" = 100'



A A8S WEST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10



B A8S WEST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10



C A8S WEST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

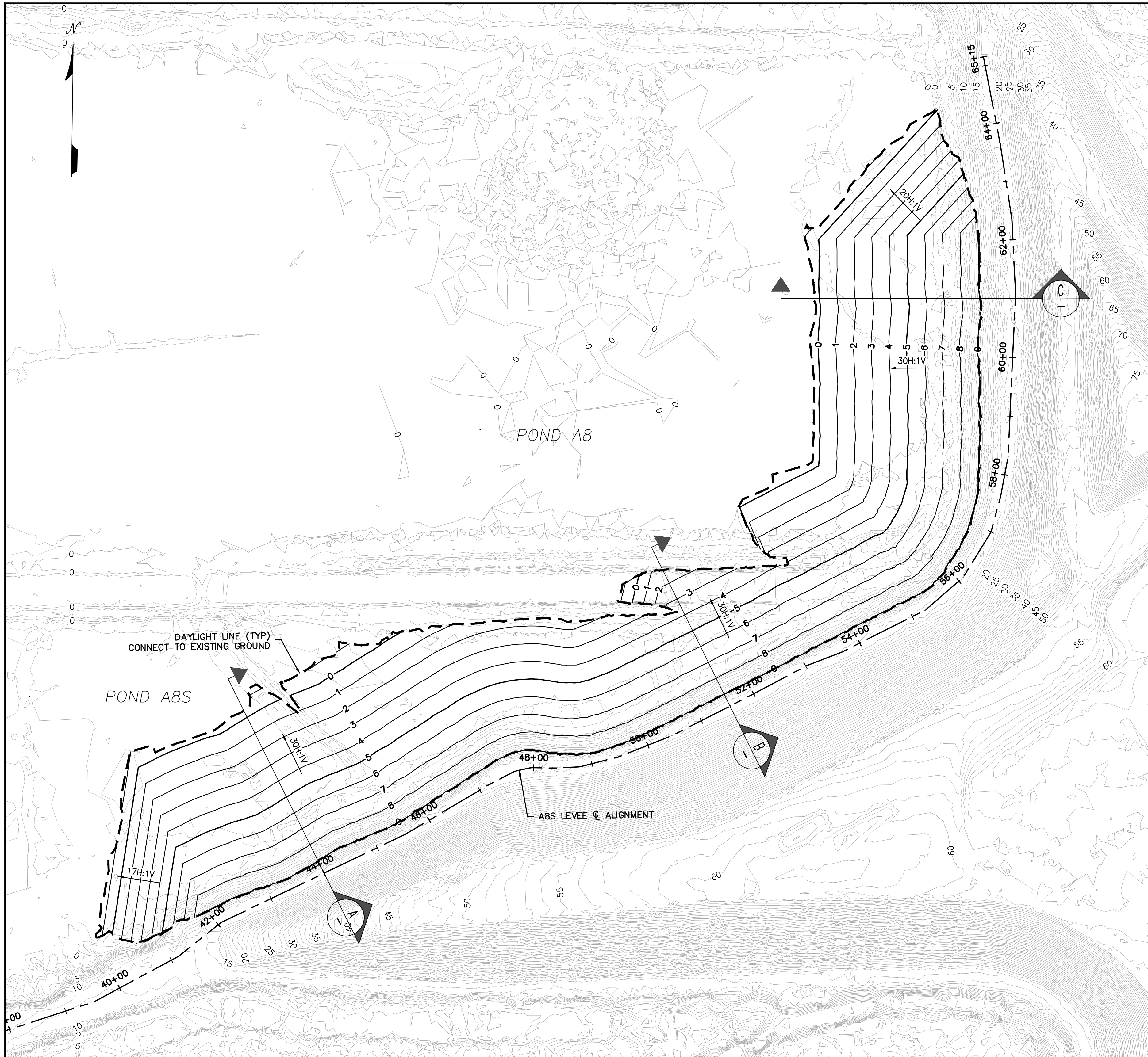
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
POND A8S WEST HTZ
GRADING PLAN

SHEET NO.
SHT. 8 OF 9 SHTS.
REV

DWG NO.
G-1

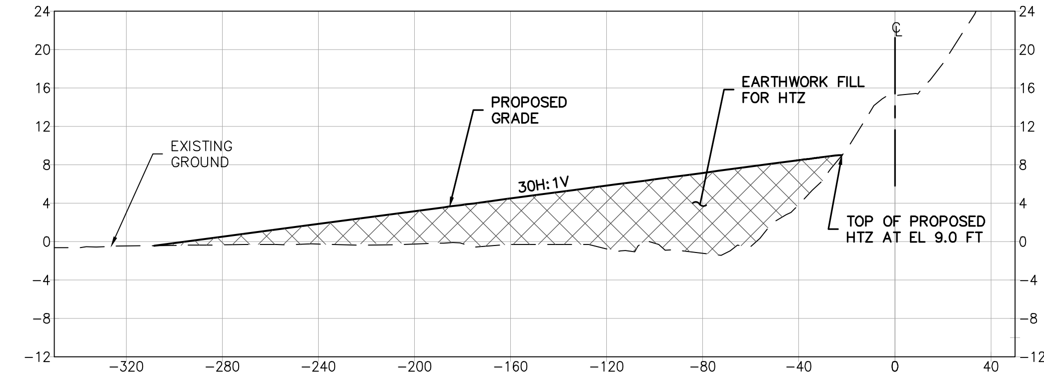
Dec 01, 2016 - 9:56am
C:\pwworking\aecom_na\chandrasekaranl\dms75826\A8_G-1.dwg



PLAN
1"=100'

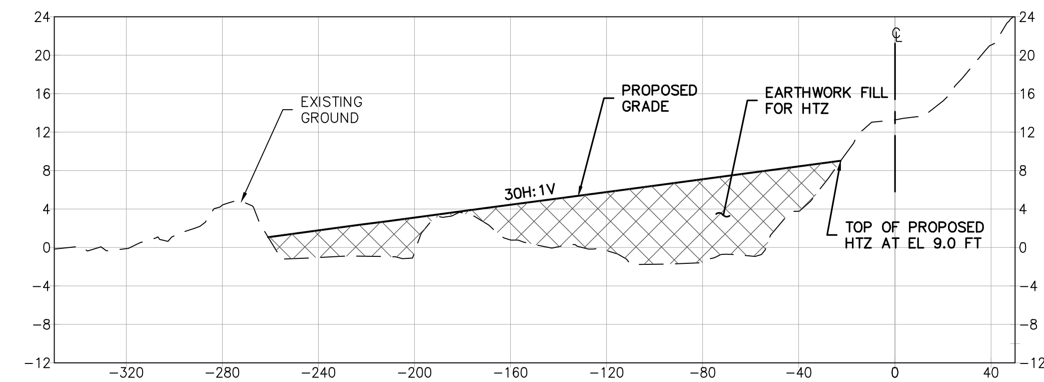
0 100 200 300
HORIZ 1" = 100'

STA 44+00



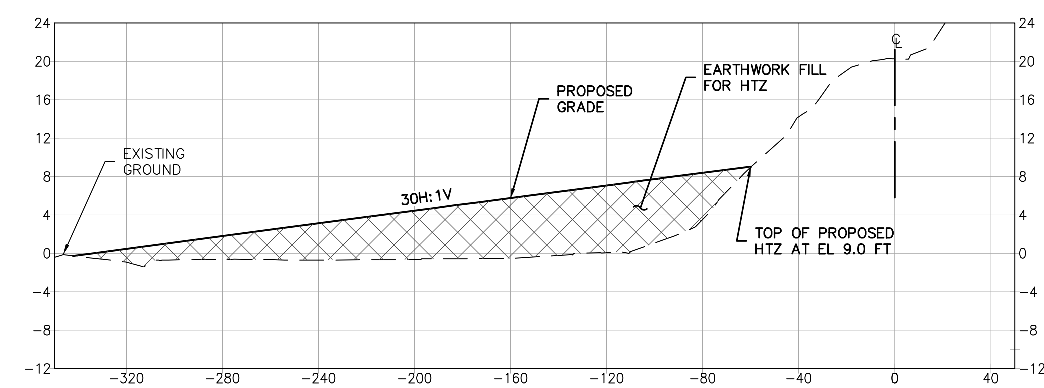
A A8S EAST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

STA 51+50



B A8S EAST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

STA 61+00



C A8S EAST HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 11-30-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
A8 PONDS
POND A8S EAST HTZ
GRADING PLAN

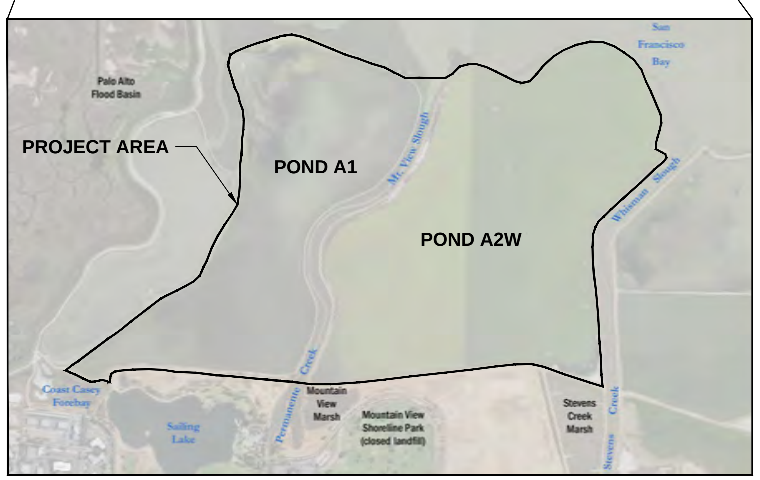
SHEET NO. SHT. 9 OF 9 SHTS.
REV
DWG NO. G-2

Dec 01, 2016 - 9:06am
C:\pwworking\aecom_na\lchandrasekaranl\dms75826\A8_G-2.dwg

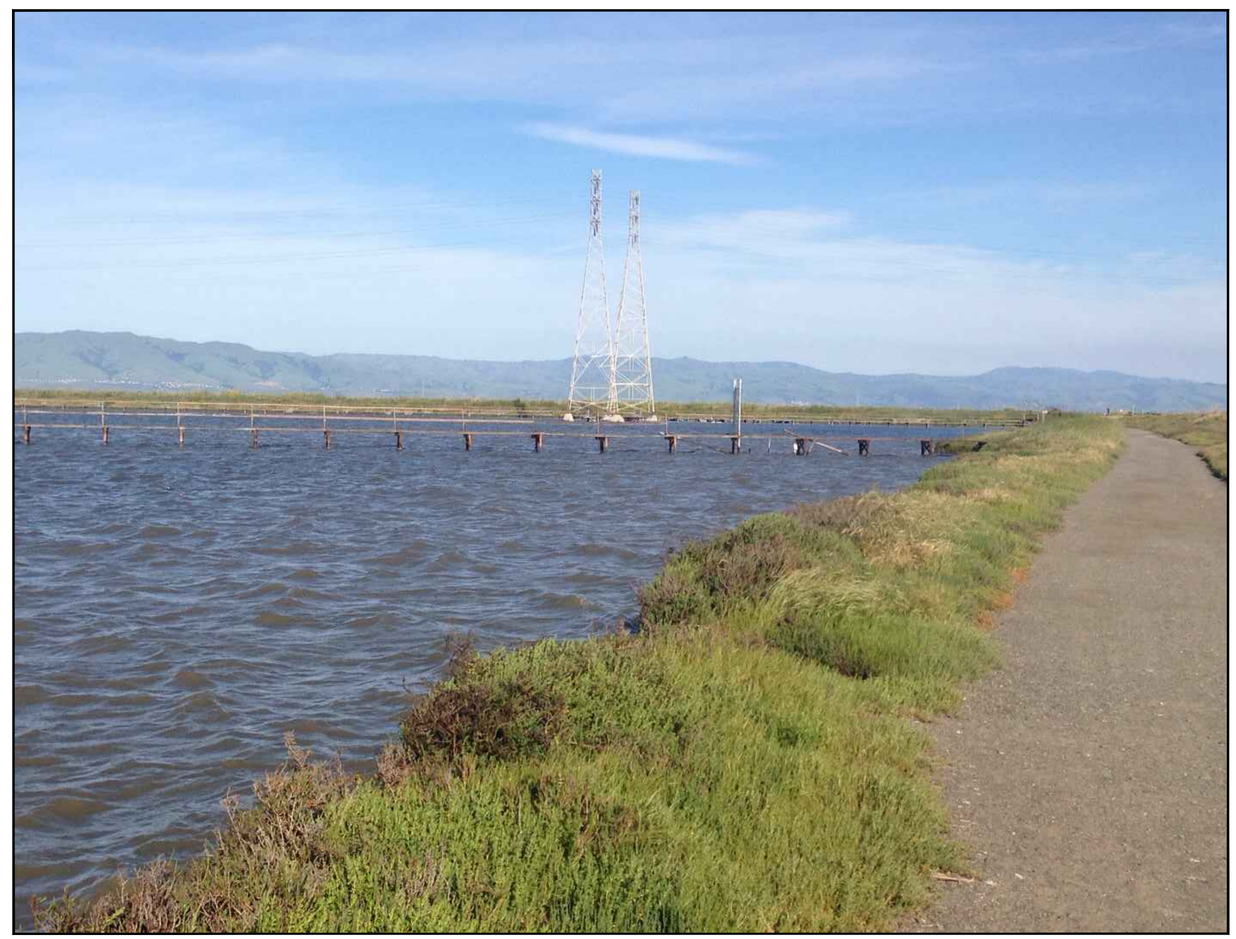
SOUTH BAY SALT POND RESTORATION PROJECT

MOUNTAIN VIEW PONDS
NEAR MOUNTAIN VIEW, CALIFORNIA

VICINITY MAP
NTS



LOCATION MAP
NTS



PROJECT AREA PHOTO

SHEETS

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE: MOUNTAIN VIEW PONDS TITLE SHEET

SHEET NO. SHT. 1 OF 33 SHTS.
REV
DWG NO. T-1

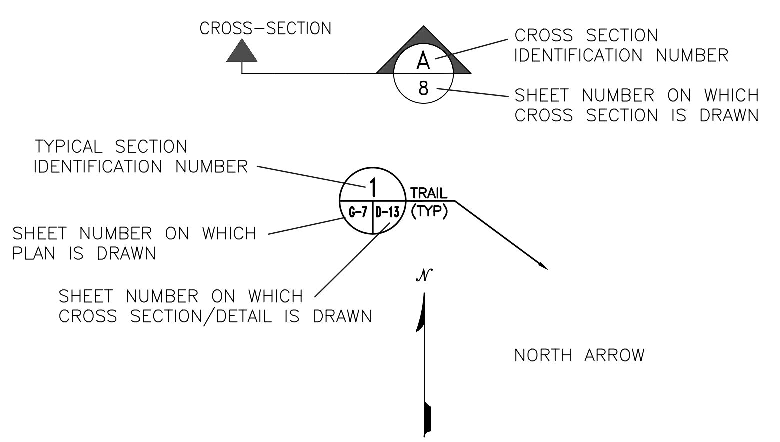
LEGEND

LINETYPES

- ALIGNMENT CENTERLINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DAYLIGHT LINE
- CONSTRUCTION ACCESS ROUTE
- EXISTING TRAIL
- PROPOSED TRAIL
- PG&E POWER LINE
- RAILING
- CHAIN LINK FENCE WITH GATE

- PROPOSED EARTHWORK FILL
- PROPOSED EARTHWORK CUT
- PROPOSED EXCAVATION/BACKFILL FOR SHEAR KEY
- TRAIL/IMPROVED SURFACE
- STAGING AREA

SYMBOLS



0 100 200 300
HORIZ 1" =100'
SCALE BAR

ABBREVIATIONS

BB	BEGIN BRIDGE	NTS	NOT TO SCALE
℄	CENTERLINE	PG&E	PACIFIC GAS AND ELECTRIC COMPANY
CCF	COAST CASEY FOREBAY	STA	STATION
EB	END BRIDGE	TYP	TYPICAL
EL	ELEVATION	VERT.	VERTICAL
FT	FEET		
HDPE	HIGH DENSITY POLYETHYLENE		
HORIZ.	HORIZONTAL		
HTZ	HABITAT TRANSITION ZONE		

GENERAL NOTES

1. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM ARE AS FOLLOWS:
   COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 3
   VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
2. TOPOGRAPHY FROM LIDAR DATA OBTAINED FROM AIRBORNE1 IN U.S. SURVEY FEET, DATED JUNE–NOVEMBER 2010. THE TOPOGRAPHY FOR THE BOTTOMS OF PONDS A1 AND A2W IS BASED ON 2005 USGS BATHYMETRY FOR THE SOUTH BAY SALT POND PROJECT.
3. PROPOSED TOPOGRAPHIC CONTOUR INFORMATION IS SHOWN AT 1–FOOT CONTOUR INTERVALS, UNLESS OTHERWISE STATED.
4. ALL CONSTRUCTION AND CONSTRUCTION MATERIAL SHALL BE IN ACCORDANCE WITH THESE PLANS.
5. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BE KNOWLEDGEABLE ABOUT AND OBEY ALL PERMIT REQUIREMENTS WHILE PERFORMING THE WORK ON THESE PLANS.
6. THE CONTRACTOR SHALL PRACTICE SAFETY AT ALL TIMES AND SHALL FURNISH, ERECT, AND MAINTAIN SUCH FENCES, BARRICADES, LIGHTS, AND SIGNS NECESSARY TO GIVE ADEQUATE PROTECTION TO THE PUBLIC AT ALL TIMES.
7. THE CONTRACTOR SHALL HAVE COPIES OF THE APPROVED PLANS AND SPECIFICATIONS FOR THIS PROJECT AT ALL TIMES AND SHALL BE FAMILIAR WITH ALL APPLICABLE STANDARDS AND SPECIFICATIONS.
8. THE CONTRACTOR IS RESPONSIBLE FOR SETTING ONSITE SURVEY CONTROL FOR CONSTRUCTION STAKING IN PROJECT COORDINATE SYSTEM AND VERTICAL DATUM.
9. UNDERGROUND FACILITIES AND SUB–STRUCTURES SHOWN IN THESE PLANS WERE OBTAINED FROM THE BEST AVAILABLE SOURCES. HOWEVER, SINCE SOME INFORMATION WAS OBTAINED FROM OTHERS, AECOM CANNOT GUARANTEE SAID INFORMATION AS BEING ACCURATE. PRIOR TO BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY THE DEPTH AND LOCATION OF ALL EXISTING UTILITIES, EQUIPMENT, AND SUB–STRUCTURES. IN THE EVENT OF DAMAGE TO EXISTING UTILITIES, EQUIPMENT, OR SUB–STRUCTURES, THE CONTRACTOR SHALL PERFORM ALL REPAIRS AT THEIR EXPENSE.
10. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY OF ALL EXCAVATIONS.

EARTHWORK SUMMARY

LEVEE IMPROVEMENTS (INCLUDING TRAIL CONNECTIONS)	144,300 CY (FILL, INCLUDES SHRINKAGE OF 24% FOR A1 WEST LEVEE AND 28% FOR COAST CASEY FOREABY LEVEE)
HABITAT TRANSITION ZONES	161,900 CY (FILL, INCLUDES 3% FOR SHRINKAGE)
HABITAT ISLANDS	58,400 CY (FILL, INCLUDES 9% FOR SHRINKAGE)
BREACH EXCAVATION	12,100 CY (CUT, BANK–MEASURE)
SHEAR KEY EXCAVATION	3,100 CY (CUT, BANK–MEASURE)
SHEAR KEY BACKFILL	4,000 CY (FILL, INCLUDES 28% FOR SHRINKAGE)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

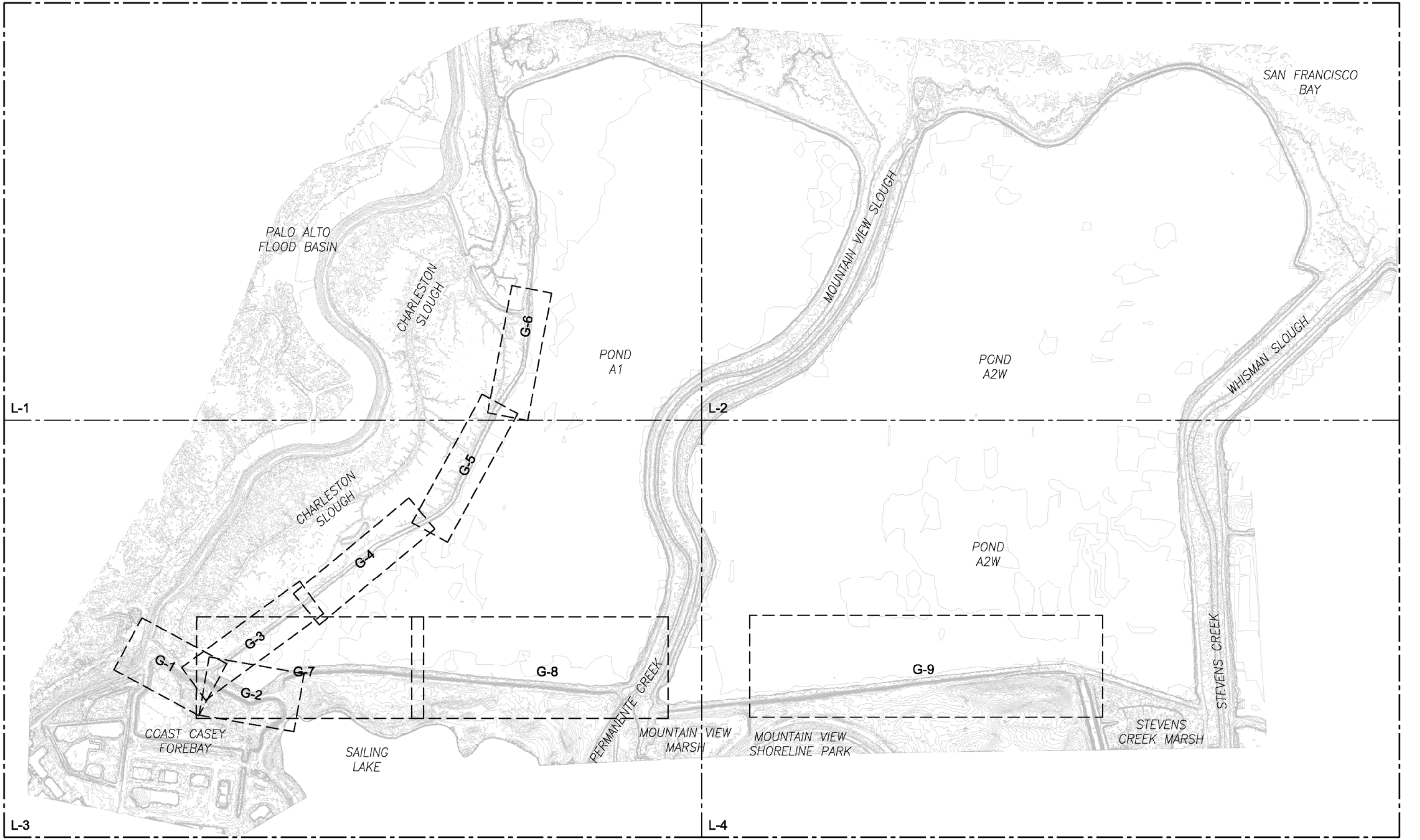
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE MOUNTAIN VIEW PONDS NOTES AND LEGEND

SHEET NO. SHT. 2 OF 33 SHTS.
DWG NO. T-2
REV

Dec 10, 2016 - 3:52pm
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_T-2.dwg



PLAN
1"=400'

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

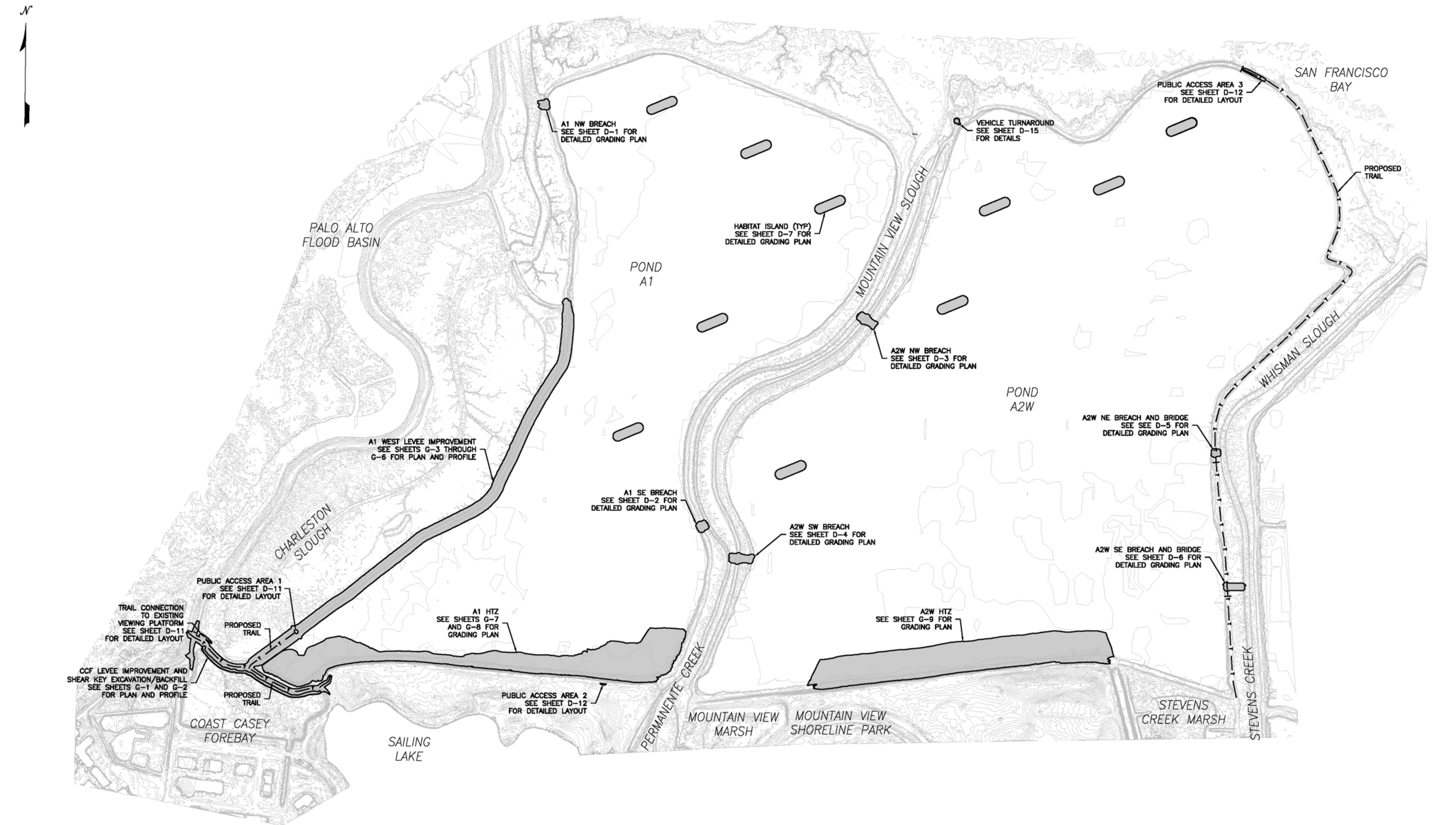
DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE: MOUNTAIN VIEW PONDS KEY MAP

SHEET NO. SHT. 3 OF 33 SHTS.
DWG NO. T-3
REV



PLAN
1"=400'

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE: MOUNTAIN VIEW PONDS GENERAL ARRANGEMENT PLAN

SHEET NO. SHT. 4 OF 33 SHTS. REV

DWG NO. T-4

Dec 09, 2016 - 12:05pm
C:\pwworking\aecom_na\chandrasekaranl\dms75627\MV_T-4.dwg

NOTES

1. THE ACCESS ROUTES SHOWN ARE PRELIMINARY AND INTENDED FOR PLANNING AND IMPACT ANALYSIS PURPOSES. THE EXACT ROUTES WILL BE FINALIZED BY THE CITY OF MOUNTAIN VIEW BASED ON REQUIREMENTS FOR TRAFFIC CONTROL, SHORELINE PARK ACTIVITIES, AND BURROWING OWL PROTECTION.

2. THE CONTRACTOR MAY LOCATE FILL MATERIAL WITHIN THE INDICATED STOCKPILING AREA.

PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

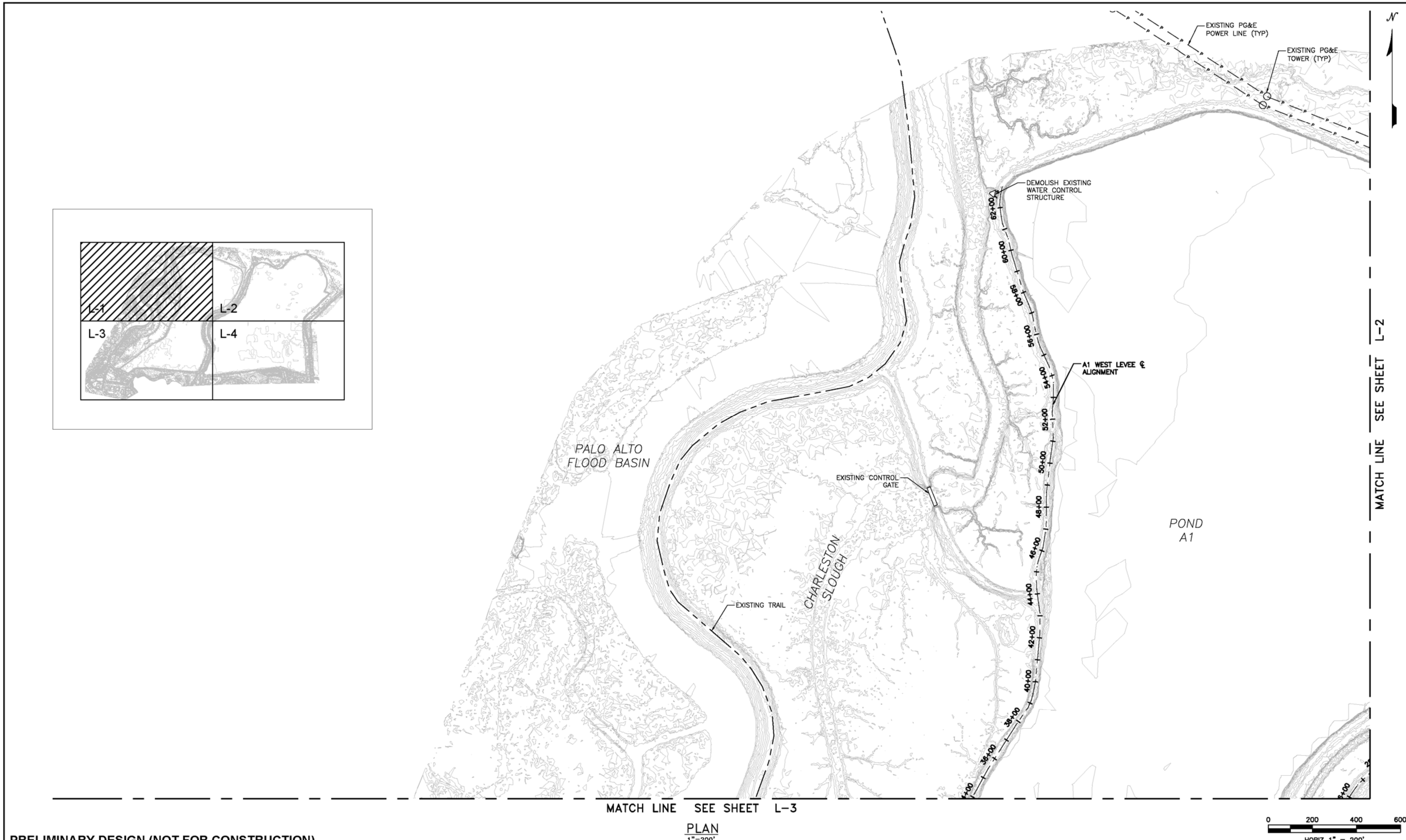
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE MOUNTAIN VIEW PONDS ACCESS ROUTE & STAGING PLAN

SHEET NO. SHT. 5 OF 33 SHTS.
REV
DWG NO. T-5

Dec 09, 2016 - 8:05am
C:\pwworking\aecom_na\lchandrasekaranl\dms75827\MV_T-5.dwg



PLAN
1"=200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

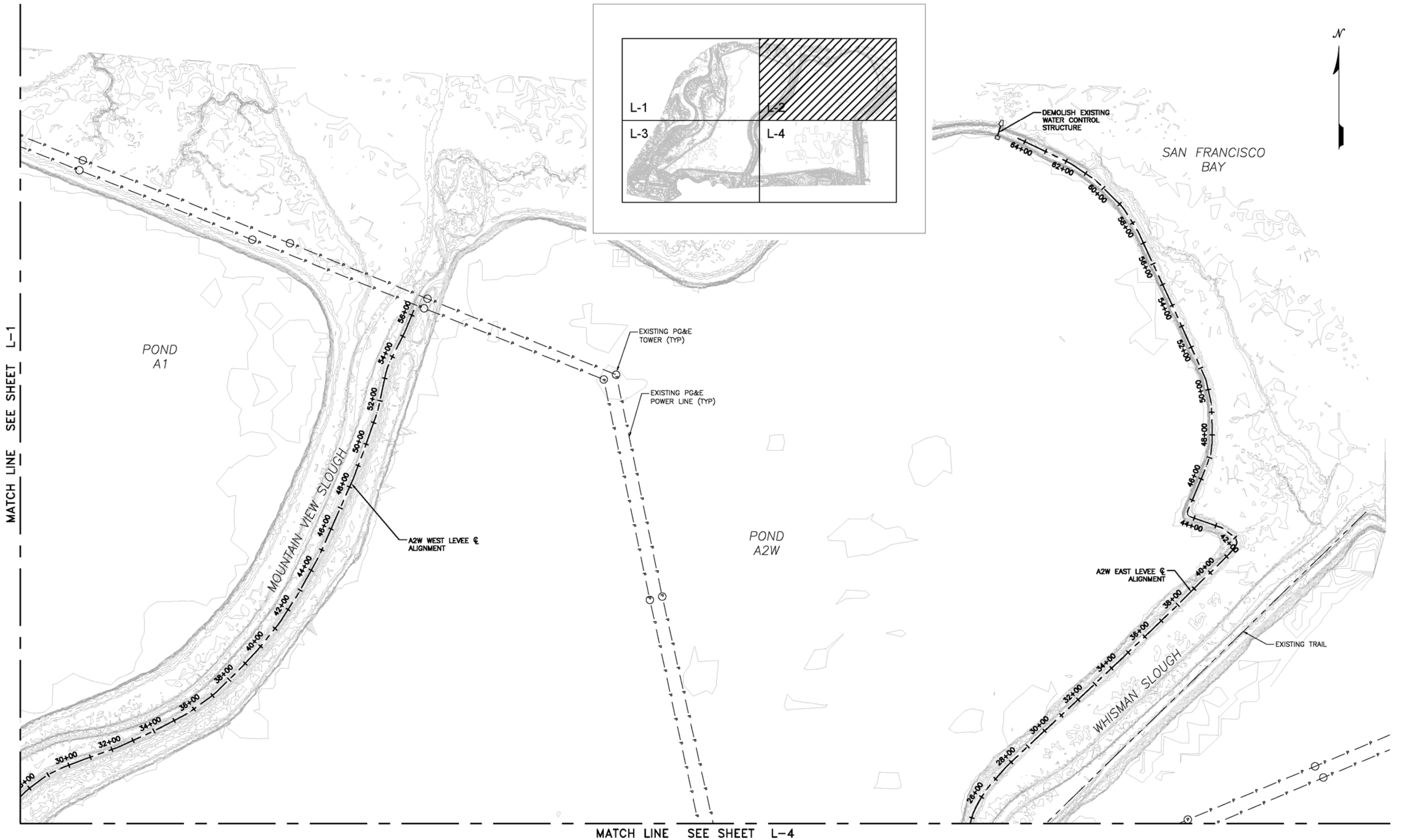
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
LAYOUT PLAN
SHEET 1 OF 4

SHEET NO. SHT. 6 OF 33 SHTS.
REV
DWG NO. L-1

Dec 09, 2016 - 8:11am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_L-1.dwg



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

PLAN
1"=200'

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

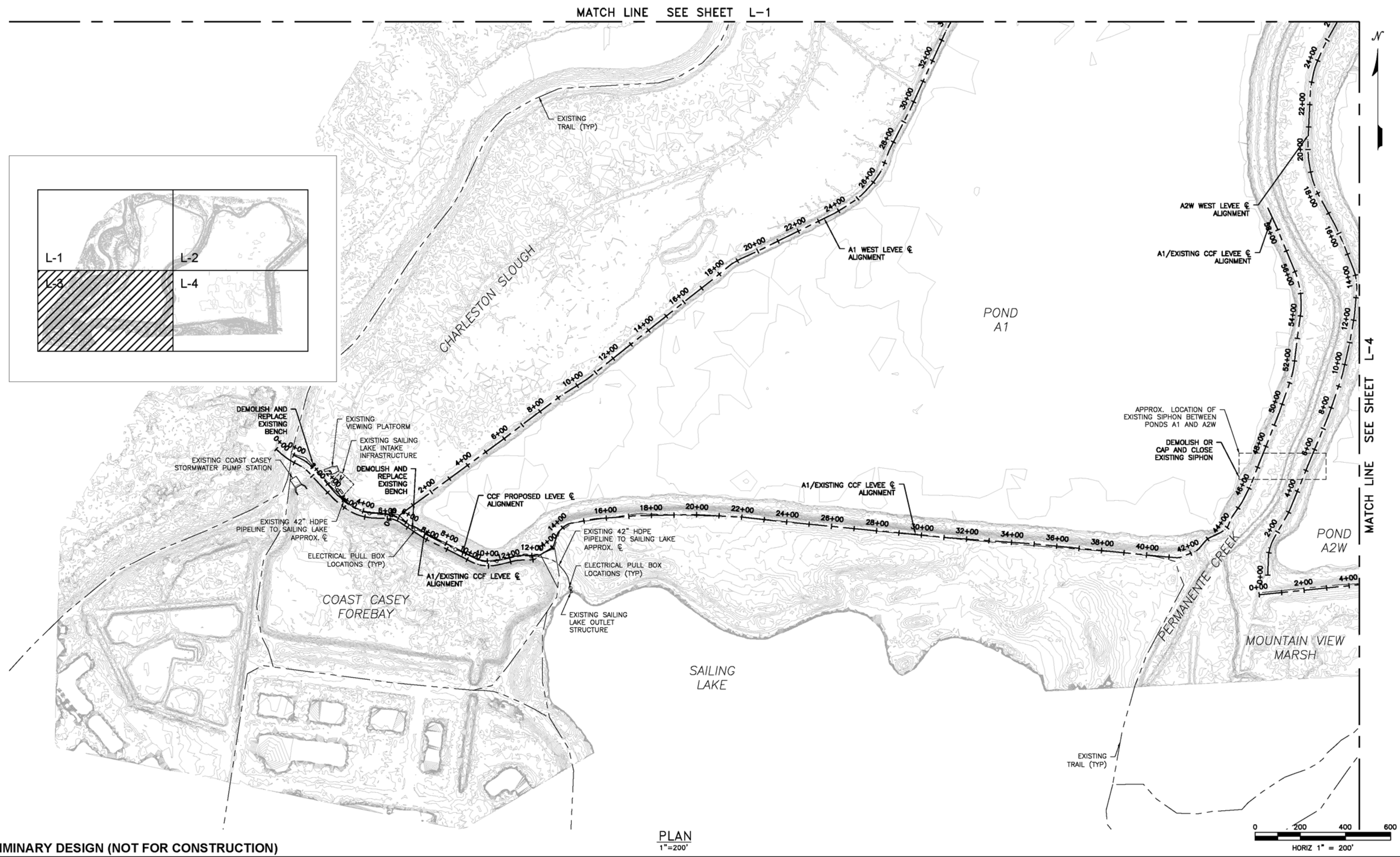
DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
MOUNTAIN VIEW PONDS
LAYOUT PLAN
SHEET 2 OF 4

SHEET NO. SHT. 7 OF 33 SHTS.
DWG NO. L-2
REV

Dec 09, 2016 - 8:16am



PLAN
1"=200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE: MOUNTAIN VIEW PONDS LAYOUT PLAN SHEET 3 OF 4

SHEET NO. SHT 8 OF 33 SHTS
REV
DWG NO. L-3

Dec 09, 2016 - 8:20am

MATCH LINE SEE SHEET L-2

PLAN
1"=200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

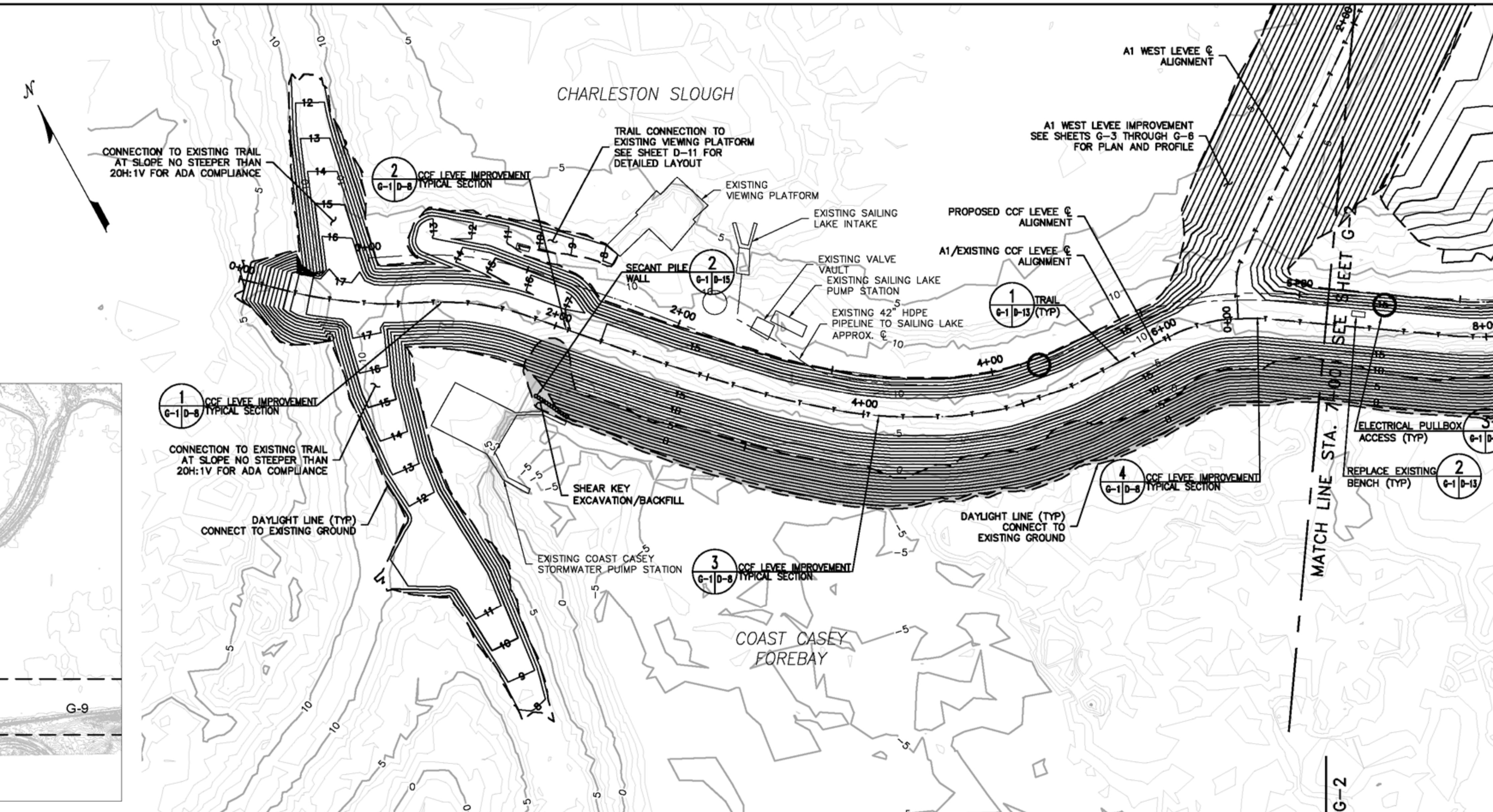
PROJECT No. 60422372
DATE 12-09-2016

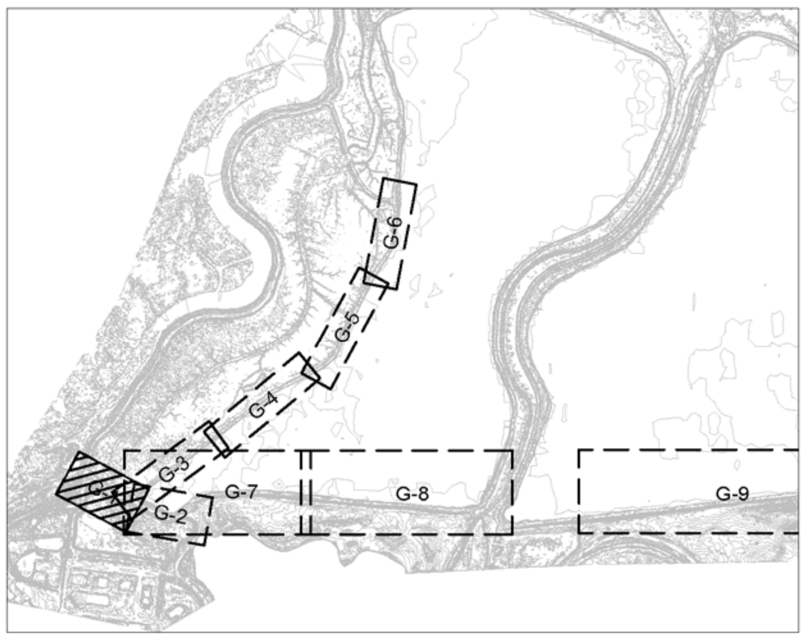
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
LAYOUT PLAN
SHEET 4 OF 4

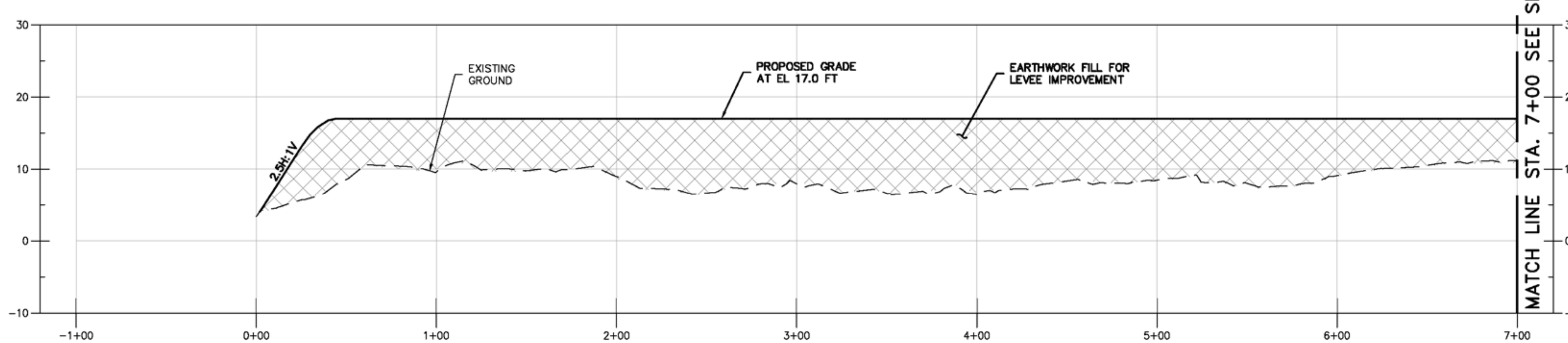
SHEET NO. SHT. 9 OF 33 SHTS.
REV
DWG NO. L-4

Dec 09, 2016 - 8:23am





PLAN
1"=40'



PROPOSED CCF LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

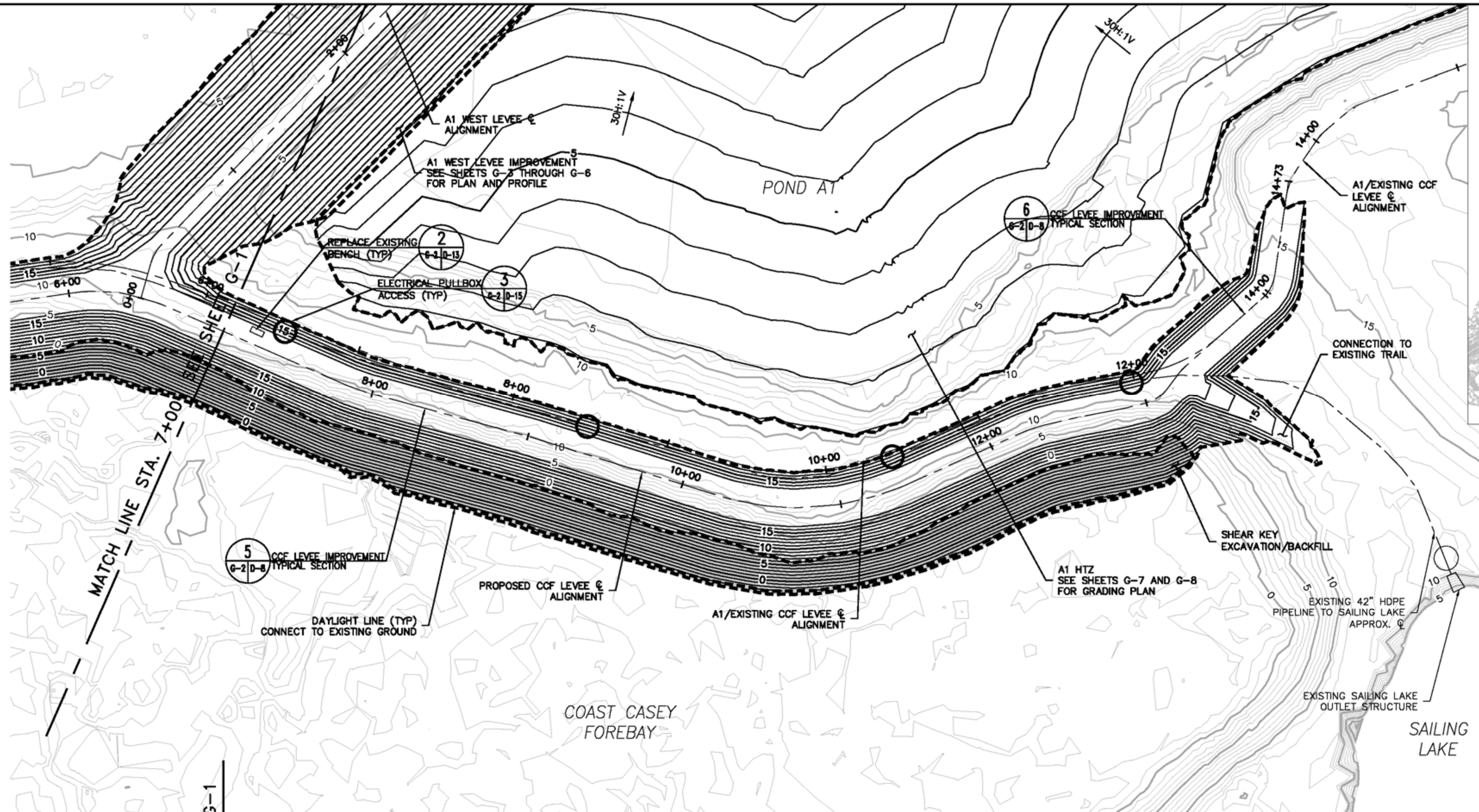
STATE OF CALIFORNIA
Coastal Conservancy

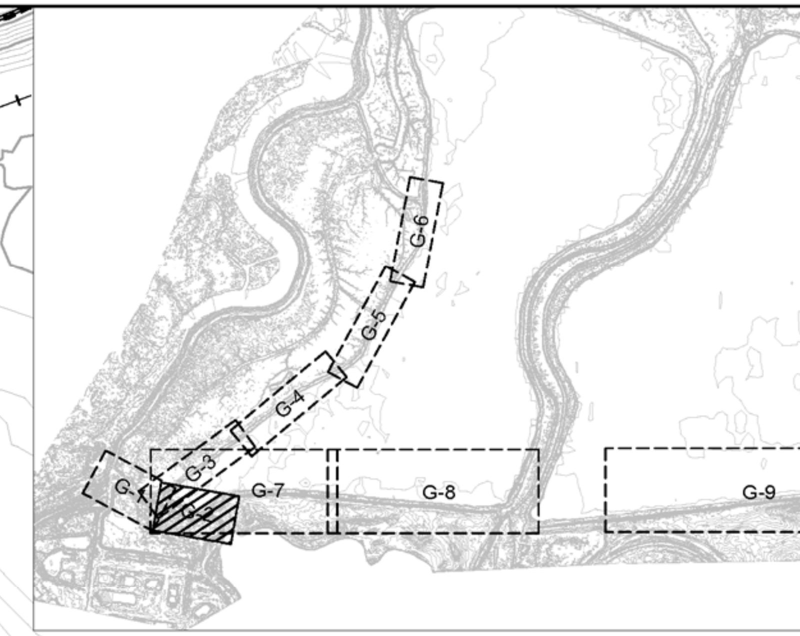
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

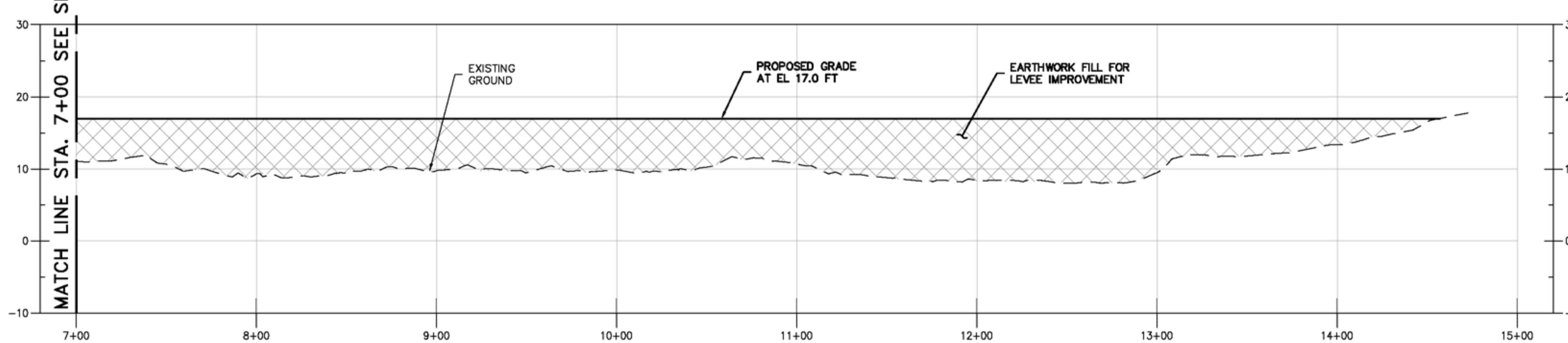
SHEET TITLE
MOUNTAIN VIEW PONDS
CCF LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 1 OF 2

SHEET NO. SHT. 10 OF 33 SHTS.
REV
DWG NO. G-1





PLAN
1"=40'



PROPOSED CCF LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'

0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

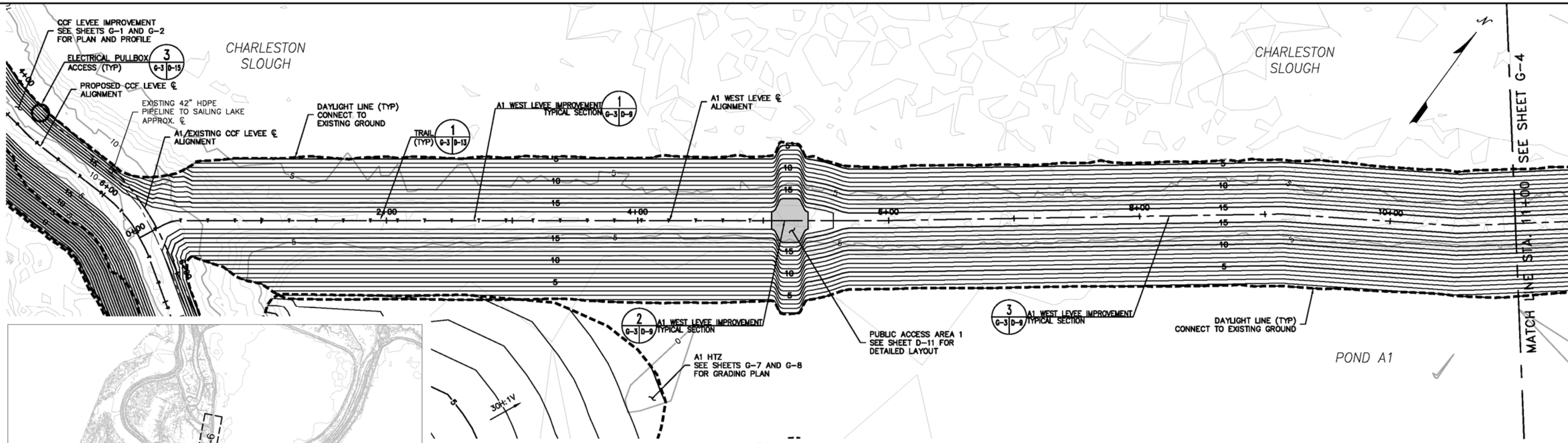
PROJECT No. 60422372
DATE 12-09-2016

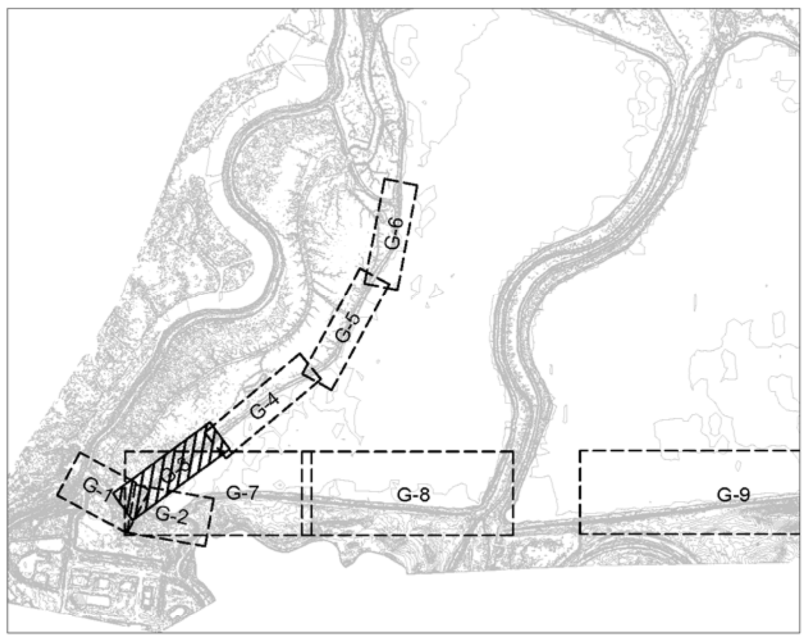
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
CCF LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 2 OF 2

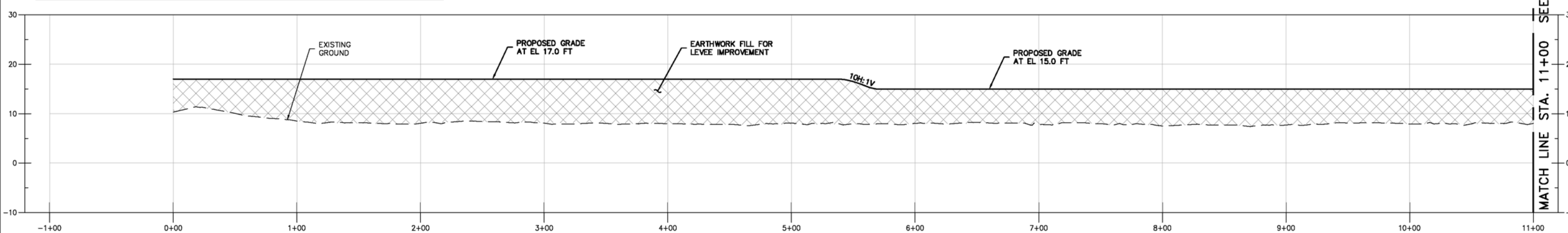
SHEET NO. SHT 11 OF 33 SHTS
REV
DWG NO. G-2

Dec 09, 2016 - 8:32am
C:\pwwork\lchandrasekaran\dms75827\MV_G-2.dwg





PLAN
1"=40'



A1 WEST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

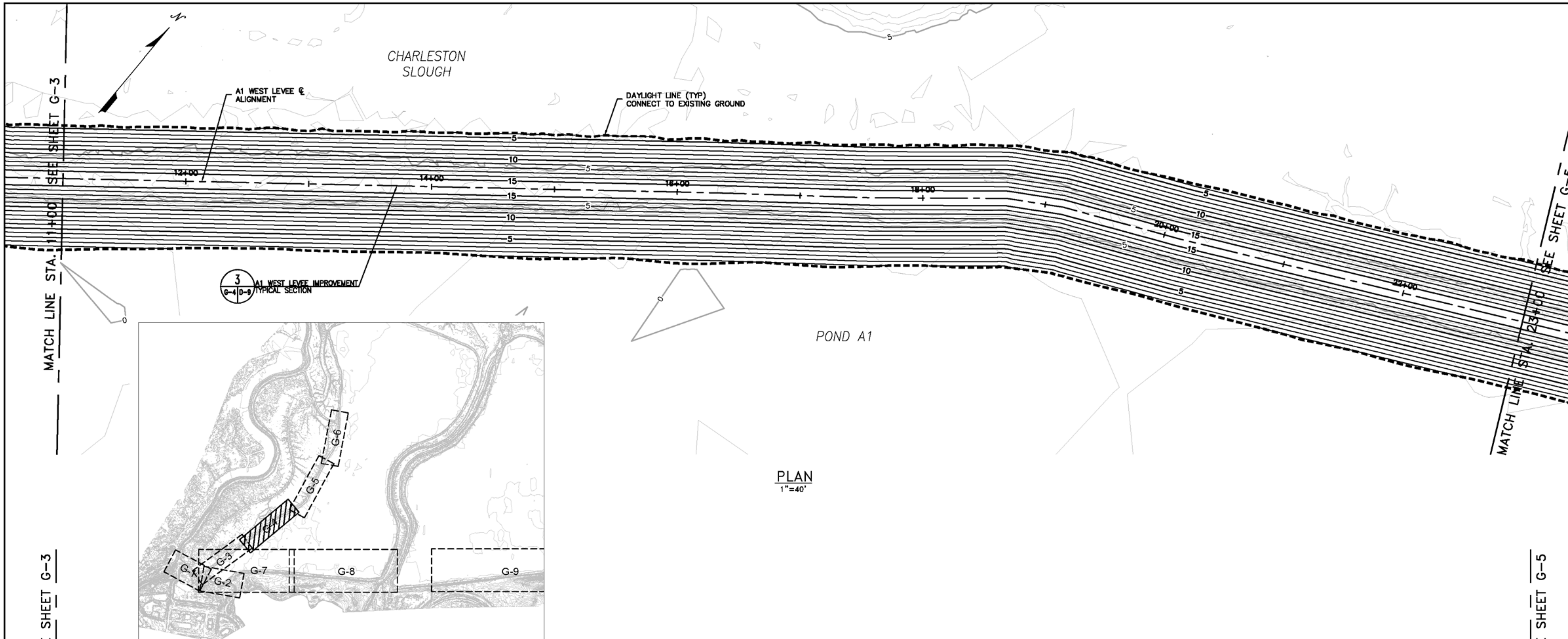
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

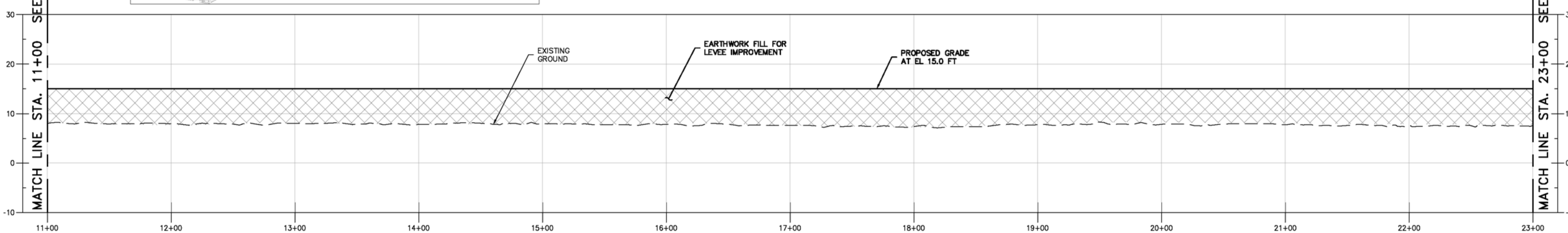
PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE: MOUNTAIN VIEW PONDS
POND A1 WEST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 1 OF 4

SHEET NO. SHT. 12 OF 33 SHTS.
REV
DWG NO. G-3



PLAN
1"=40'



A1 WEST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'

0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

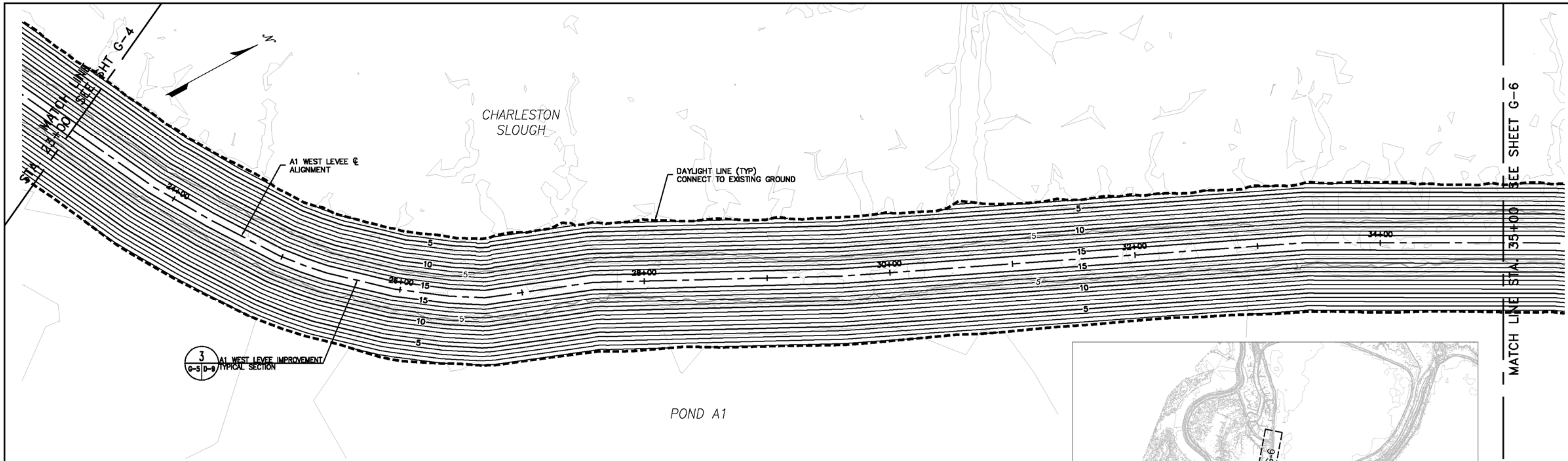
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

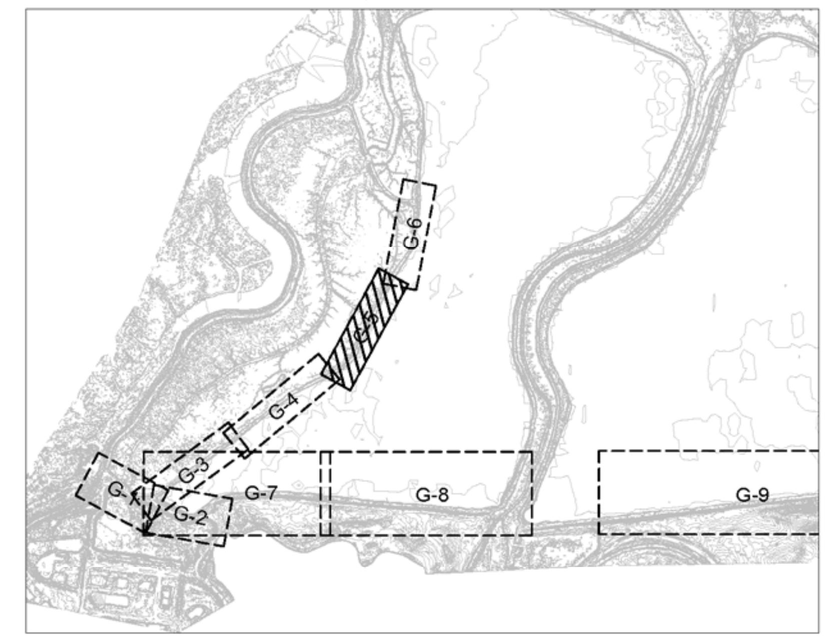
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

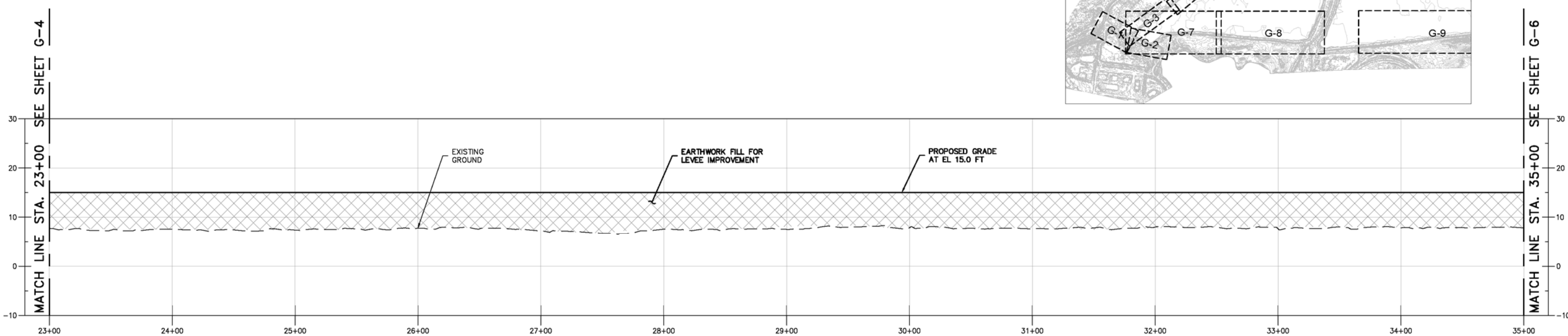
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 WEST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 2 OF 4

SHEET NO. SHT. 13 OF 33 SHTS.
REV
DWG NO. G-4



PLAN
1"=40'





A1 WEST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

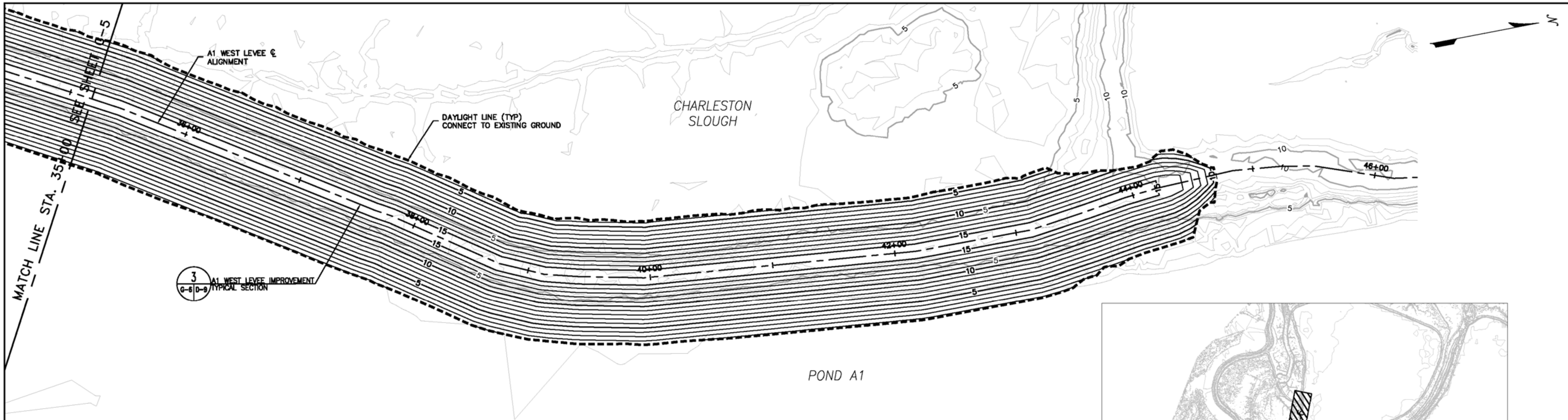
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

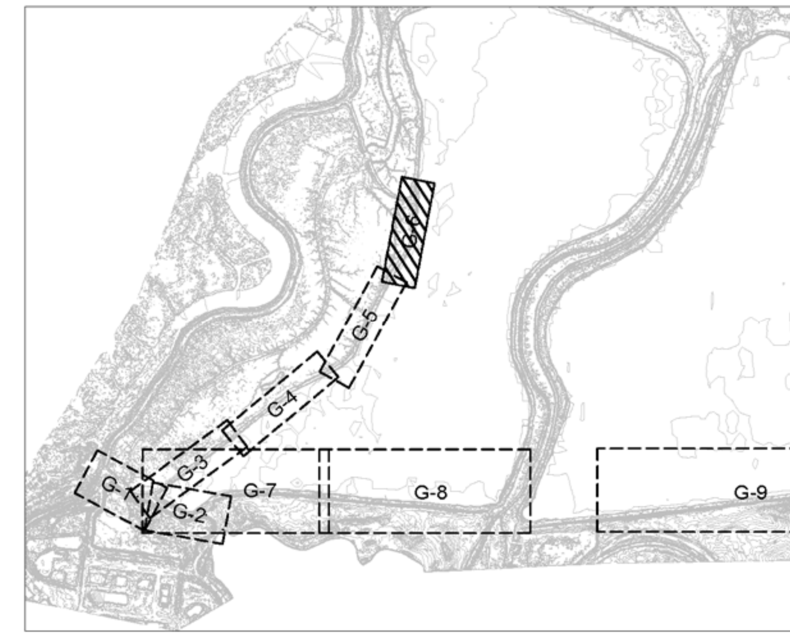
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

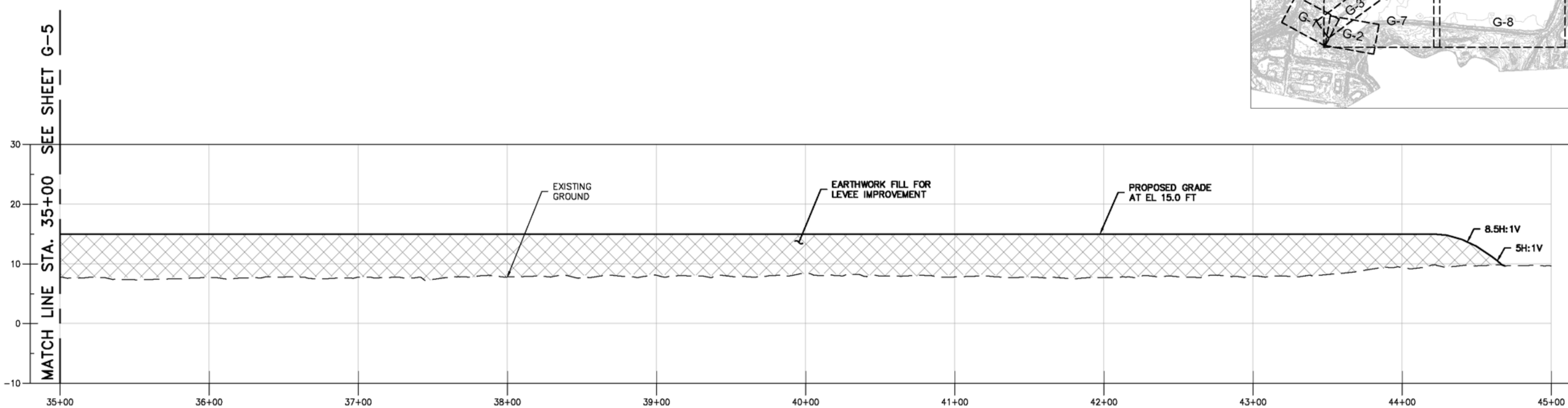
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 WEST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 3 OF 4

SHEET NO. SHT 14 OF 33 SHTS
REV
DWG NO. G-5



PLAN
1"=40'





A1 WEST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

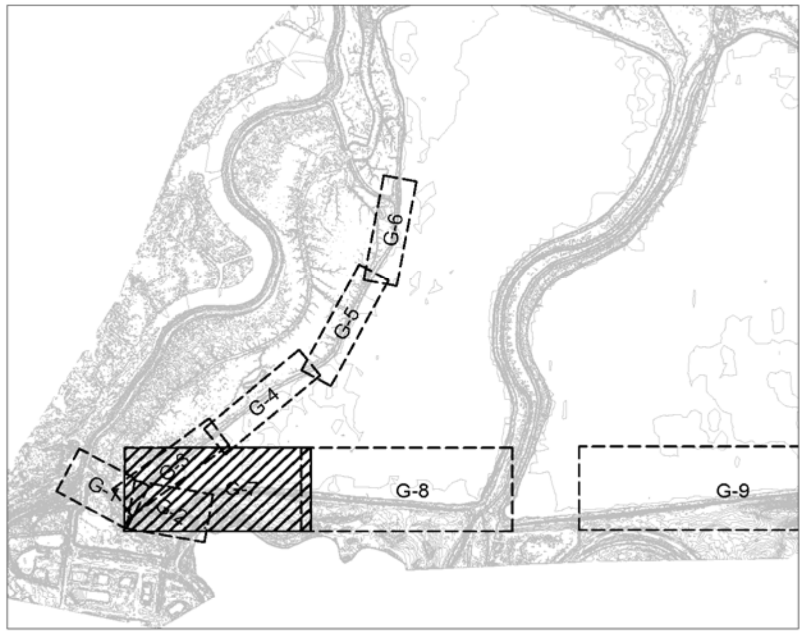
STATE OF CALIFORNIA
Coastal Conservancy

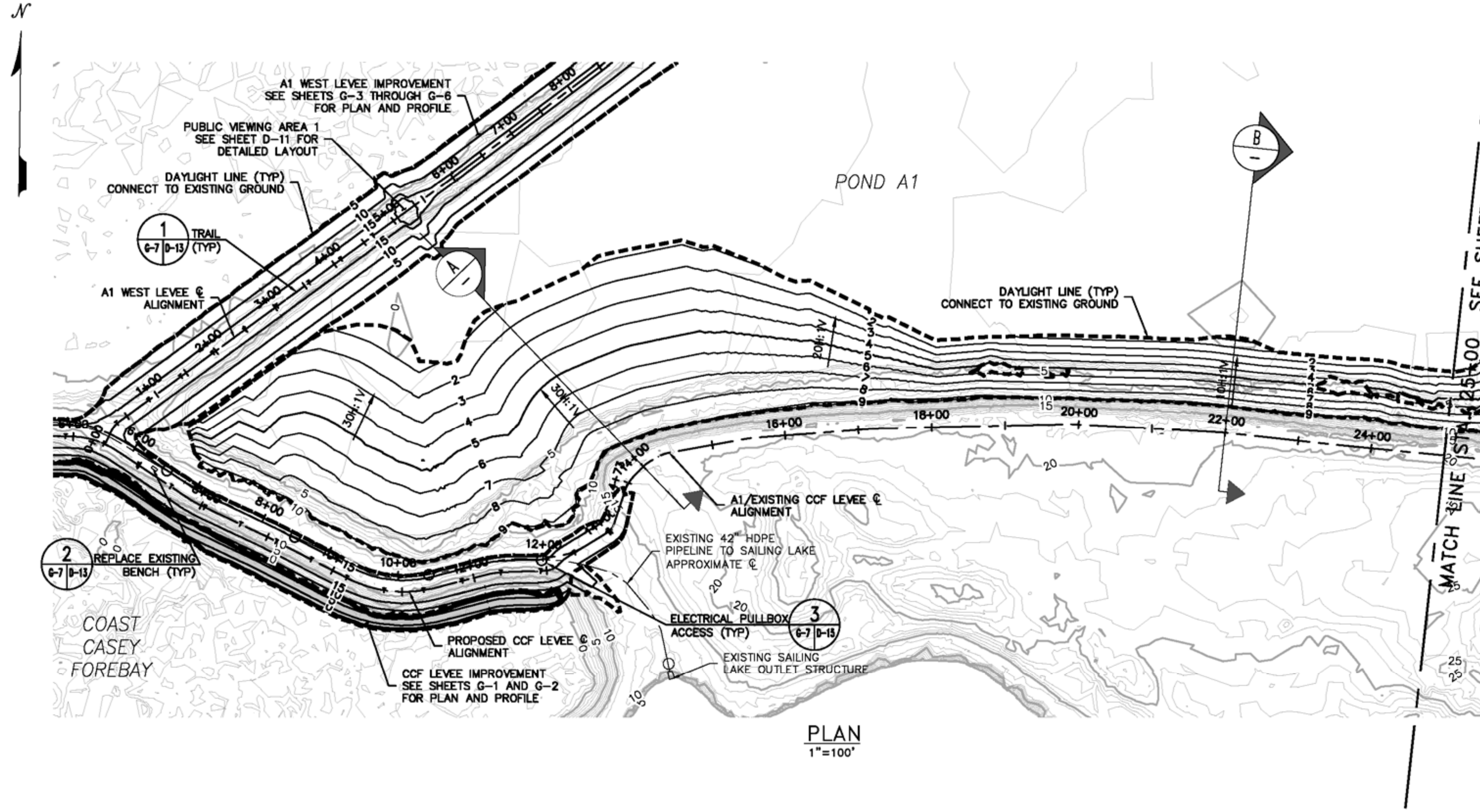
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 WEST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 4 OF 4

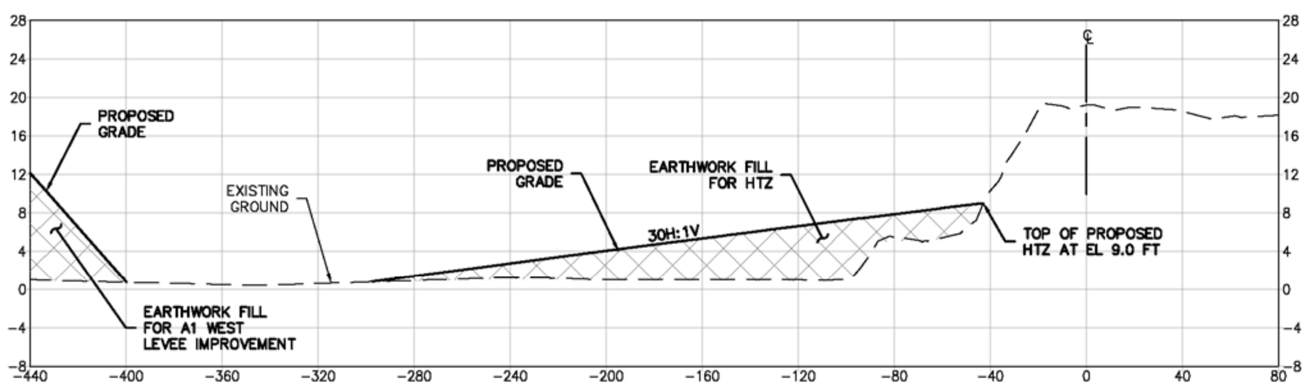
SHEET NO. SHT 15 OF 33 SHTS.
DWG NO. G-6
REV



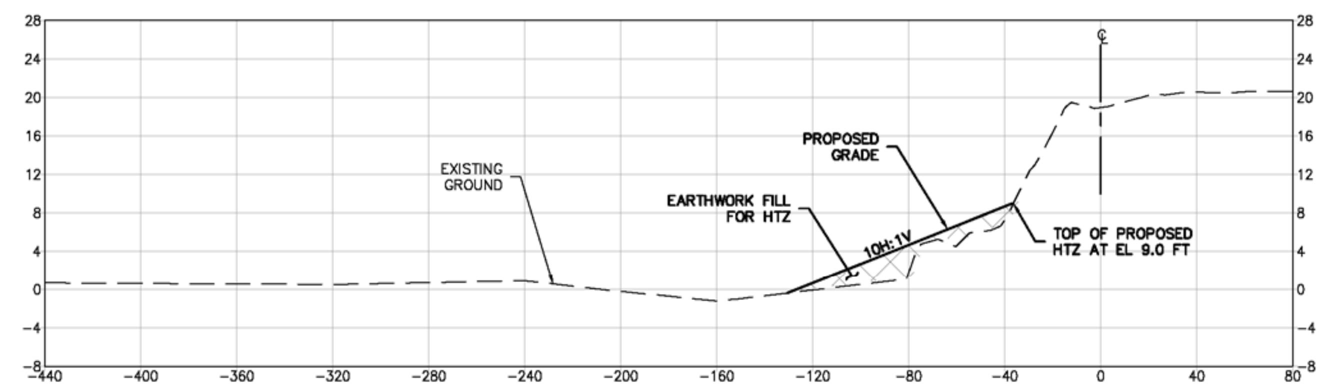


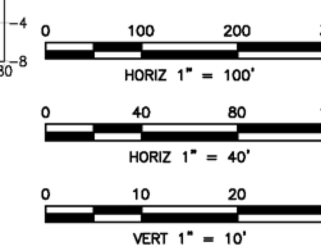
PLAN
1"=100'

STA 14+00



STA 22+00





A A1 HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

B B1 HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: AECOM, 300 Lakeside Drive, Suite 400, Oakland, CA 94612, Tel: (510) 893-3600, aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

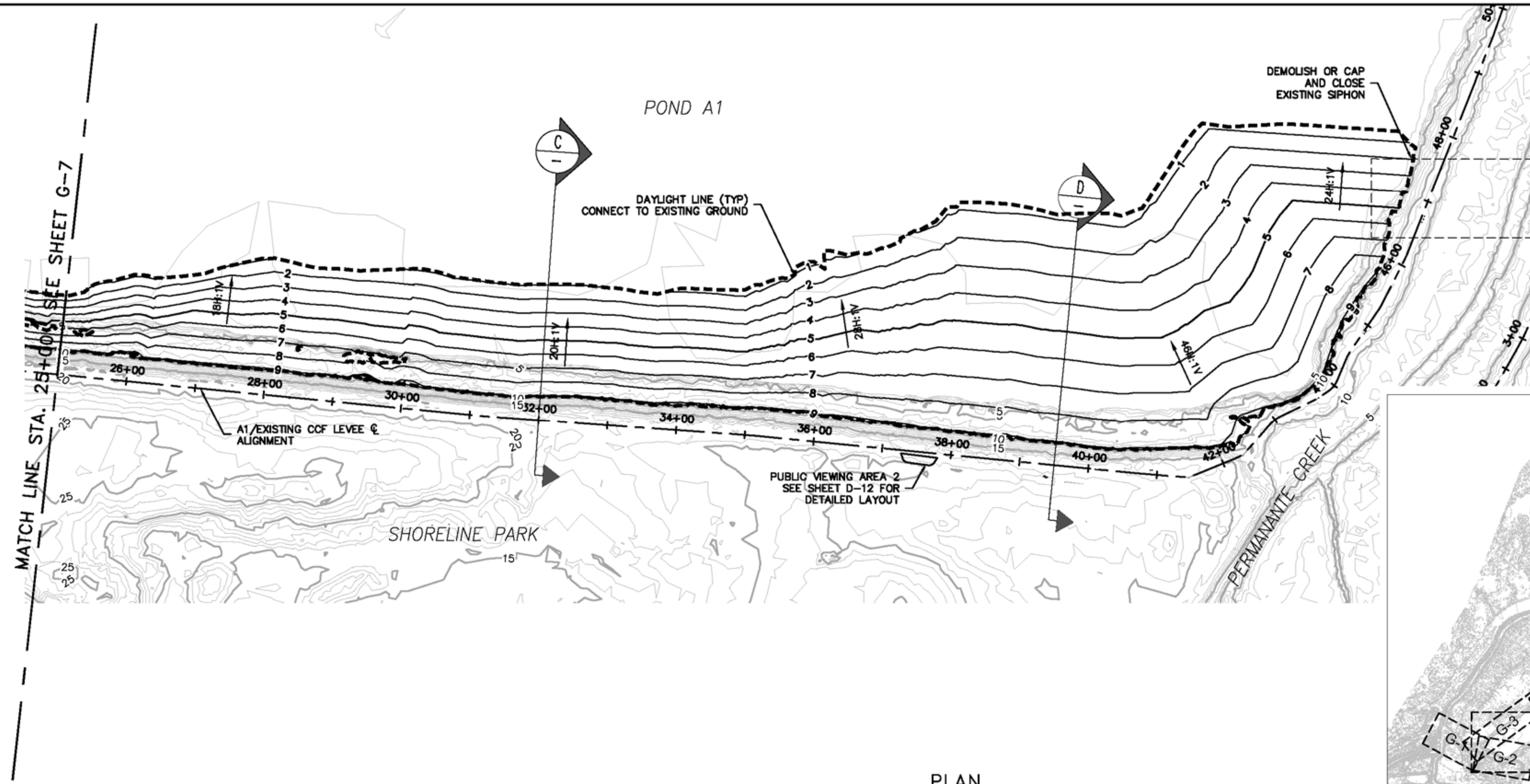
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

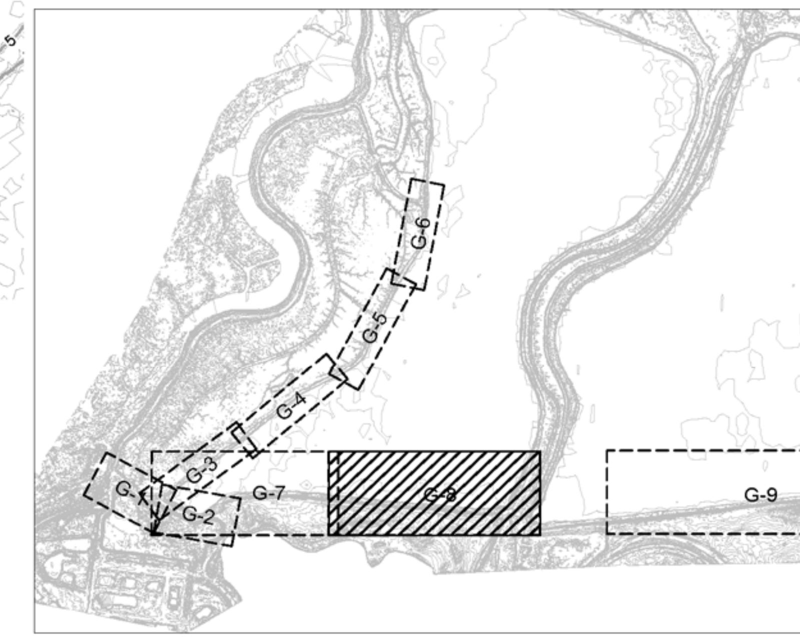
PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE: MOUNTAIN VIEW PONDS POND A1 HTZ GRADING PLAN - SHEET 1 OF 2

SHEET NO. SHT. 16 OF 33 SHTS.
DWG NO. G-7

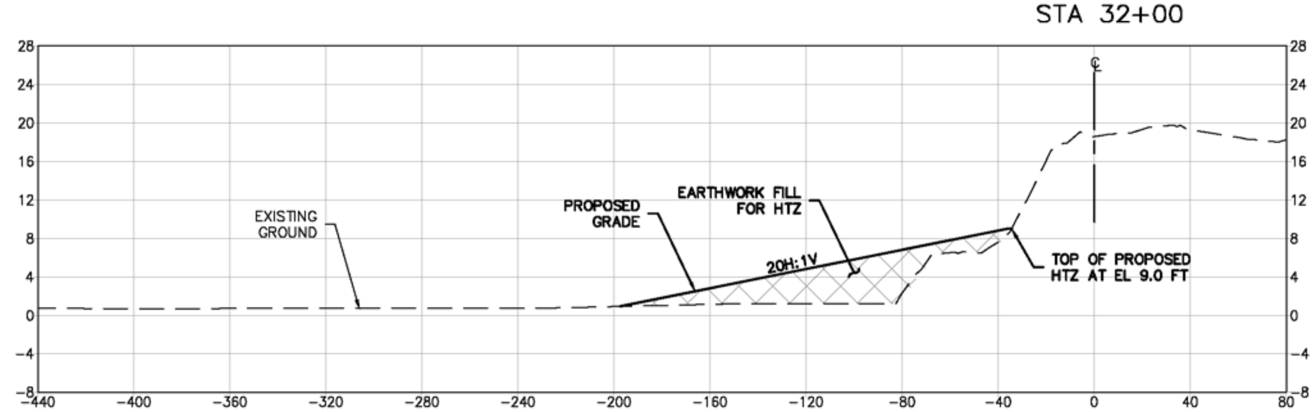
Dec 09, 2016 - 8:56am C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_G-7.dwg



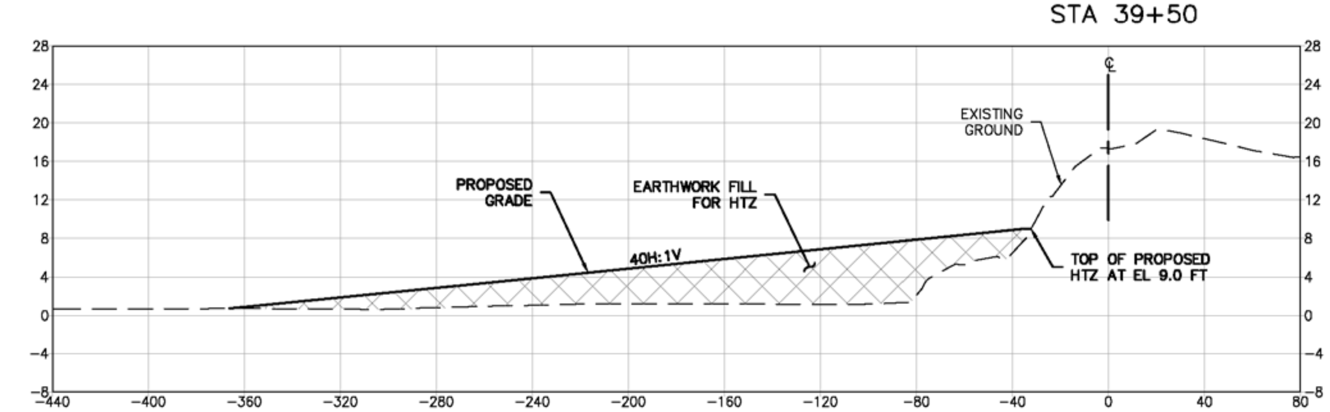
PLAN
1"=100'



STA 32+00



STA 39+50



C A1 HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

D A1 HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

0 40 80 120
HORIZ 1" = 40'

0 100 200 300
HORIZ 1" = 100'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

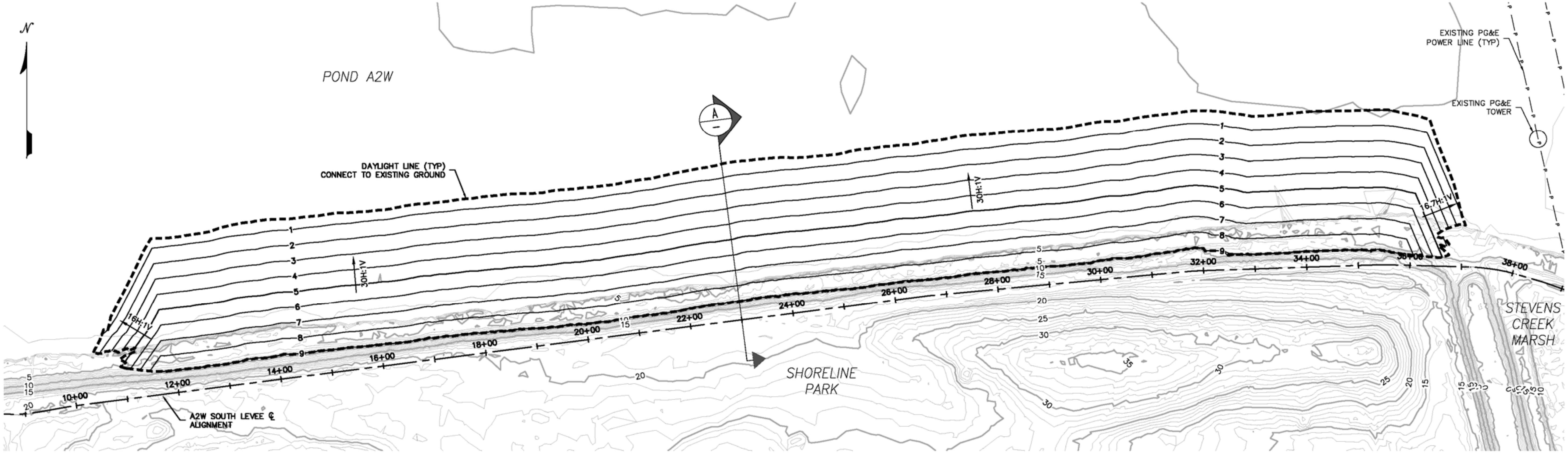
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

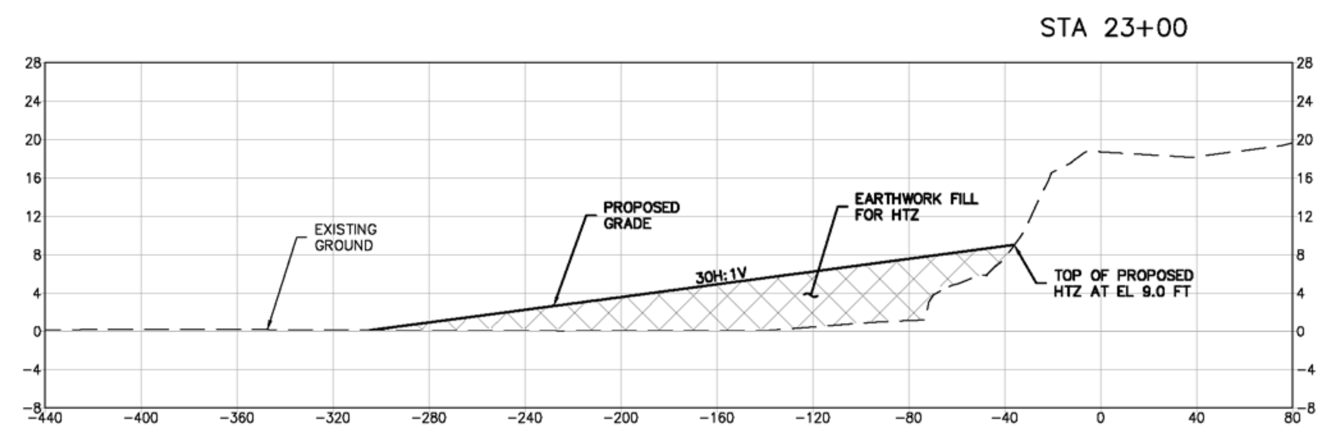
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 HTZ
GRADING PLAN - SHEET 2 OF 2

SHEET NO. SHT. 17 OF 33 SHTS.
REV
DWG NO. G-8

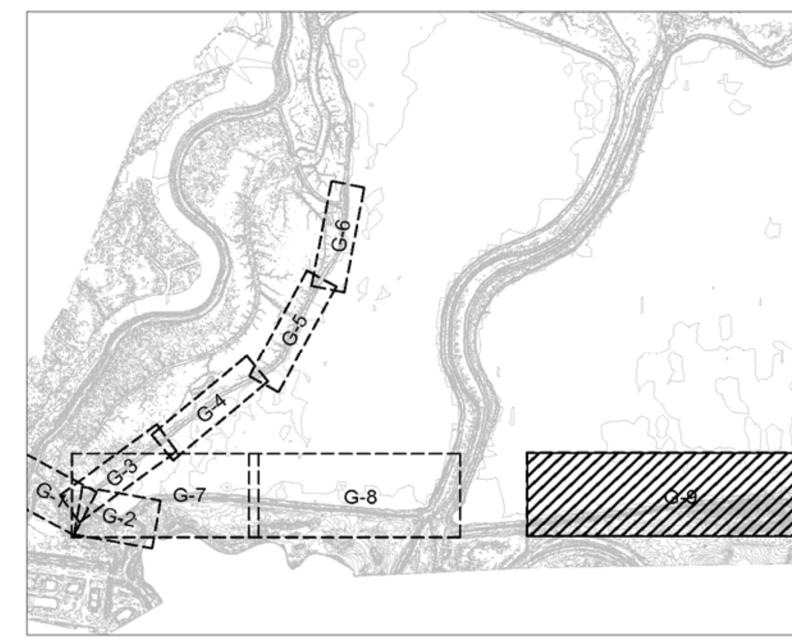
Dec 09, 2016 - 8:58am



PLAN
1"=100'



A A2W HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10



HORIZ 1" = 100' (0, 100, 200, 300)

HORIZ 1" = 40' (0, 40, 80, 120)

VERT 1" = 10' (0, 10, 20, 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

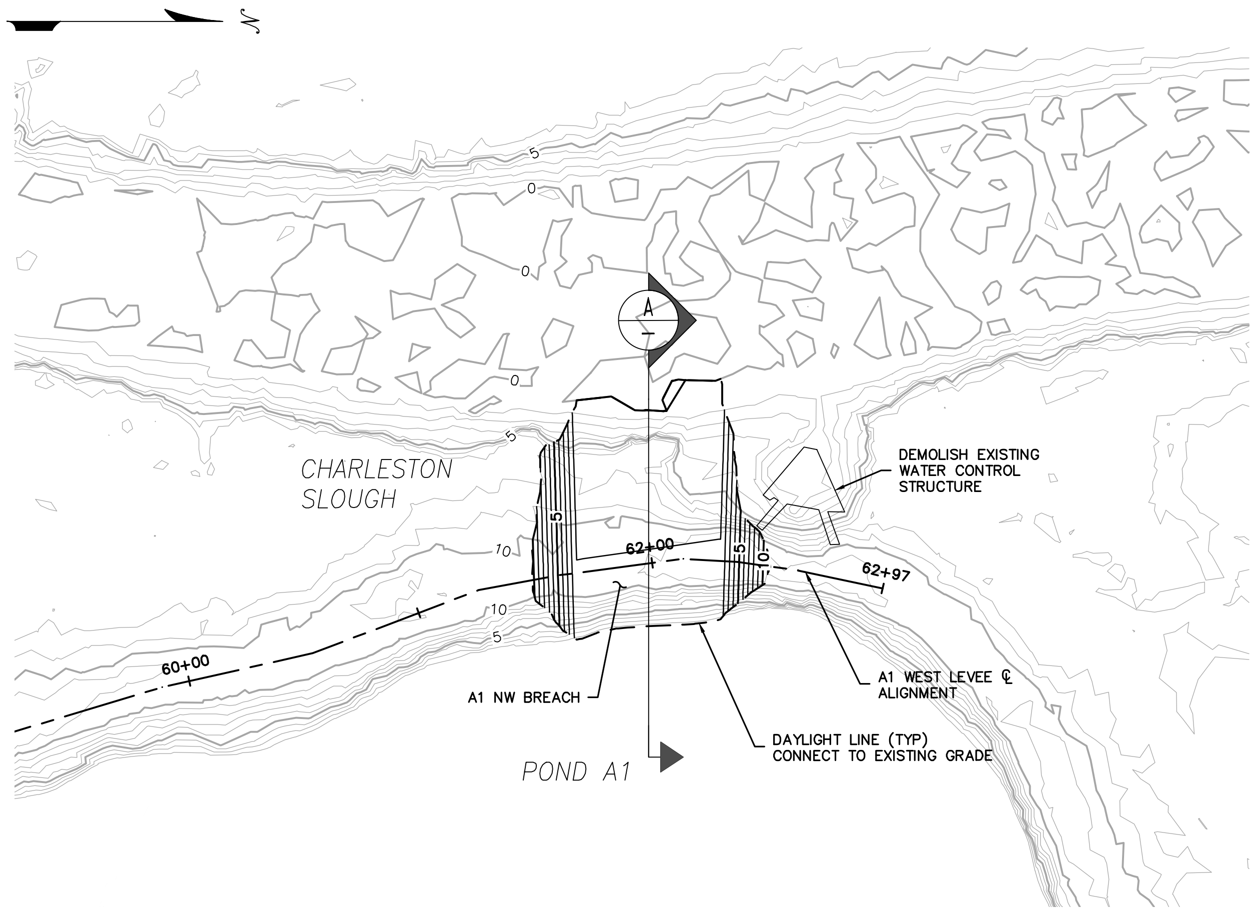
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

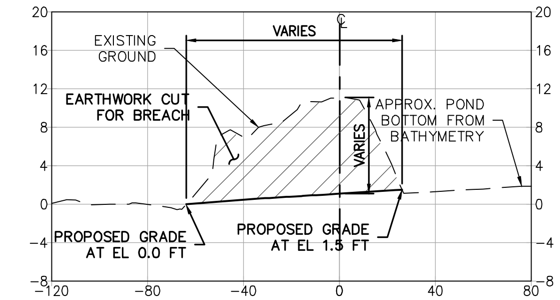
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W HTZ
GRADING PLAN

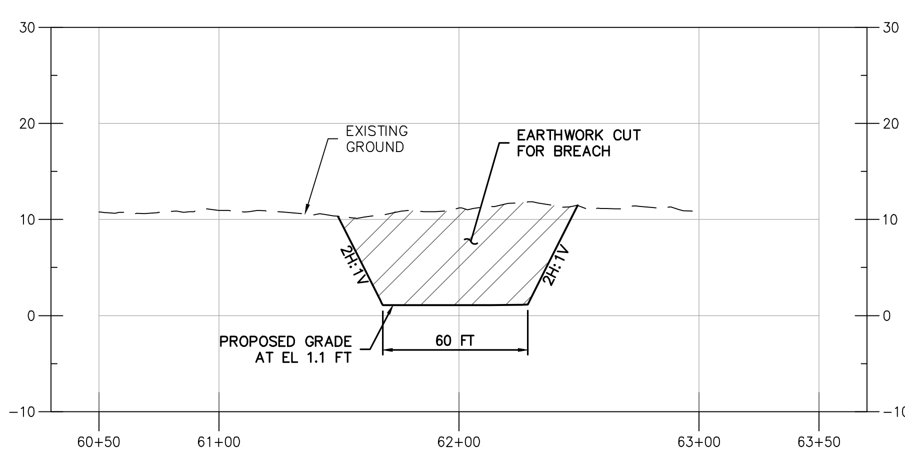
SHEET NO. SHT 18 OF 33 SHTS
REV
DWG NO. G-9



PLAN
1"=40'



A1 NW BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A1 NW BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

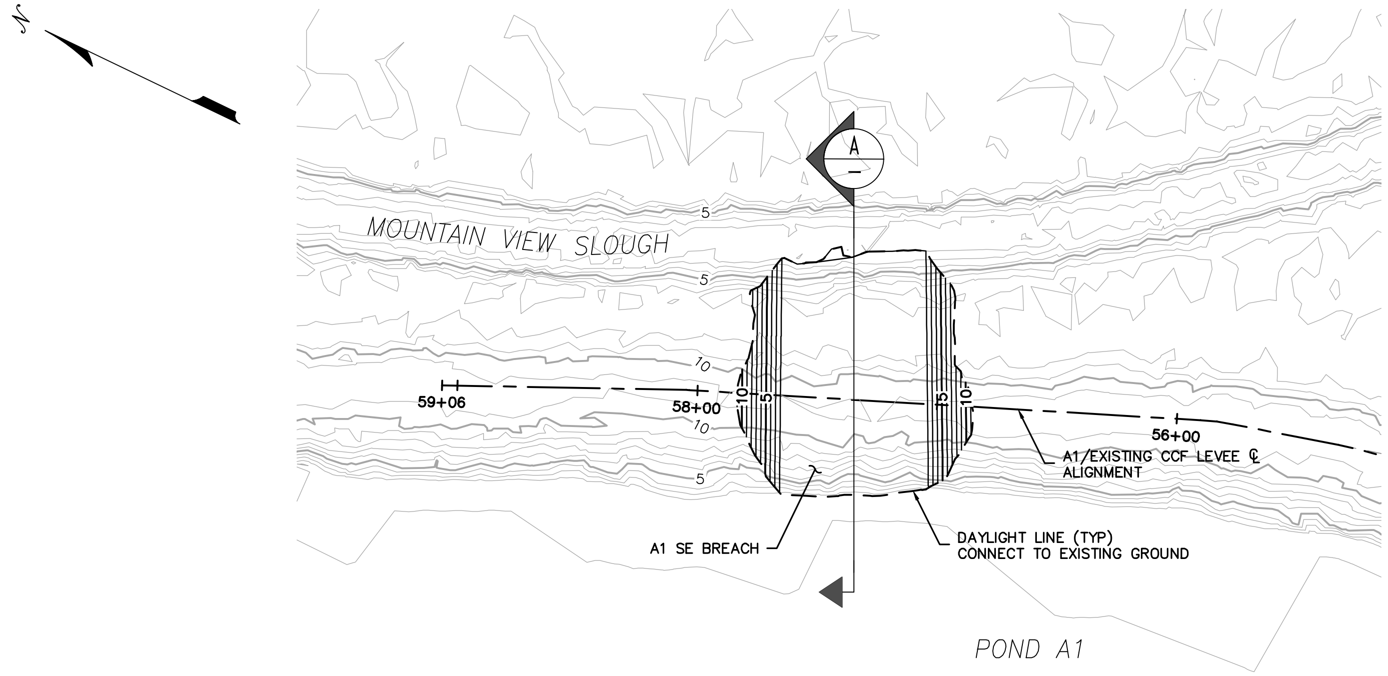
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

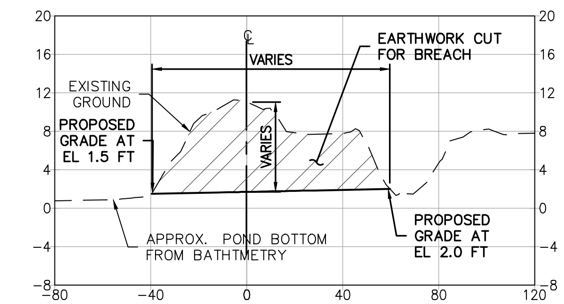
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 NORTHWEST BREACH
DETAILED GRADING PLAN

SHEET NO. SHT. 19 OF 33 SHTS.
REV
DWG NO. D-1

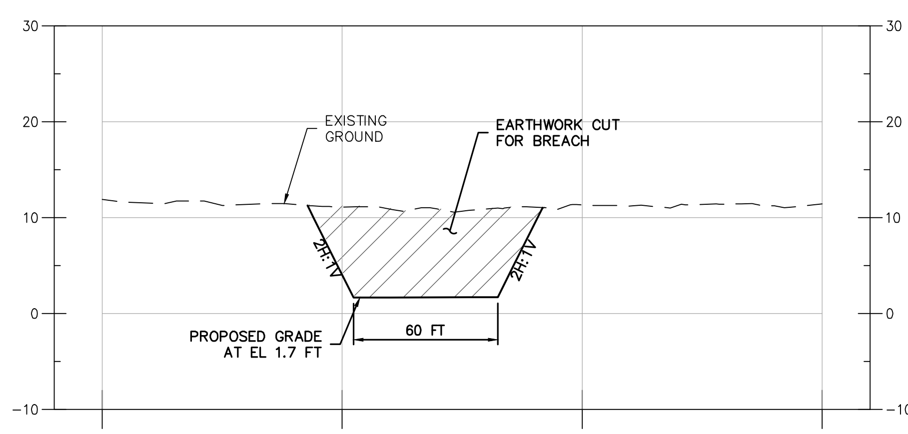
Dec 09, 2016 - 9:02am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-1.dwg



PLAN
1"=40'



A A1 SE BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A1 SE BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

Dec 09, 2016 - 9:05am
C:\pwworking\aecom_na\chandrasekarand\dms75827\MV_D-2.dwg

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

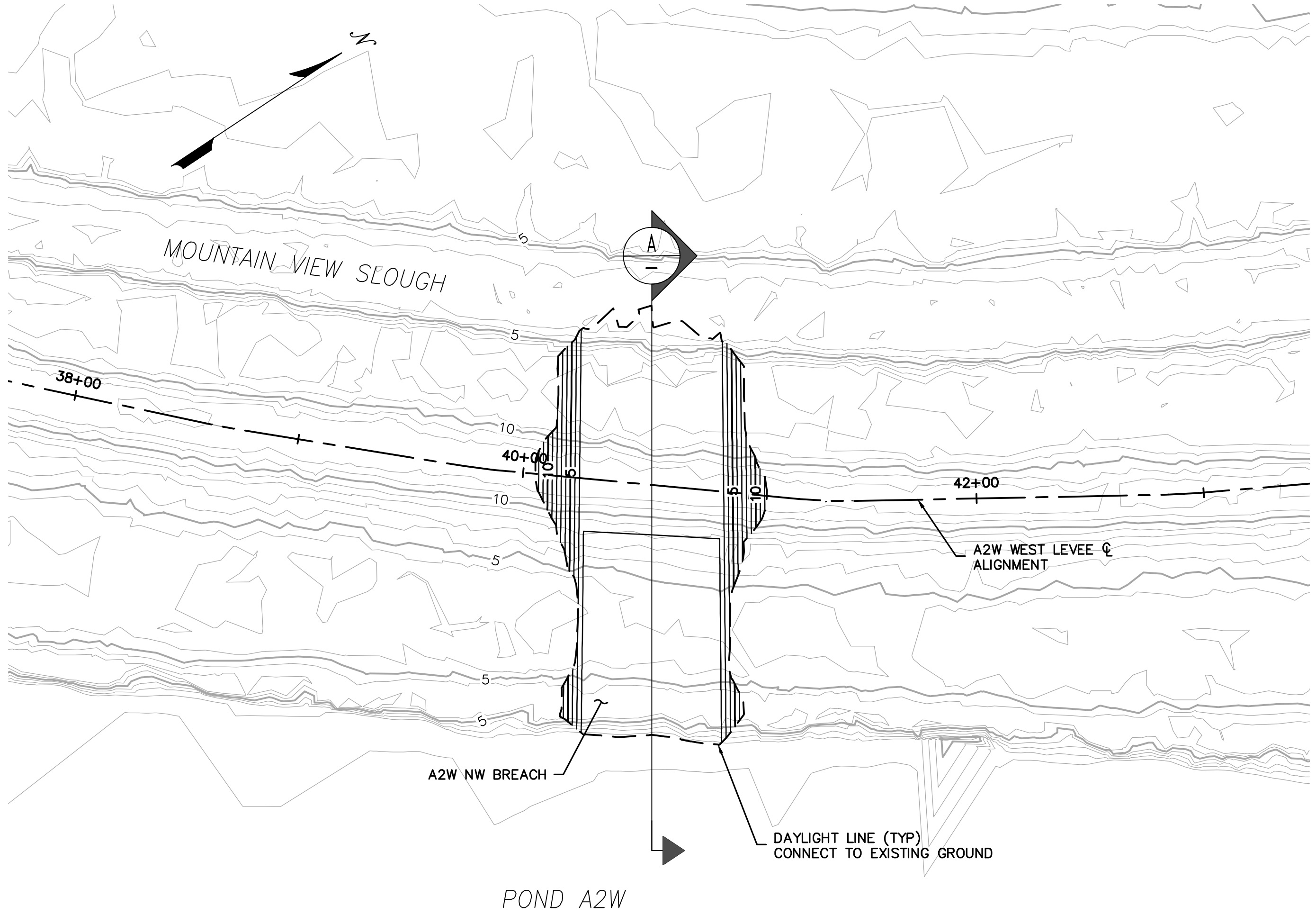
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

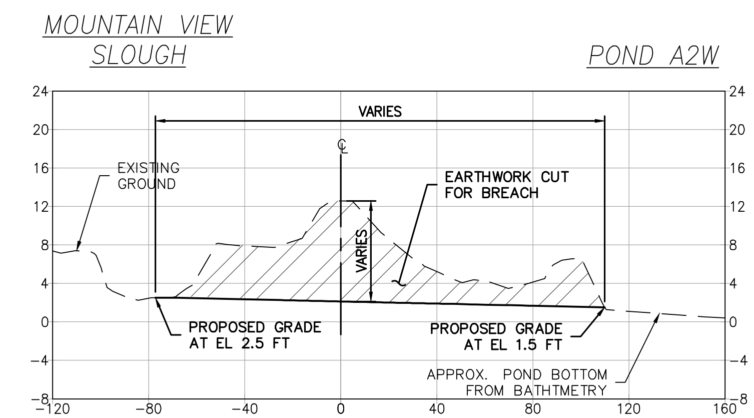
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
POND A1 SOUTHEAST BREACH
DETAILED GRADING PLAN

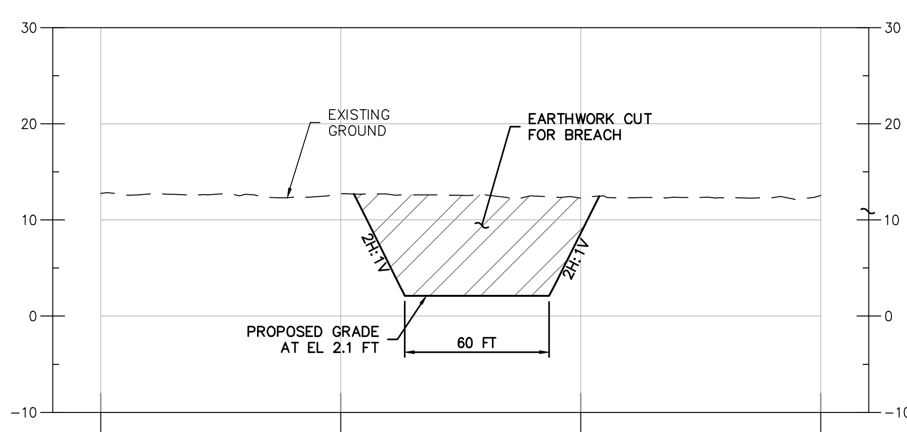
SHEET NO.
SHT. 20 OF 33 SHTS.
REV
DWG NO.
D-2



PLAN
1"=40'



A – A2W NW BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A2W NW BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

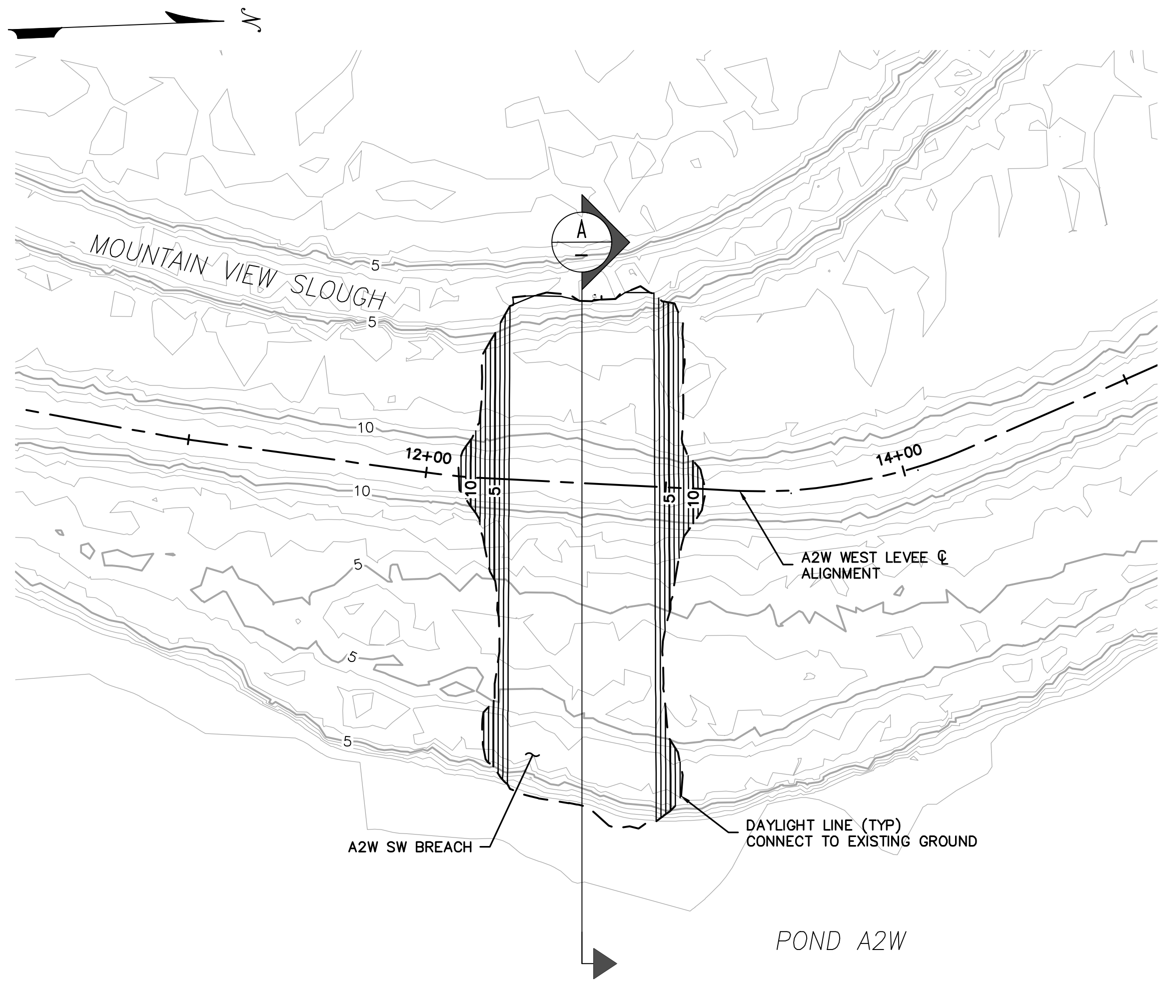
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

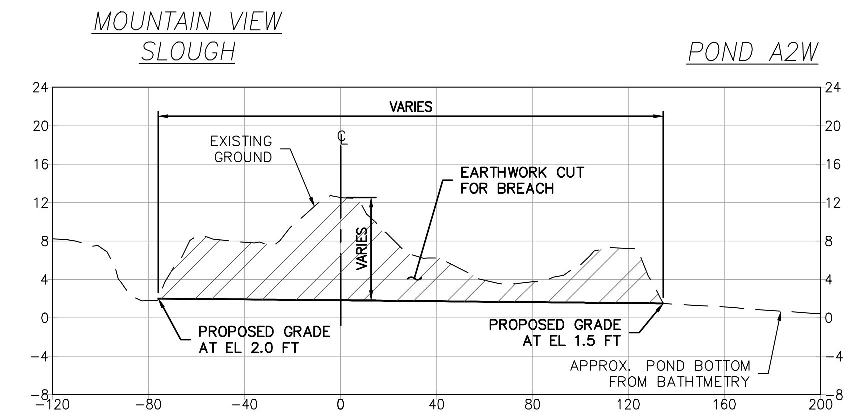
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W NORTHWEST BREACH
DETAILED GRADING PLAN

SHEET NO. SHT. 21 OF 33 SHTS.
REV
DWG NO. D-3

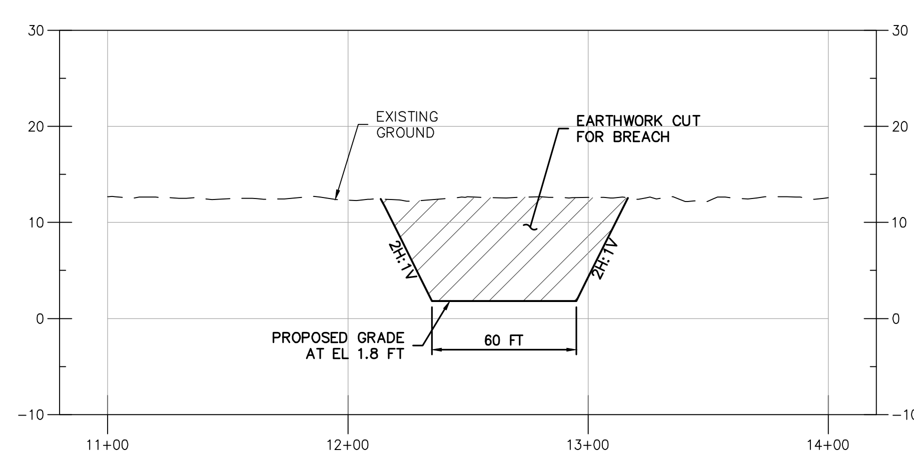
Dec 09, 2016 - 9:07am
C:\pwworking\aecom_na\lchandrasekaran\dms75827\MV_D-3.dwg



PLAN
1"=40'



A A2W SW BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A2W SW BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

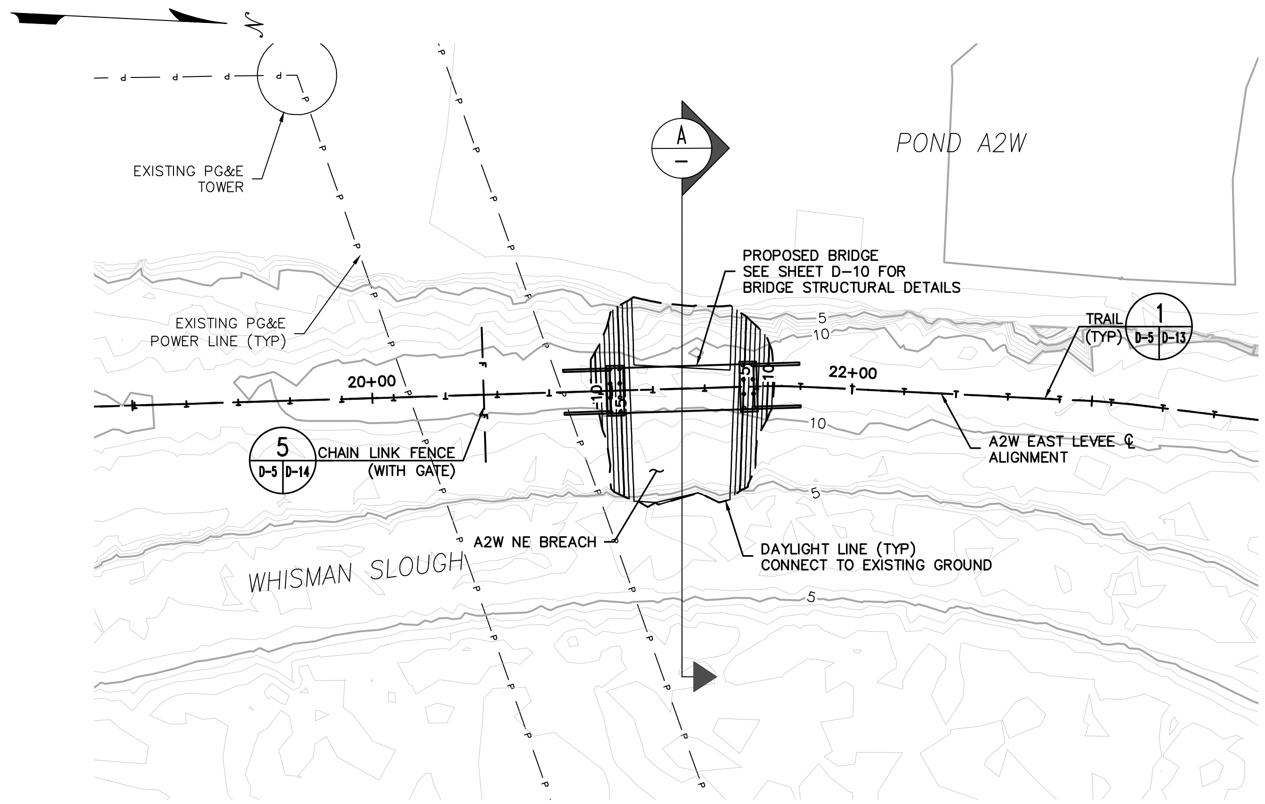
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W SOUTHWEST BREACH
DETAILED GRADING PLAN

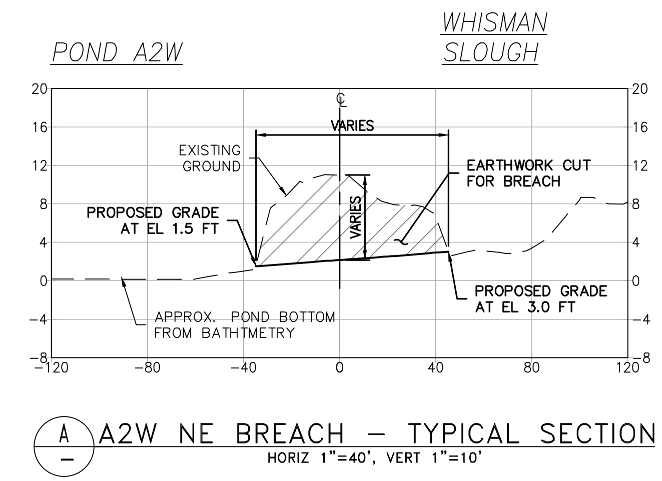
SHEET NO.
SHT. 22 OF 33 SHTS.
REV

DWG NO.
D-4

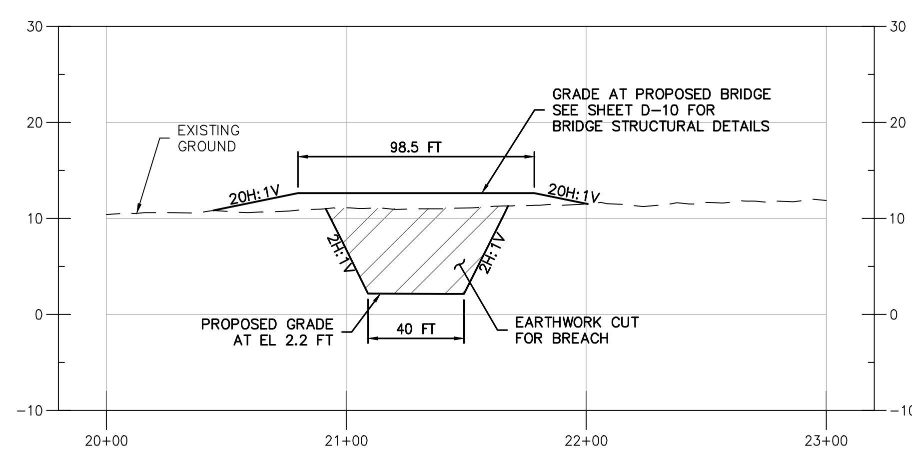
Dec 09, 2016 - 9:10am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-4.dwg



PLAN
1"=40'



A A2W NE BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A2W NE BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

Dec 09, 2016 - 9:13am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-5.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

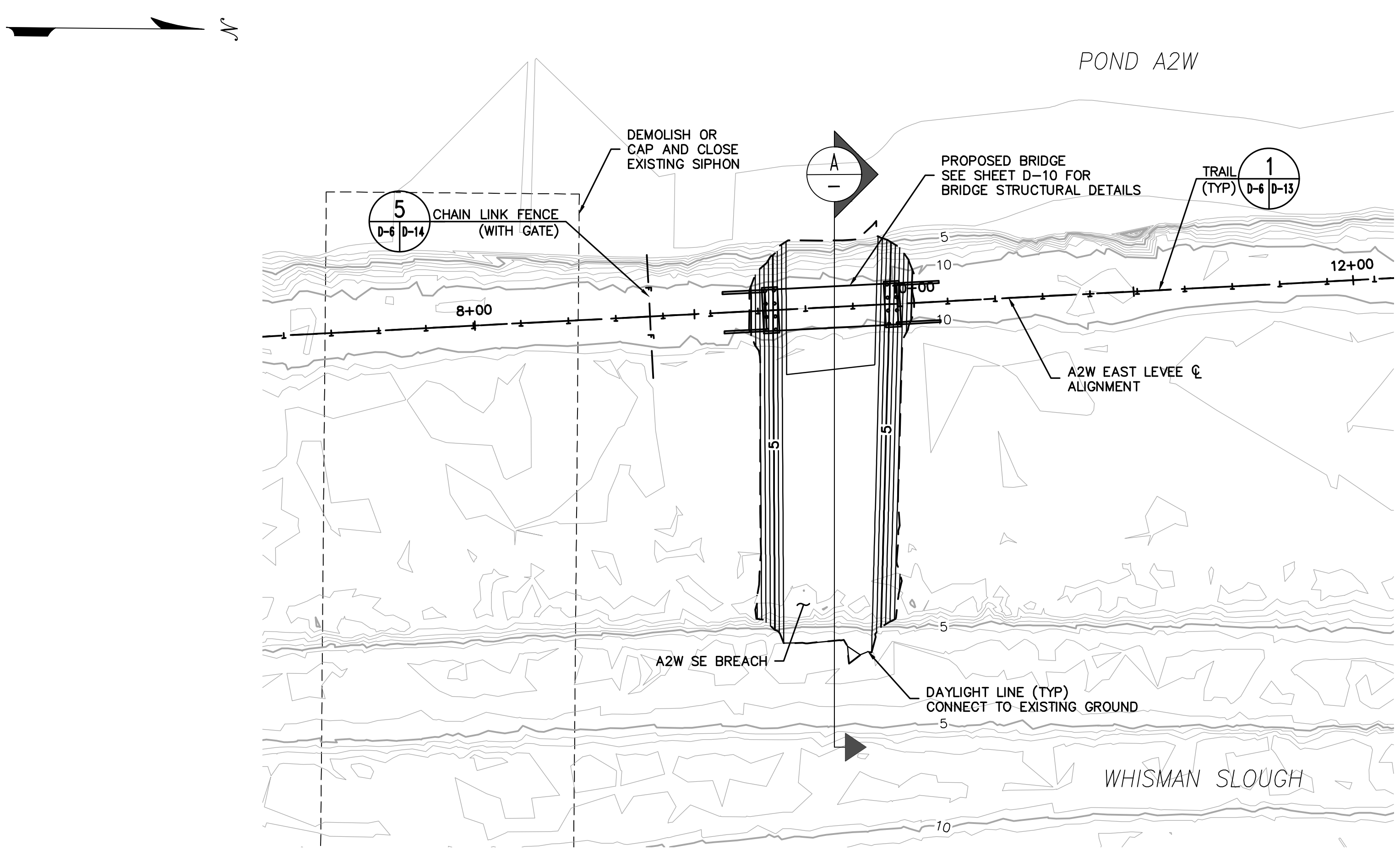
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

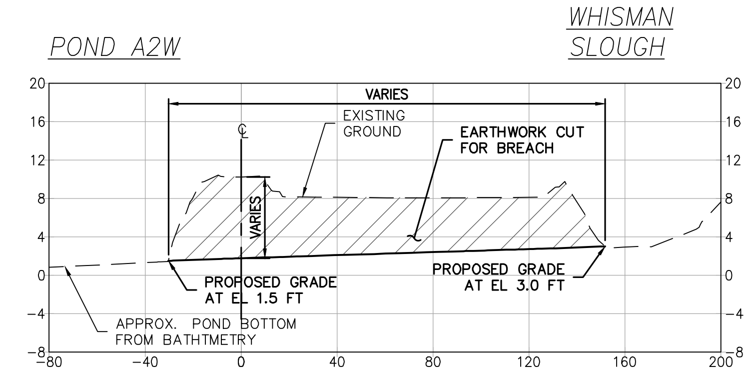
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W NORTHEAST BREACH
DETAILED GRADING PLAN

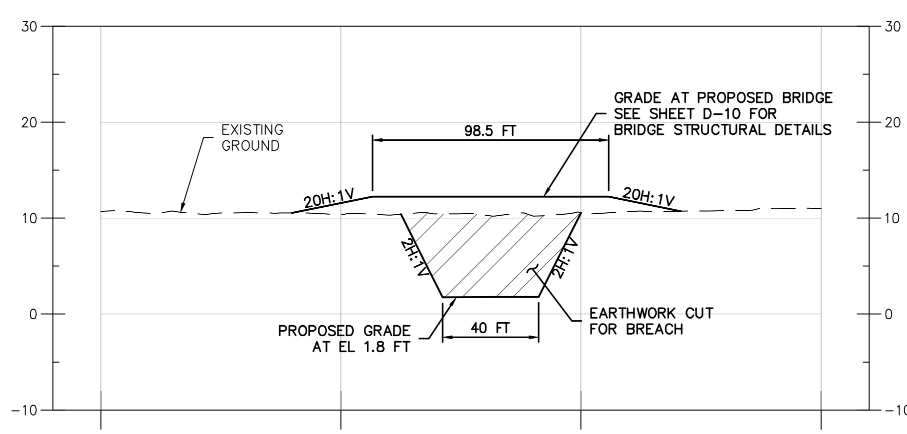
SHEET NO. SHT. 23 OF 33 SHTS.
REV
DWG NO. D-5



PLAN
1"=40'



A D-9 A2W SE BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



A2W SE BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40' (0 40 80 120)
VERT 1" = 10' (0 10 20 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV | DESCRIPTION | BY | CHK | APP | DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

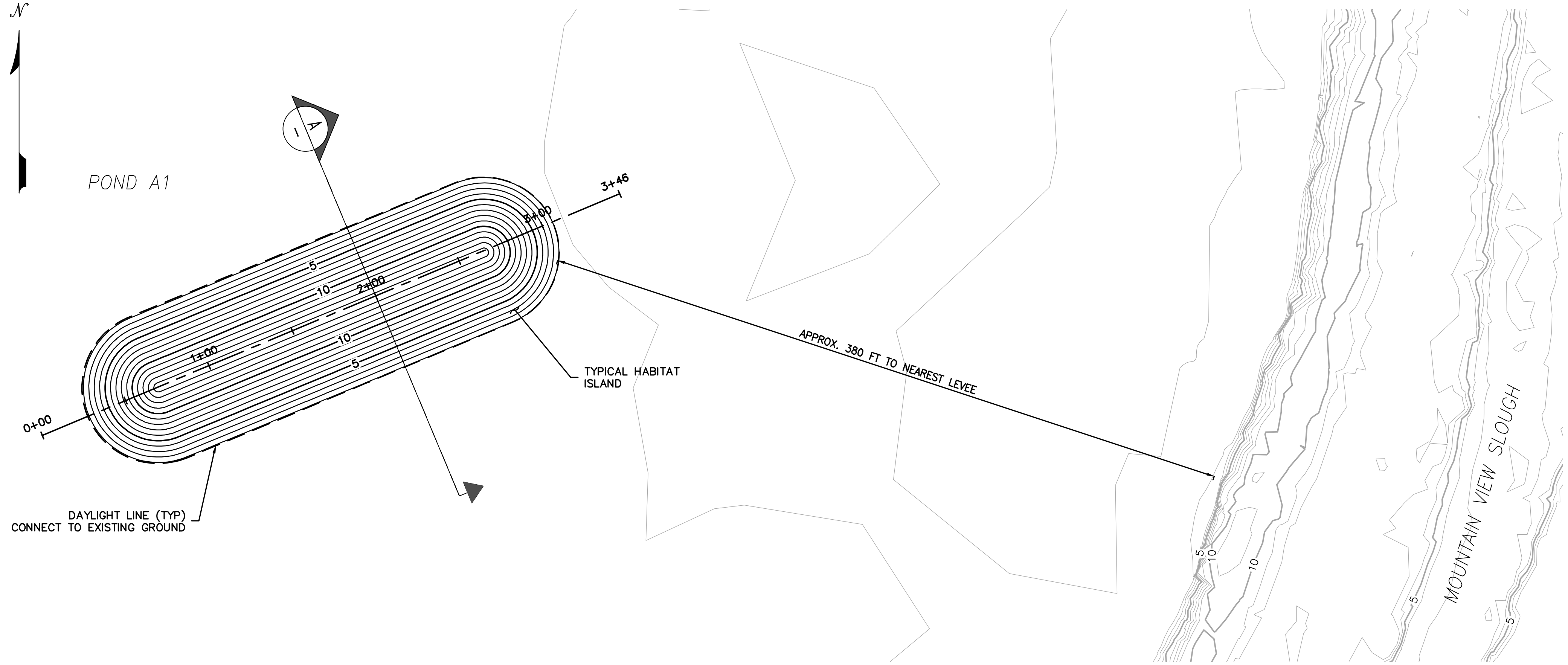
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-09-2016

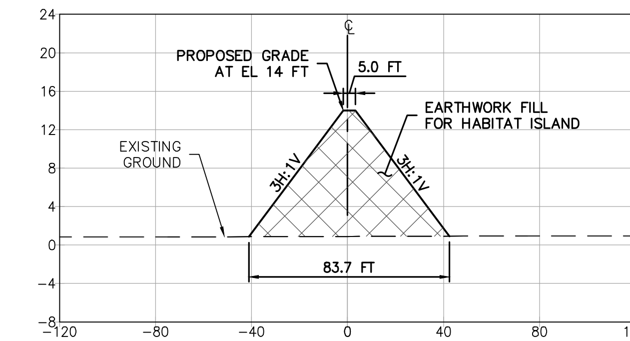
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W SOUTHEAST BREACH
DETAILED GRADING PLAN

SHEET NO. SHT. 24 OF 33 SHTS.
REV
DWG NO. D-6

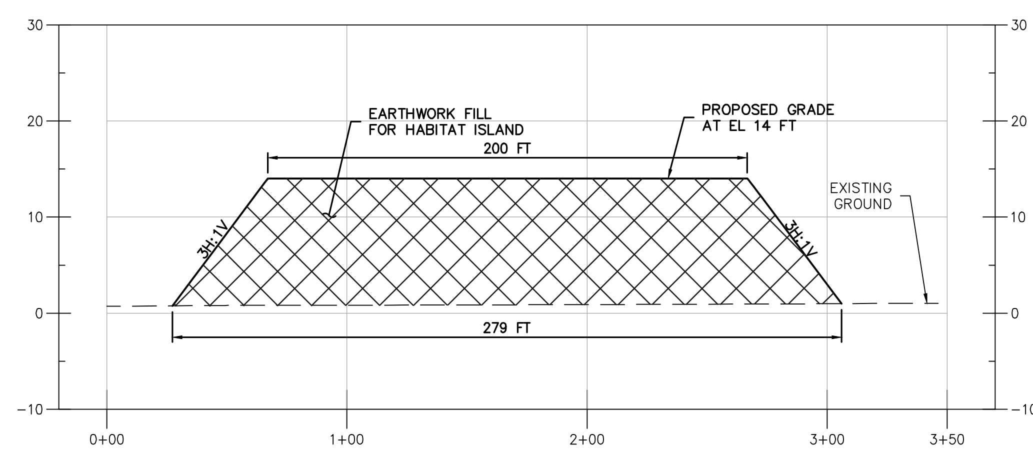
Dec 09, 2016 - 9:18am
C:\pwworking\aecom_na\chandrasekarand\dms75827\MV_D-6.dwg



PLAN
1"=40'



A HABITAT ISLAND – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



HABITAT ISLAND – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

Dec 09, 2016 - 9:20am
C:\pwworking\aecom_na\chandrasekarandms75827\MV_D-7.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

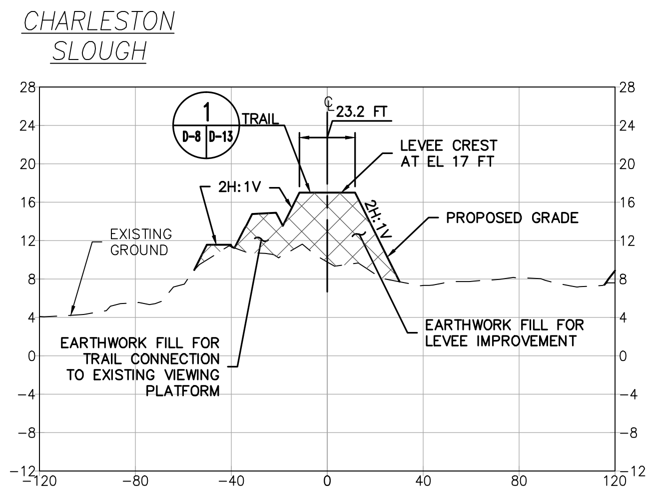
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

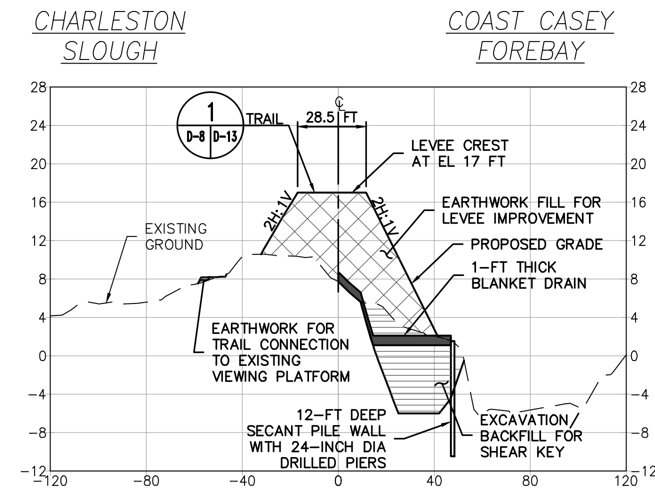
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
TYPICAL HABITAT ISLAND
DETAILED GRADING PLAN

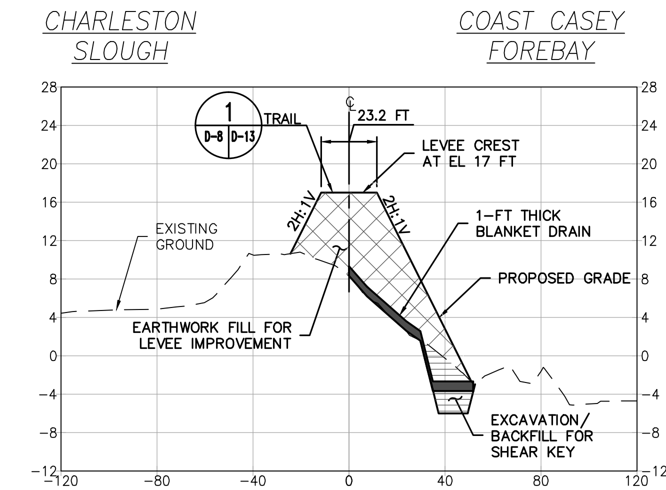
SHEET NO.
SHT. 25 OF 33 SHTS.
REV
DWG NO.
D-7



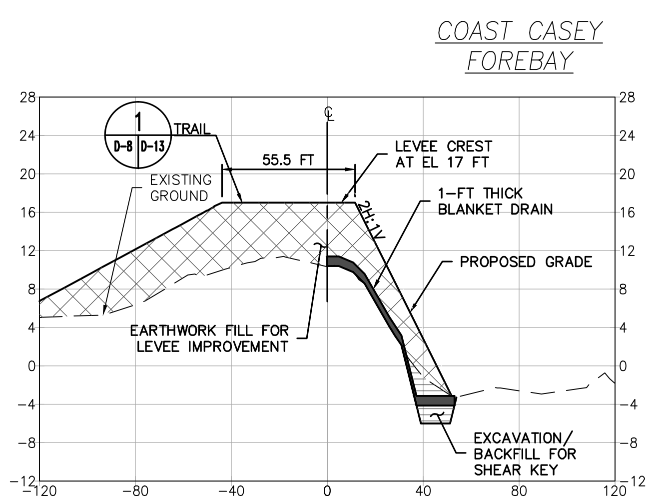
1 G-1 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 0+00 TO 2+02
HORIZ 1"=40', VERT 1"=10'



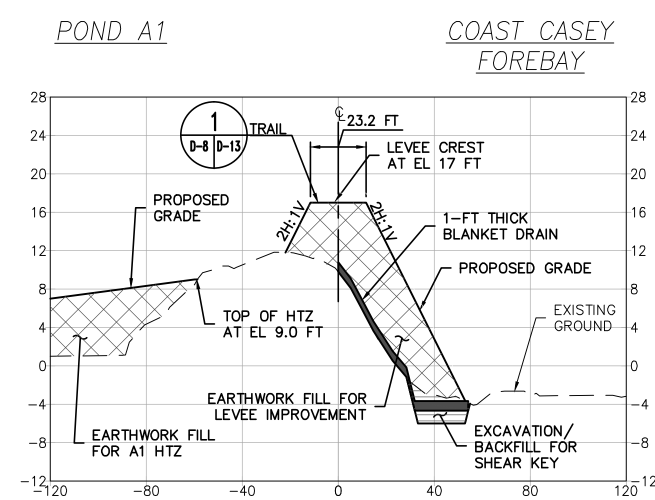
2 G-1 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 2+02 TO 2+27
HORIZ 1"=40', VERT 1"=10'



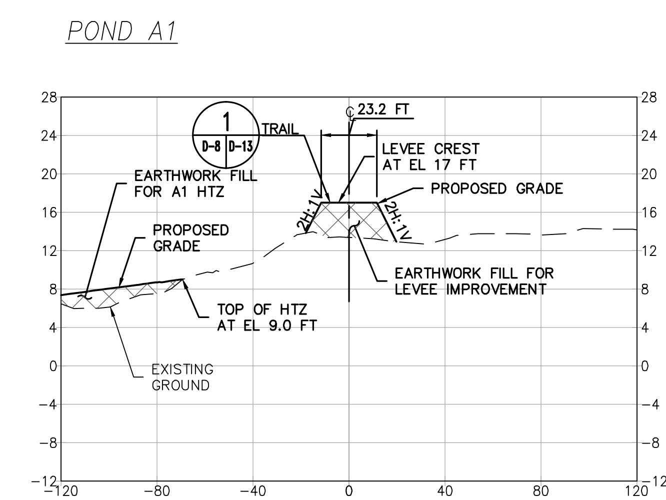
3 G-1 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 2+27 TO 6+11
HORIZ 1"=40', VERT 1"=10'



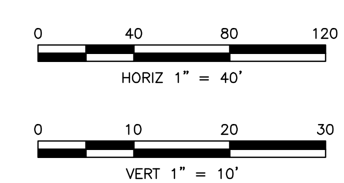
4 G-1 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 6+11 TO 6+61
HORIZ 1"=40', VERT 1"=10'



5 G-2 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 6+61 TO 13+07
HORIZ 1"=40', VERT 1"=10'



6 G-2 D-8 CCF LEVEE IMPROVEMENT – TYPICAL SECTION
STA 13+07 TO 14+57
HORIZ 1"=40', VERT 1"=10'



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

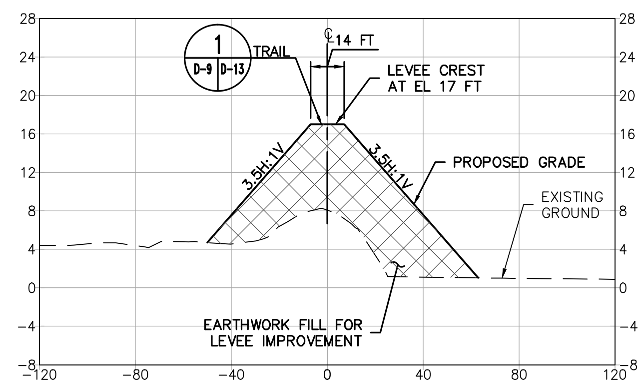
PROJECT No. 60422372 DATE 12-09-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

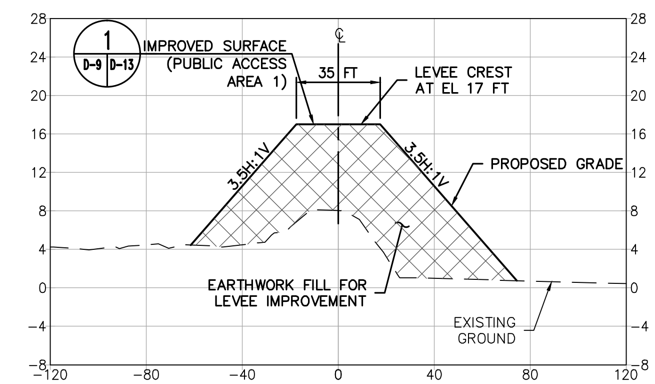
SHEET TITLE MOUNTAIN VIEW PONDS TYPICAL GRADING SECTIONS SHEET 1 OF 2

SHEET NO. SHT. 26 OF 33 SHTS.
REV
DWG NO. D-8

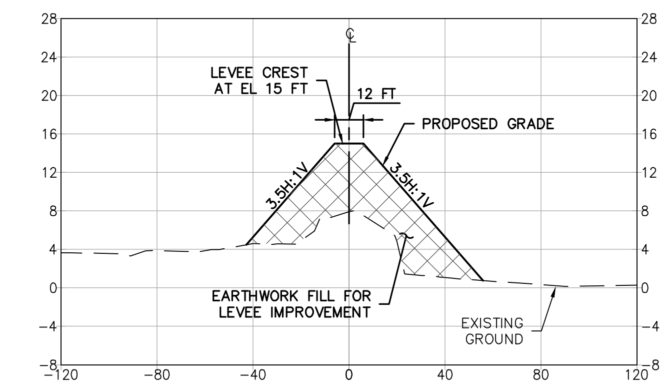
Dec 09, 2016 - 9:22am
C:\pwworking\aecom_na\chandrasekarandms75827\MV_D-8.dwg



1 A1 WEST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 0+00 TO 5+07
HORIZ 1"=40', VERT 1"=10'



2 A1 WEST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 5+07 TO 5+36
HORIZ 1"=40', VERT 1"=10'



3 A1 WEST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 5+36 TO 44+69
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

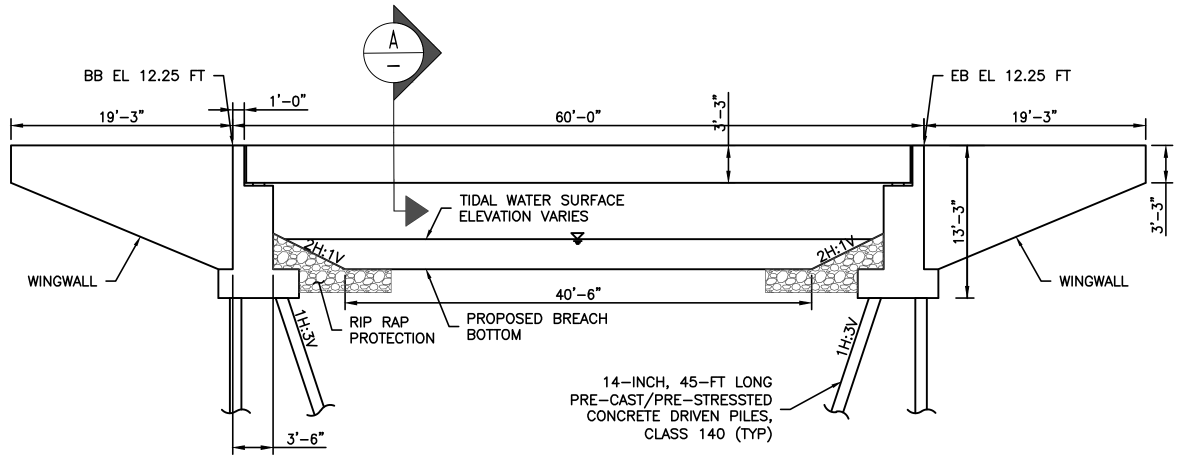
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

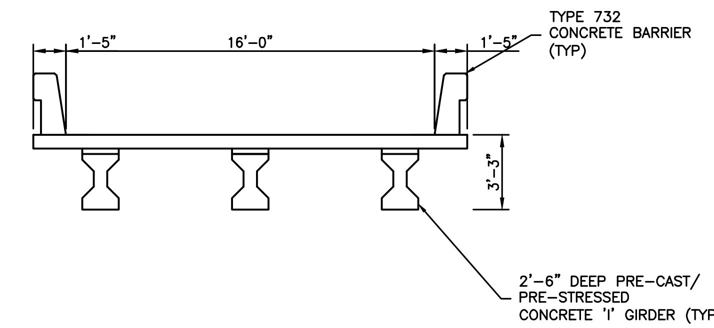
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
MOUNTAIN VIEW PONDS
TYPICAL GRADING SECTIONS
SHEET 2 OF 2

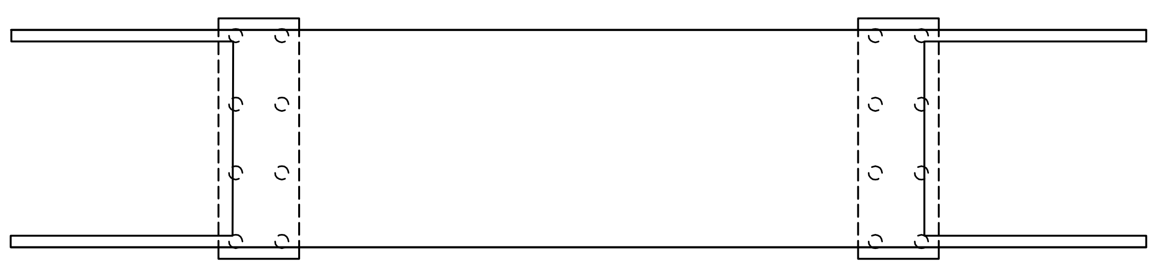
SHEET NO. SHT. 27 OF 33 SHTS.
REV
DWG NO. D-9



BRIDGE ELEVATION
NTS



A BRIDGE TYPICAL SECTION
NTS



BRIDGE PLAN
NTS

NOTES

1. THE TWO BRIDGES ARE LOCATED AT THE NORTHEAST AND SOUTHEAST BREACHES, RESPECTIVELY, ALONG THE EAST LEVEE OF POND A2W.
2. SEE SHEETS D-5 AND D-6 FOR DETAILED GRADING PLANS OF THE NORTHEAST AND SOUTHEAST BREACHES IN POND A2W, RESPECTIVELY, WITH EXISTING AND PROPOSED TOPOGRAPHY.

Dec 09, 2016 - 11:03am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-10.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED B. CARTER
DRAWN L. DIFUNTORUM
CHECKED L. CHANDRASEKARAN
PEER REVIEWED S. KAZMI
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

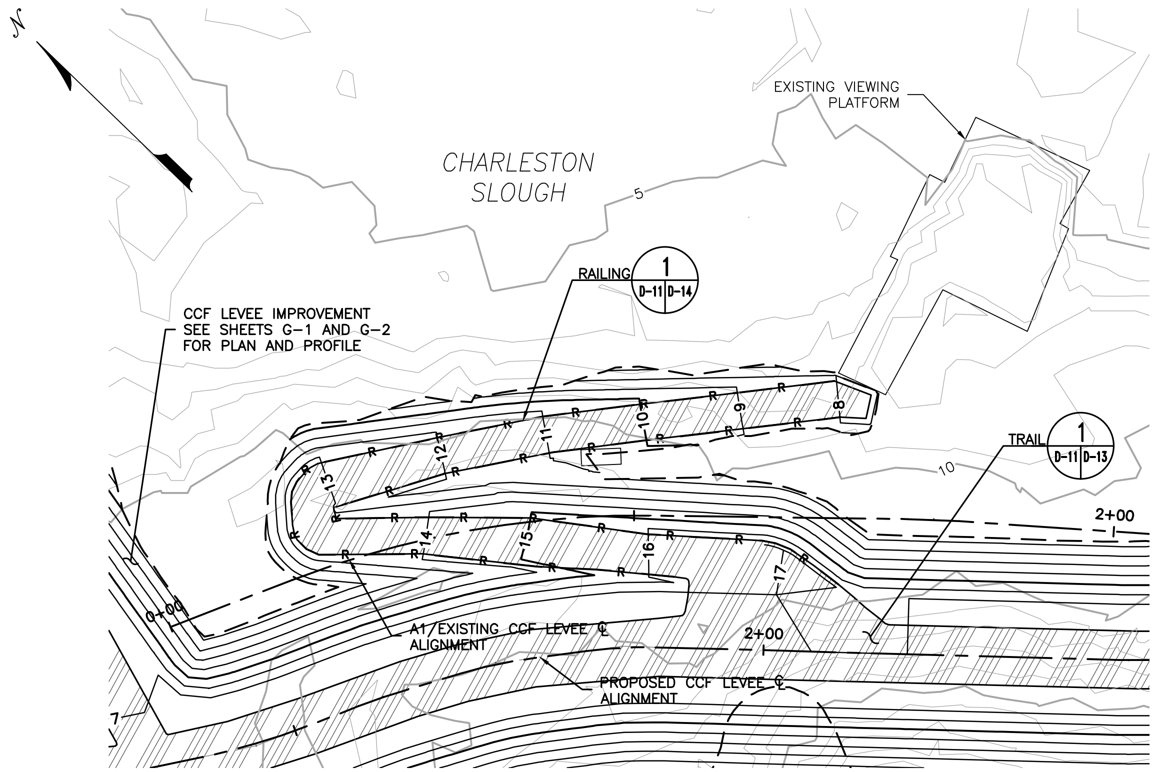
PROJECT No. 60422372
DATE 12-09-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

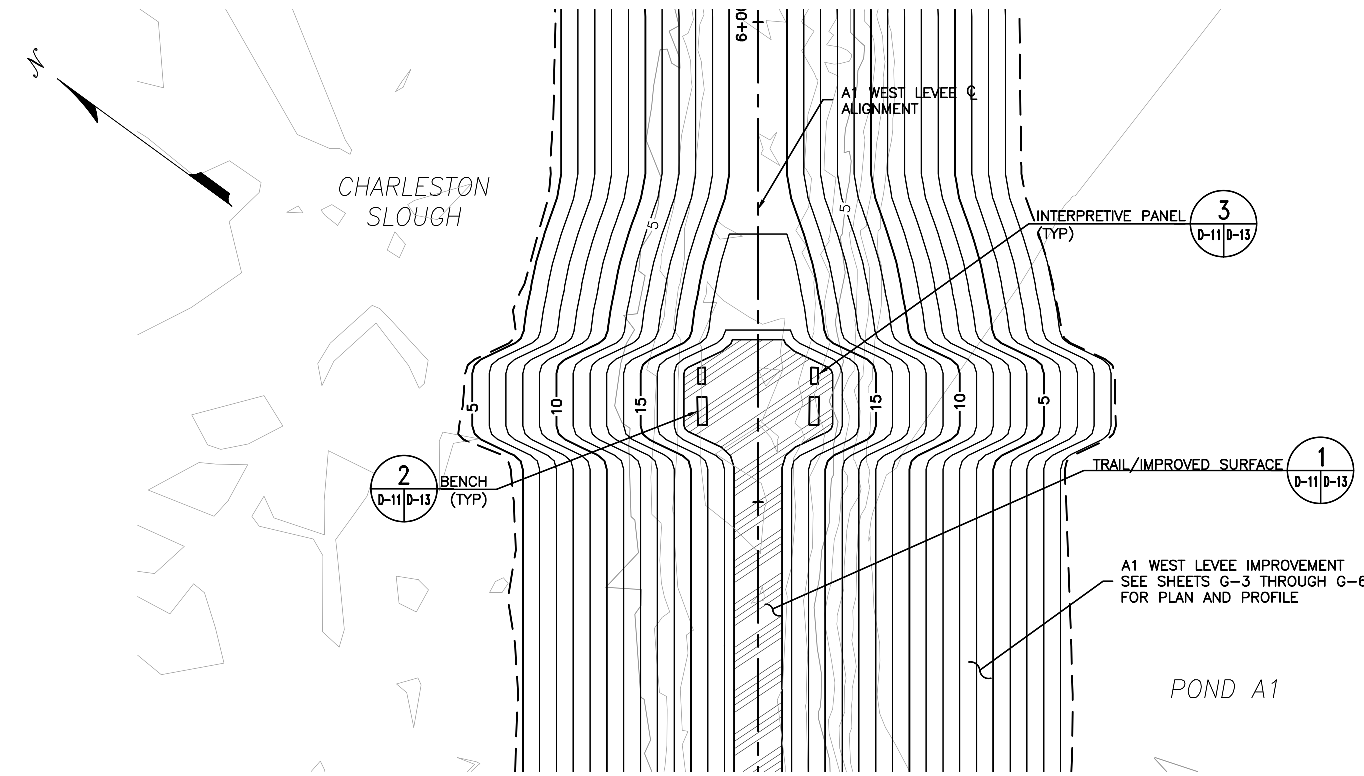
SHEET TITLE
MOUNTAIN VIEW PONDS
POND A2W EAST LEVEE BRIDGES
TYPICAL STRUCTURAL DETAILS

SHEET NO.
SHT. 28 OF 33 SHTS.
REV

DWG NO.
D-10



1 TRAIL CONNECTION TO EXISTING VIEWING PLATFORM – PLAN
1" = 20'



2 PUBLIC ACCESS AREA 1 – PLAN
1" = 20'

0 20 40 60
HORIZ 1" = 20'

QUESTA ENGINEERING CORP. Civil Environmental & Water Resources
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: AECOM, 300 Lakeside Drive, Suite 400, Oakland, CA 94612, Tel: (510) 893-3600, aecom.com

DESIGNED: M. HENDERSON
DRAWN: L. CHANDRASEKARAN
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

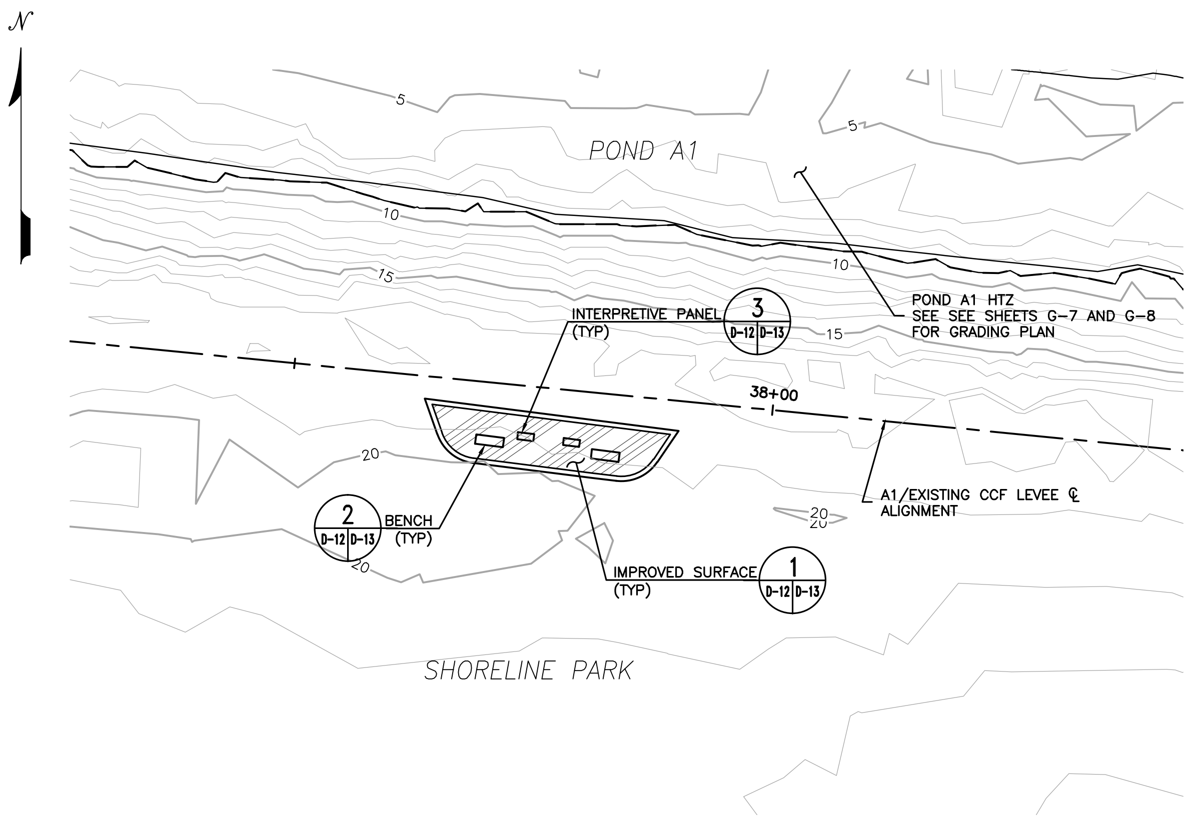
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

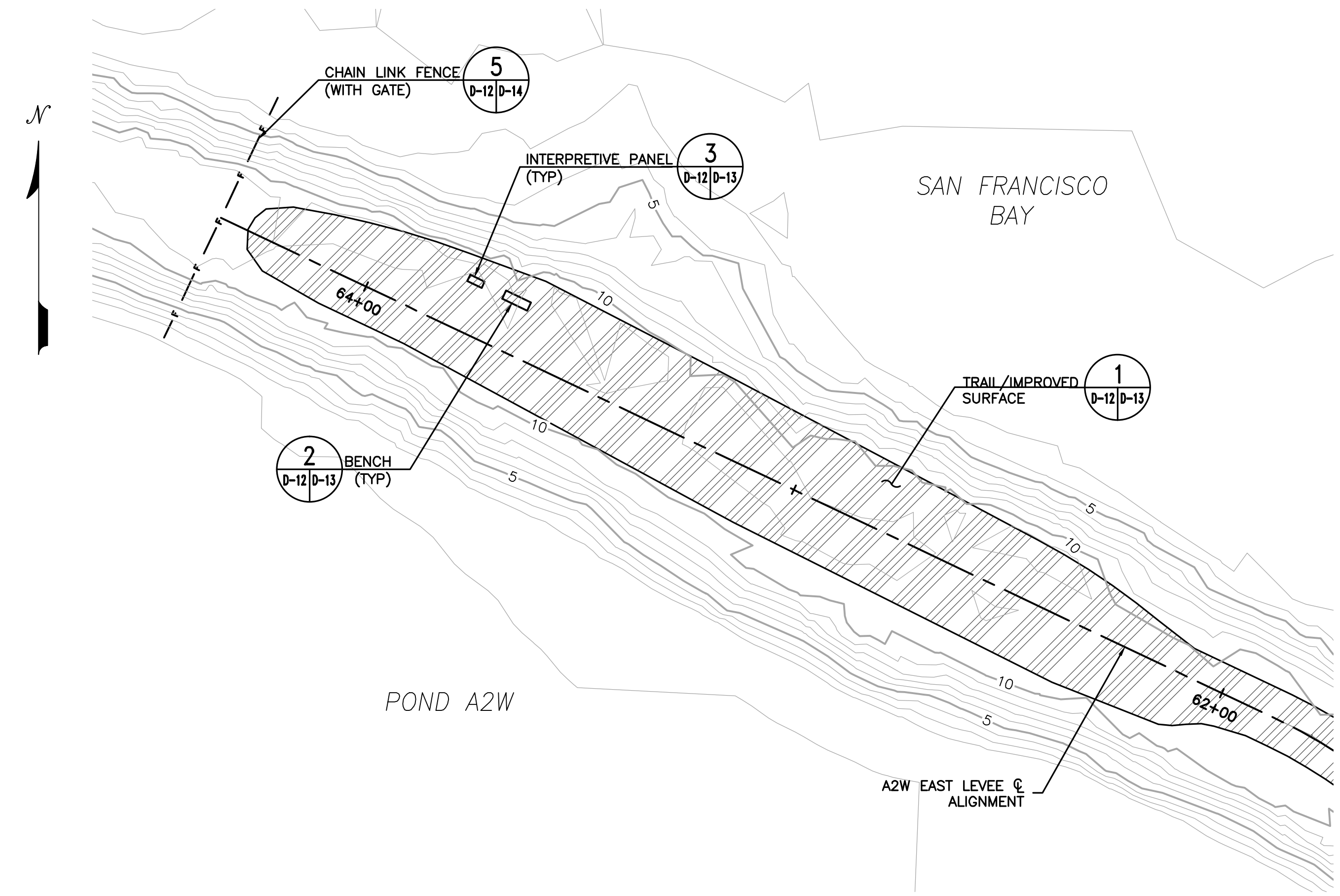
PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE: MOUNTAIN VIEW PONDS PUBLIC ACCESS FEATURES DETAILED LAYOUTS - SHEET 1 OF 2

SHEET NO. SHT. 29 OF 33 SHTS.
DWG NO. D-11

Dec 14, 2016 - 4:49pm
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-11.dwg



3 PUBLIC ACCESS AREA 2 – PLAN
1" = 20'



4 PUBLIC ACCESS AREA 3 – PLAN
1" = 20'

0 20 40 60
HORIZ 1" = 20'

QUESTA ENGINEERING CORP.
Civil Environmental & Water Resources
(510) 236-6114
FAX (510) 236-2423
questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	M. HENDERSON
DRAWN	L. CHANDRASEKARAN
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

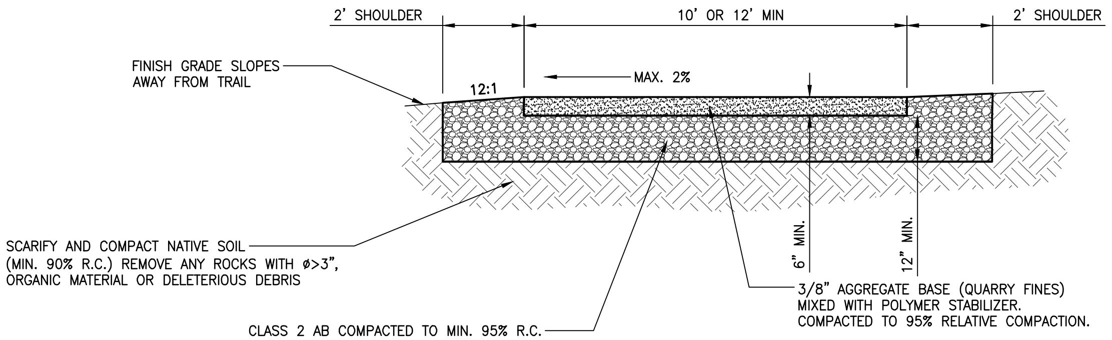
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

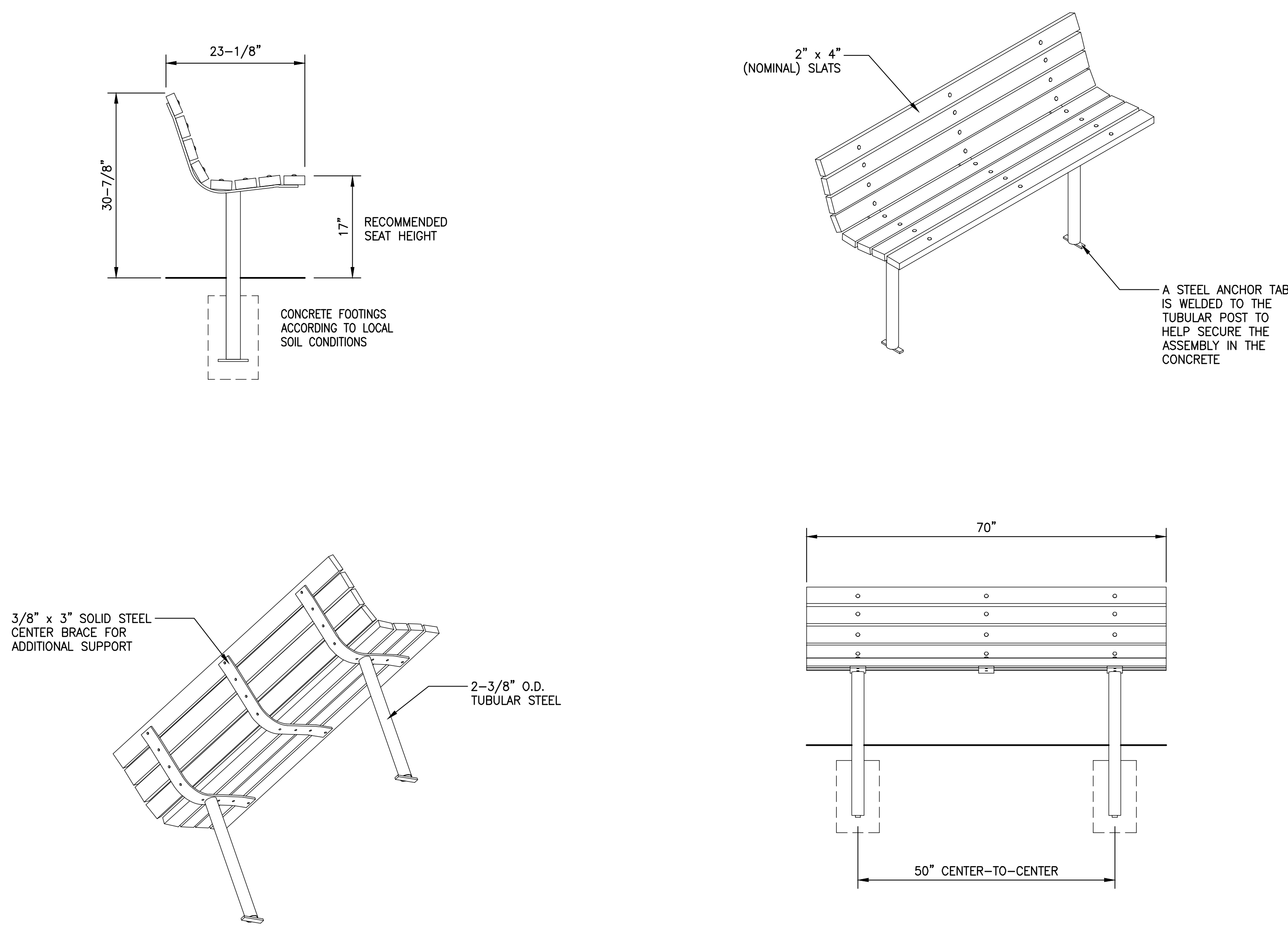
PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE MOUNTAIN VIEW PONDS PUBLIC ACCESS FEATURES DETAILED LAYOUTS - SHEET 2 OF 2

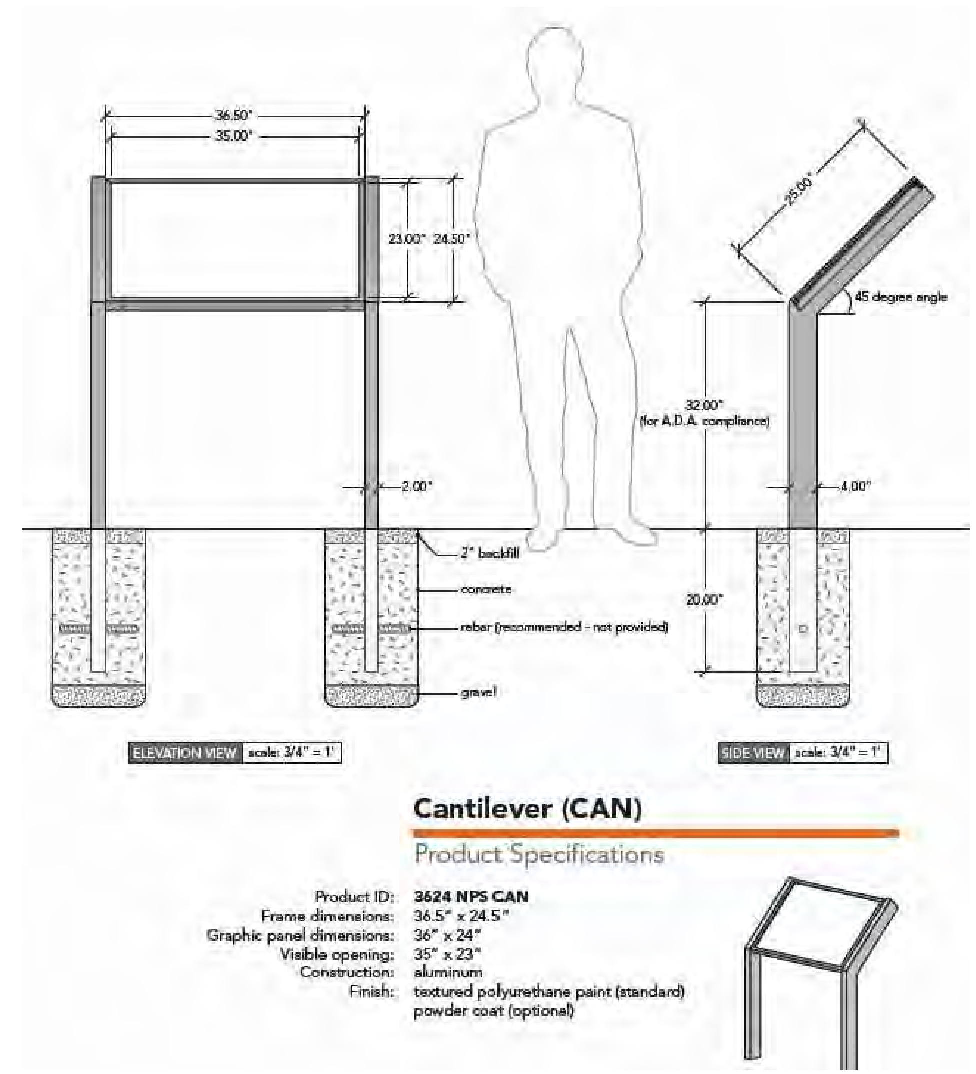
SHEET NO. SHT. 30 OF 33 SHTS.
REV
DWG NO. D-12



1 – TRAIL/IMPROVED SURFACE
NTS



2 – BENCH
NTS



3 – INTERPRETIVE PANEL
NTS

QUESTA ENGINEERING CORP.
Civil
Environmental
& Water Resources
(510) 236-6114
FAX (510) 236-2423
questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED M. HENDERSON
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

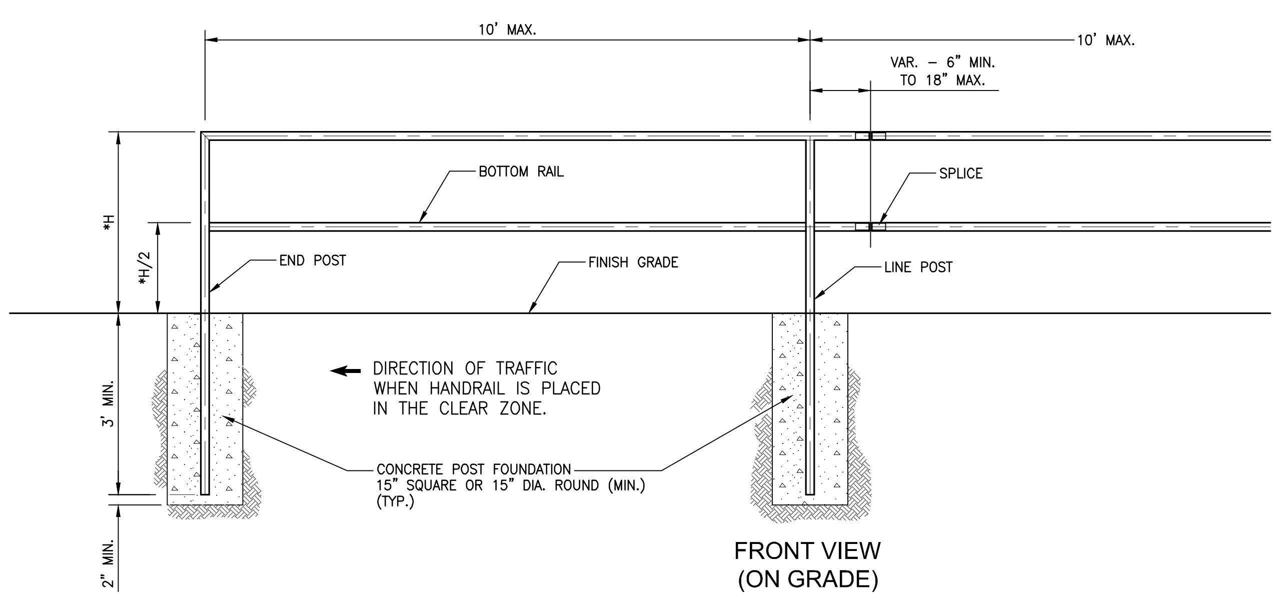
PROJECT No. 60422372
DATE 12-09-2016

PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE: MOUNTAIN VIEW PONDS PUBLIC ACCESS FEATURES DETAILS - SHEET 1 OF 2

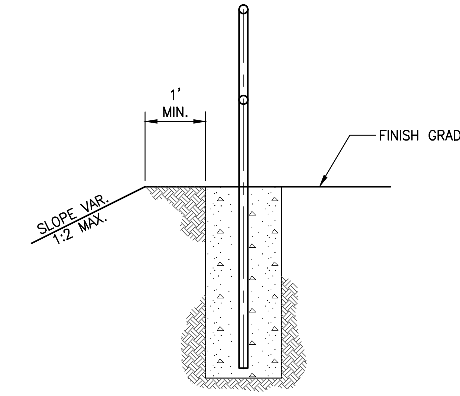
SHEET NO. SHT. 31 OF 33 SHTS.
REV
DWG NO. D-13

Dec 15, 2016 - 5:18pm
C:\pwworking\aecom_na\chandrasekarand\dms75827\MV_D-13.dwg

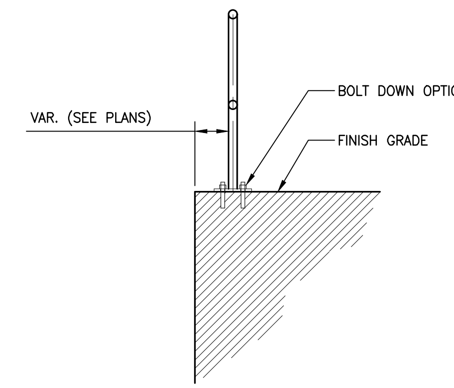
TWO RAIL HANDRAIL



FRONT VIEW
(ON GRADE)



SIDE VIEW
(ON GRADE)

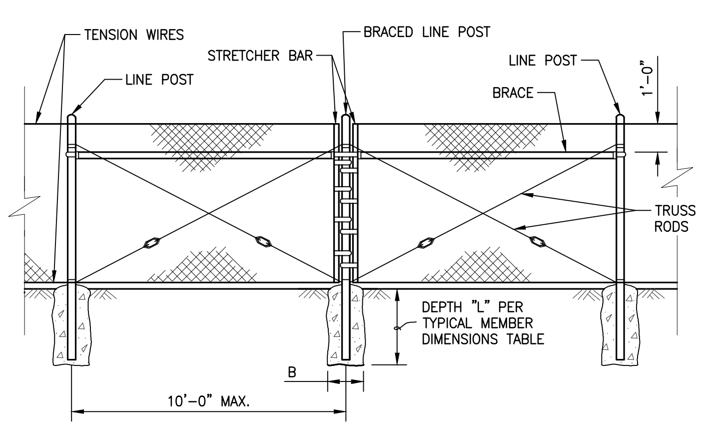


SIDE VIEW
(ON STRUCTURE)

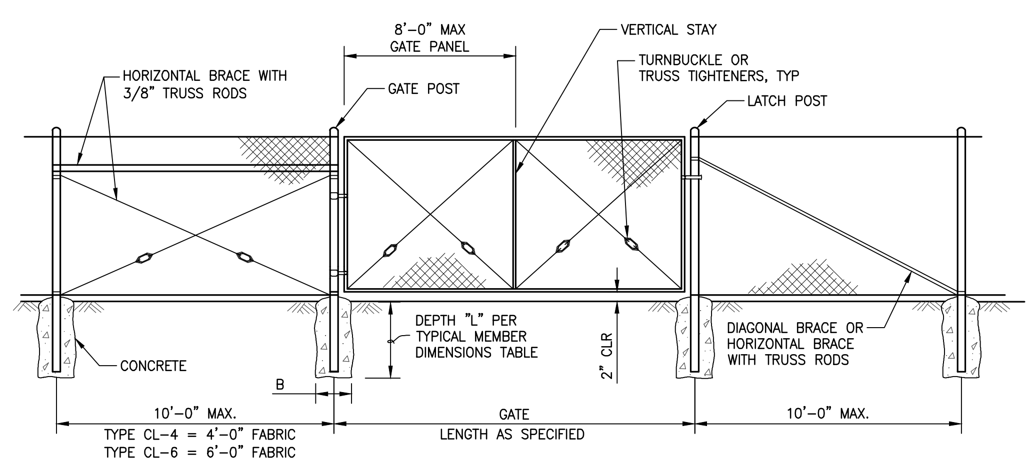
4 – RAILING DETAILS
NTS

BRACED LINE POST INSTALLATION

BRACED LINE POST AT INTERVALS NOT EXCEEDING 1000'



CHAIN LINK GATE INSTALLATION



TYPICAL MEMBER DIMENSIONS

FENCE HEIGHT (Max)	SLATTED	B (in)	L (ft)	ROUND PIPE GATE/LINE POST		
				SECTION	ROUND OD PIPE	WEIGHT (lb/ft)
5'-0"	NO	12"	2'-6"	3 Std	3.50"	7.58
6'-0"	NO	12"	2'-6"	3 Std	3.50"	7.58
8'-0"	NO	12"	3'-0"	3 Std	3.50"	7.58
10'-0"	NO	14"	3'-6"	3 Std	3.50"	7.58
5'-0"	YES	12"	3'-0"	31/2 Std	4.00"	9.12
6'-0"	YES	14"	3'-6"	4 Std	4.50"	10.80
8'-0"	YES	18"	3'-6"	5 Std	5.56"	14.60
10'-0"	YES	20"	4'-0"	6 Std	6.63"	19.00

Above post dimensions and weights are minimums.
Larger sizes may be used upon approval.
Maximum Gate Width is 24'-0".

5 – CHAIN LINK FENCE WITH GATE
NTS

QUESTA ENGINEERING CORP. Civil Environmental & Water Resources
(510) 236-6114 FAX (510) 236-2423 questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED M. HENDERSON
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

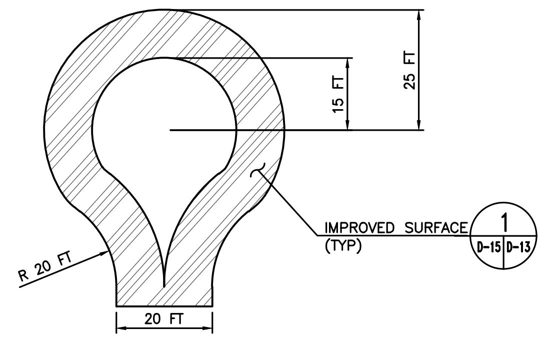
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-09-2016

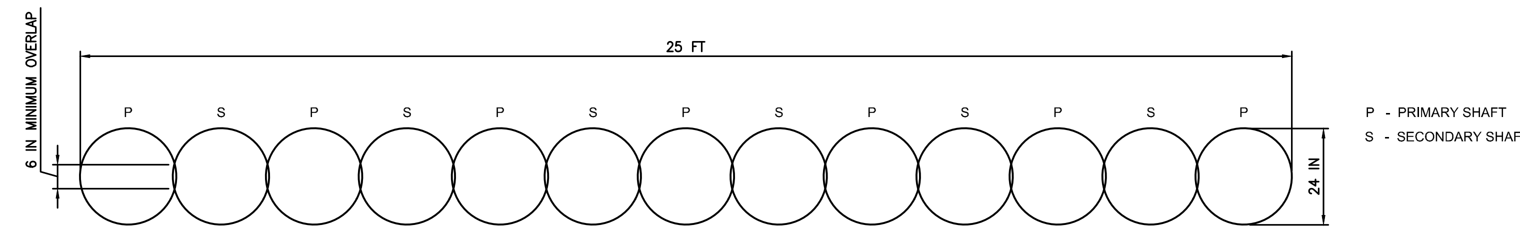
PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE MOUNTAIN VIEW PONDS PUBLIC ACCESS FEATURES DETAILS - SHEET 2 OF 2

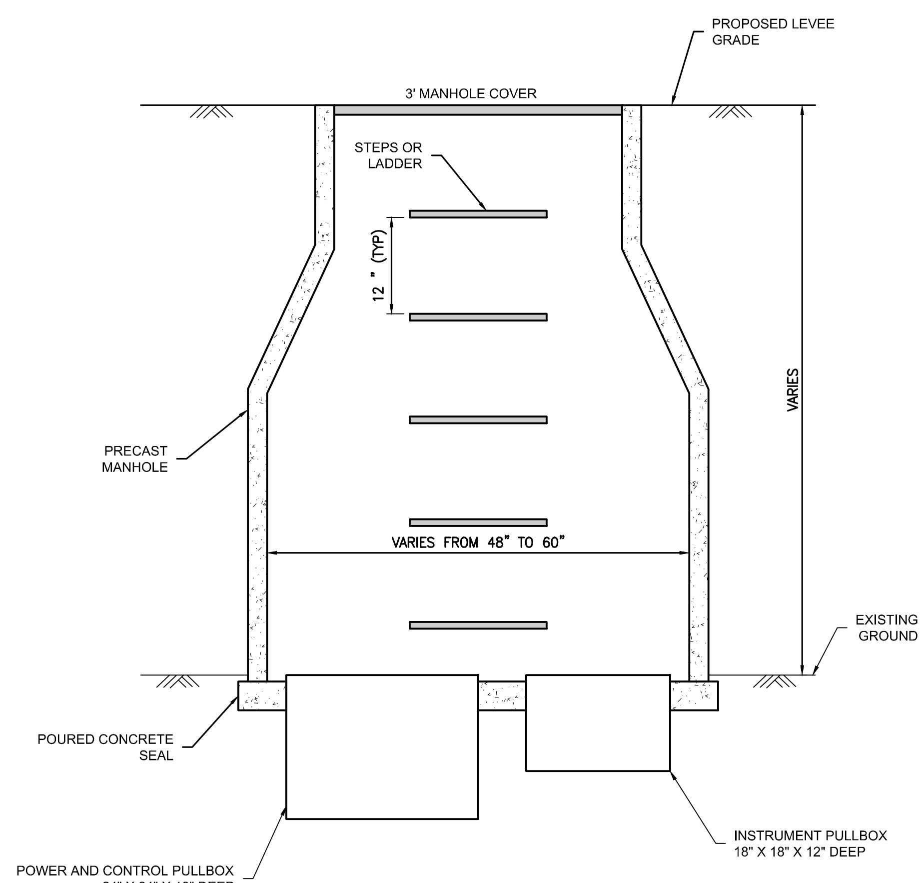
SHEET NO. SHT. 32 OF 33 SHTS.
REV
DWG NO. D-14



1 VEHICLE TURNAROUND
– NTS



2 SECANT PILE WALL
– NTS



3 ELECTRICAL PULL BOX ACCESS
– NTS

Dec 09, 2016 - 9:37am
C:\pwworking\aecom_na\chandrasekaranl\dms75827\MV_D-15.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-09-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE MOUNTAIN VIEW PONDS MISCELLANEOUS DETAILS

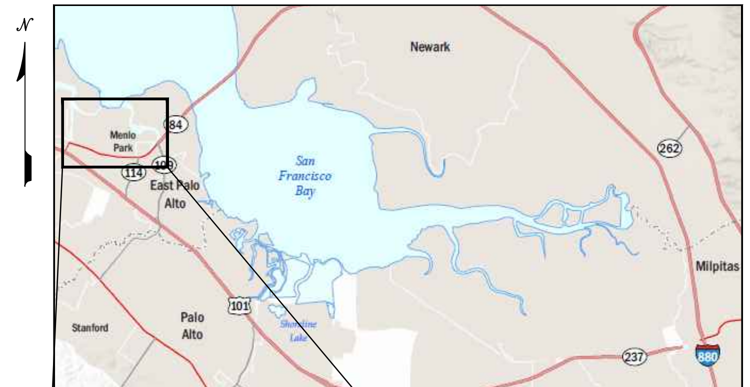
SHEET NO. SHT. 33 OF 33 SHTS.

REV

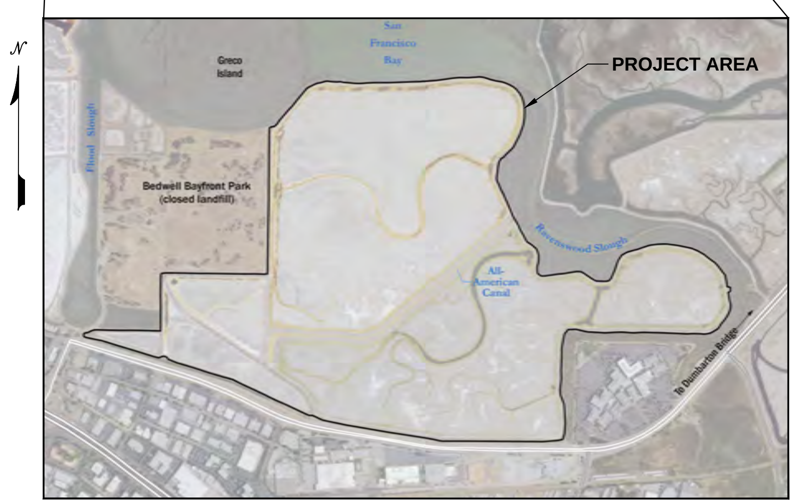
DWG NO. D-15

SOUTH BAY SALT POND RESTORATION PROJECT

RAVENSWOOD PONDS
NEAR MENLO PARK, CALIFORNIA



VICINITY MAP
NTS



LOCATION MAP
NTS

PROJECT AREA PHOTO

SHEETS

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE: RAVENSWOOD PONDS TITLE SHEET

SHEET NO. SHT. 1 OF 40 SHTS.
REV
DWG NO. T-1

Dec 14, 2016 - 3:12pm
C:\pwworking\aecom_na\chandrasekaran\dms75824\RW_T-1.dwg

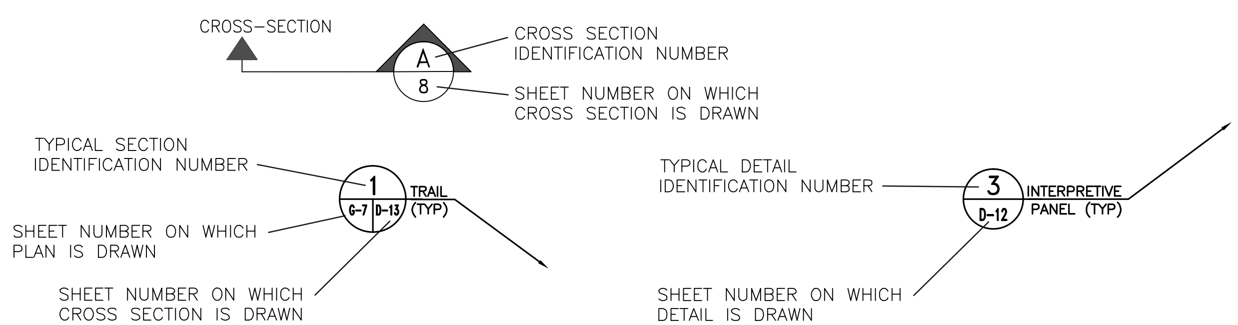
LEGEND

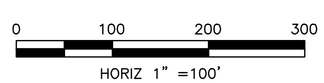
LINETYPES

- ALIGNMENT CENTERLINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DAYLIGHT LINE
- CONSTRUCTION ACCESS ROUTE
- EXISTING TRAIL
- PROPOSED TRAIL
- WOOD POST AND CABLE FENCE
- VINYL CLAD CHAIN LINK FENCE
- CHAIN LINK FENCE WITH GATE
- EXISTING CARGILL PIPELINE

- PROPOSED EARTHWORK FILL
- PROPOSED EARTHWORK CUT
- STAGING/STOKCPILING AREA
- TRAIL/IMPROVED SURFACE

SYMBOLS





SCALE BAR

NORTH ARROW

ABBREVIATIONS

AAC	ALL AMERICAN CANAL
℄	CENTERLINE
DIA	DIAMETER
EL	ELEVATION
FT	FEET
HDPE	HIGH DENSITY POLYETHYLENE
HORIZ.	HORIZONTAL
HTZ	HABITAT TRANSITION ZONE
NTS	NOT TO SCALE
STA	STATION
TYP	TYPICAL
VERT.	VERTICAL
WCS	WATER CONTROL STRUCTURE

GENERAL NOTES

1. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM ARE AS FOLLOWS:
   COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 3
   VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)
2. TOPOGRAPHY FROM LIDAR DATA OBTAINED FROM AIRBORNE1 IN U.S. SURVEY FEET, DATED JUNE–NOVEMBER 2010.
3. PROPOSED TOPOGRAPHIC CONTOUR INFORMATION IS SHOWN AT 1–FOOT CONTOUR INTERVALS, UNLESS OTHERWISE STATED.
4. ALL CONSTRUCTION AND CONSTRUCTION MATERIAL SHALL BE IN ACCORDANCE WITH THESE PLANS.
5. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO BE KNOWLEDGEABLE ABOUT AND OBEY ALL PERMIT REQUIREMENTS WHILE PERFORMING THE WORK ON THESE PLANS.
6. THE CONTRACTOR SHALL PRACTICE SAFETY AT ALL TIMES AND SHALL FURNISH, ERECT, AND MAINTAIN SUCH FENCES, BARRICADES, LIGHTS, AND SIGNS NECESSARY TO GIVE ADEQUATE PROTECTION TO THE PUBLIC AT ALL TIMES.
7. THE CONTRACTOR SHALL HAVE COPIES OF THE APPROVED PLANS AND SPECIFICATIONS FOR THIS PROJECT AT ALL TIMES AND SHALL BE FAMILIAR WITH ALL APPLICABLE STANDARDS AND SPECIFICATIONS.
8. THE CONTRACTOR IS RESPONSIBLE FOR SETTING ONSITE SURVEY CONTROL FOR CONSTRUCTION STAKING IN PROJECT COORDINATE SYSTEM AND VERTICAL DATUM.
9. UNDERGROUND FACILITIES AND SUB–STRUCTURES SHOWN IN THESE PLANS WERE OBTAINED FROM THE BEST AVAILABLE SOURCES. HOWEVER, SINCE SOME INFORMATION WAS OBTAINED FROM OTHERS, AECOM CANNOT GUARANTEE SAID INFORMATION AS BEING ACCURATE. PRIOR TO BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY THE DEPTH AND LOCATION OF ALL EXISTING UTILITIES, EQUIPMENT, AND SUB–STRUCTURES. IN THE EVENT OF DAMAGE TO EXISTING UTILITIES, EQUIPMENT, OR SUB–STRUCTURES, THE CONTRACTOR SHALL PERFORM ALL REPAIRS AT THEIR EXPENSE.
10. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY OF ALL EXCAVATIONS.

EARTHWORK SUMMARY

LEVEE IMPROVEMENTS	226,300 CY (FILL, INCLUDE 24% FOR SHRINKAGE)
HABITAT TRANSITION ZONES	130,400 CY (FILL, INCLUDES 3% FOR SHRINKAGE)
LEVEE REMOVAL	10,700 CY (CUT, BANK–MEASURE)
LEVEE LOWERING	2,100 CY (CUT, BANK–MEASURE)
BREACH EXCAVATION	13,300 CY (CUT, BANK–MEASURE)
PILOT CHANNEL	16,000 CY (CUT, BANK–MEASURE)
DITCH BLOCK	1,000 CY (FILL, ASSUMES NO SHRINKAGE)
CHANNEL (WCS–4 TO RAVENSWOOD SLOUGH)	1,000 CY (CUT, BANK–MEASURE)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

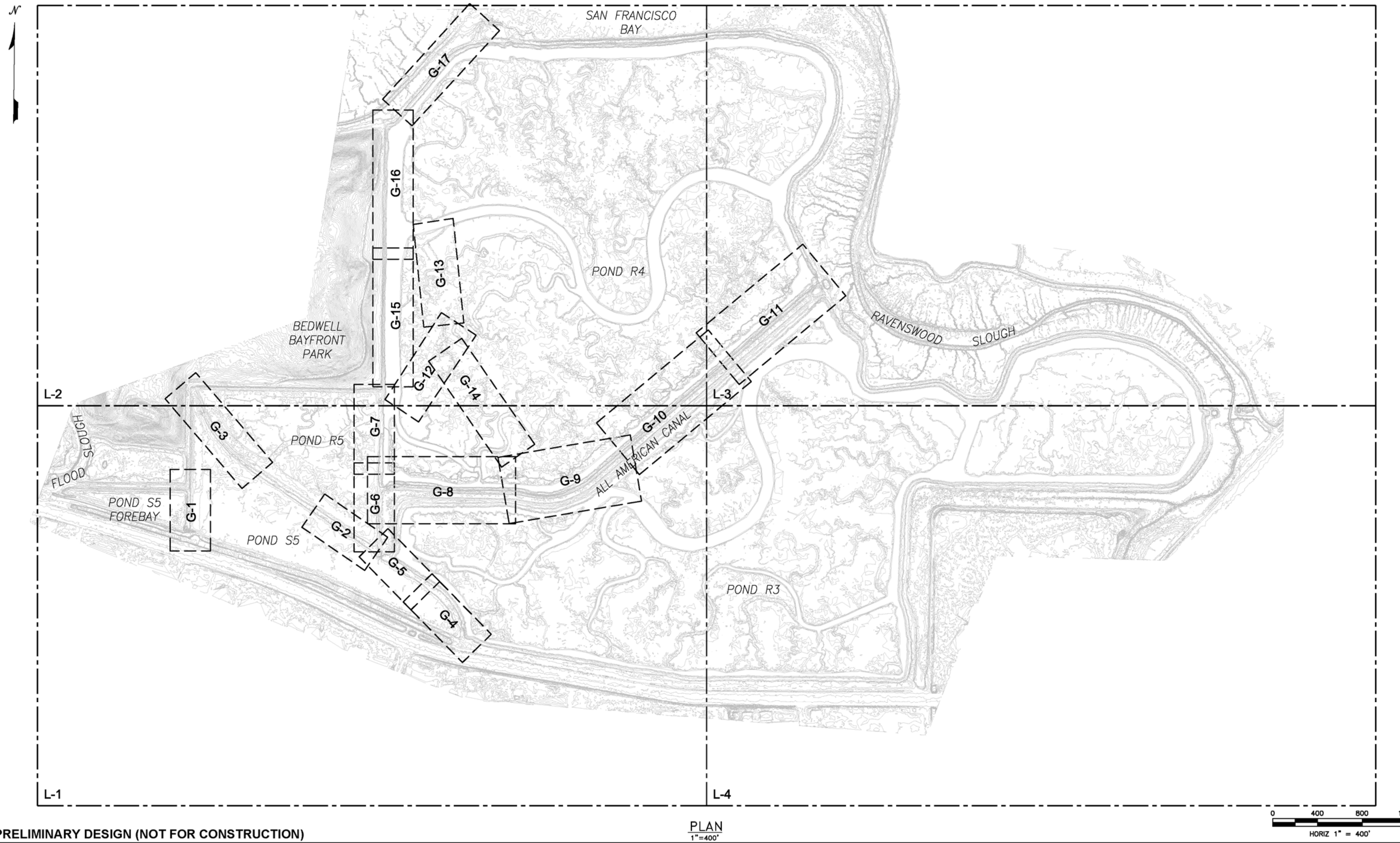
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE RAVENSWOOD PONDS NOTES AND LEGEND

SHEET NO. SHT. 2 OF 40 SHTS.
REV
DWG NO. T-2

Dec 15, 2016 - 2:50pm



PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

PLAN
1"=400'

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

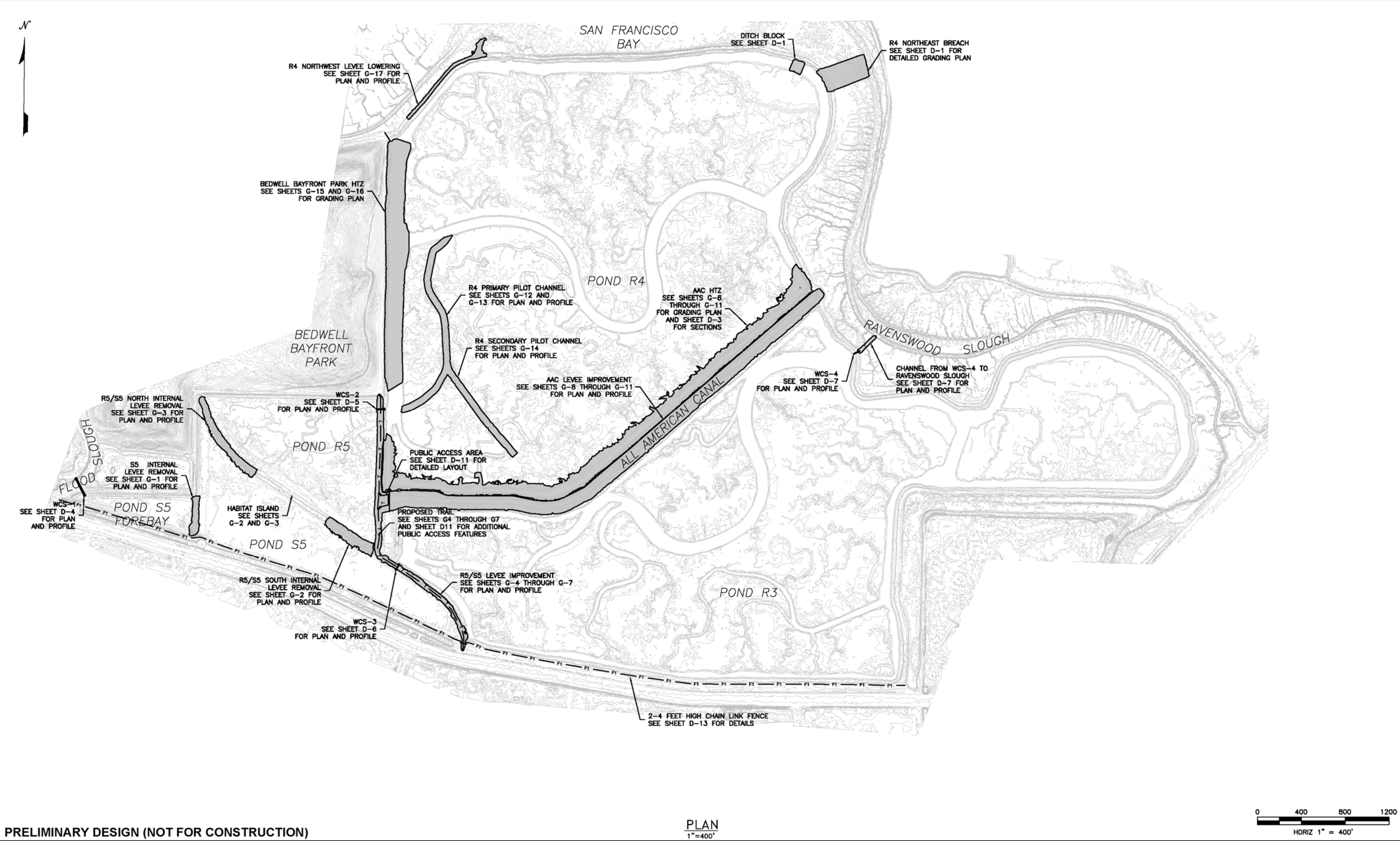
PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE: RAVENSWOOD PONDS KEY MAP

SHEET NO. SHT. 3 OF 40 SHTS.

DWG NO. T-3

REV



PLAN
1"=400'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
RAVENSWOOD PONDS
GENERAL ARRANGEMENT PLAN

SHEET NO. SHT. 4 OF 40 SHTS.
DWG NO. T-4
REV

Dec 15, 2016 - 11:00am

N

NOTES

1. THE ACCESS ROUTES SHOWN ARE PRELIMINARY AND INTENDED FOR PLANNING AND IMPACT ANALYSIS PURPOSES. THE EXACT ROUTES WILL BE FINALIZED IN COORDINATION WITH THE CITY OF MENLO PARK.
2. THE CONTRACTOR MAY LOCATE FILL MATERIAL WITHIN THE INDICATED STOCKPILING AREA.

PLAN
1"=500'

0 500 1000 1500
HORIZ 1" = 500'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

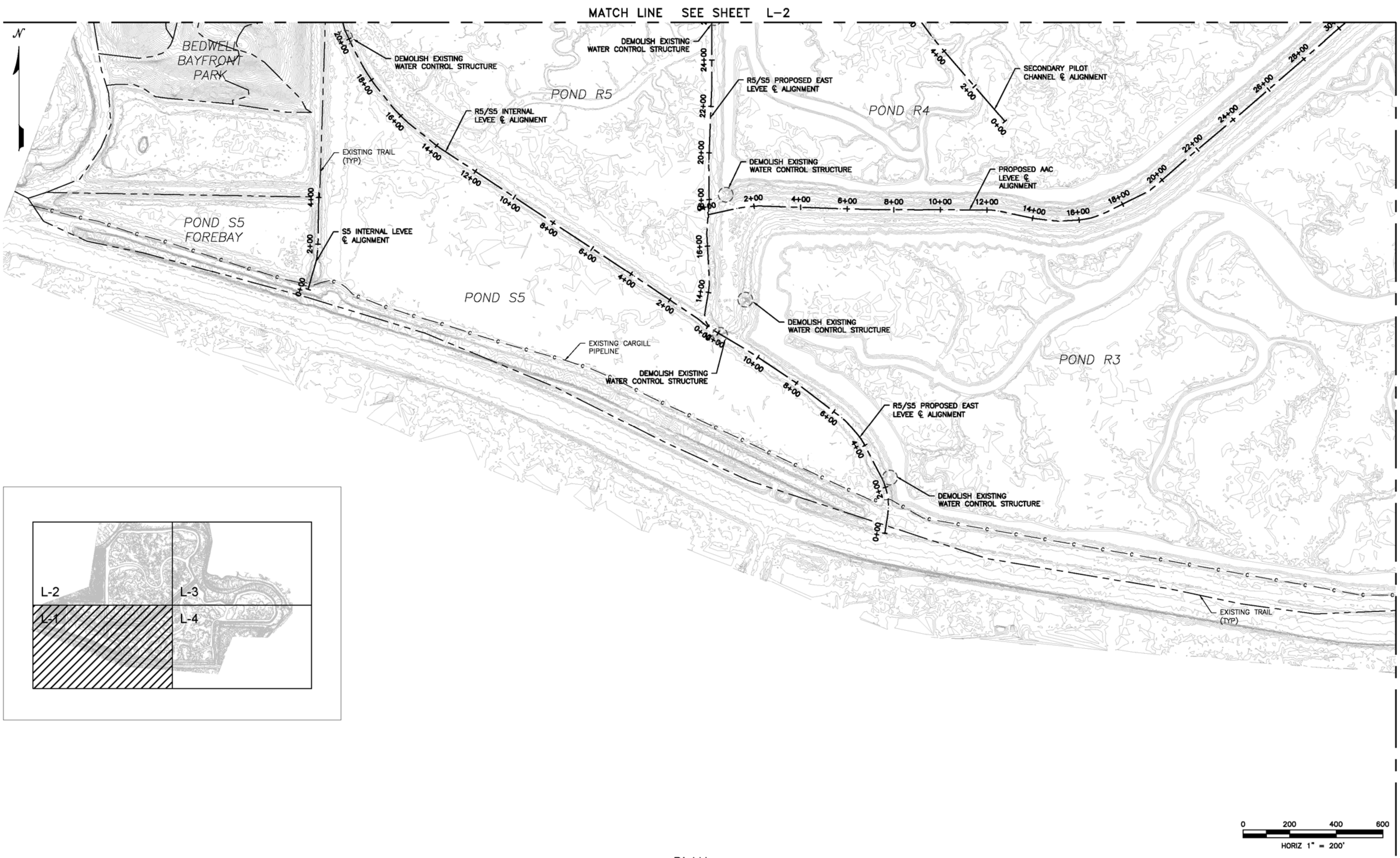
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
ACCESS ROUTE & STAGING PLAN

SHEET NO. SHT. 5 OF 40 SHTS.
REV
DWG NO. T-5

Dec 12, 2016 - 7:47pm
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_T-5.dwg



PLAN
1"=200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

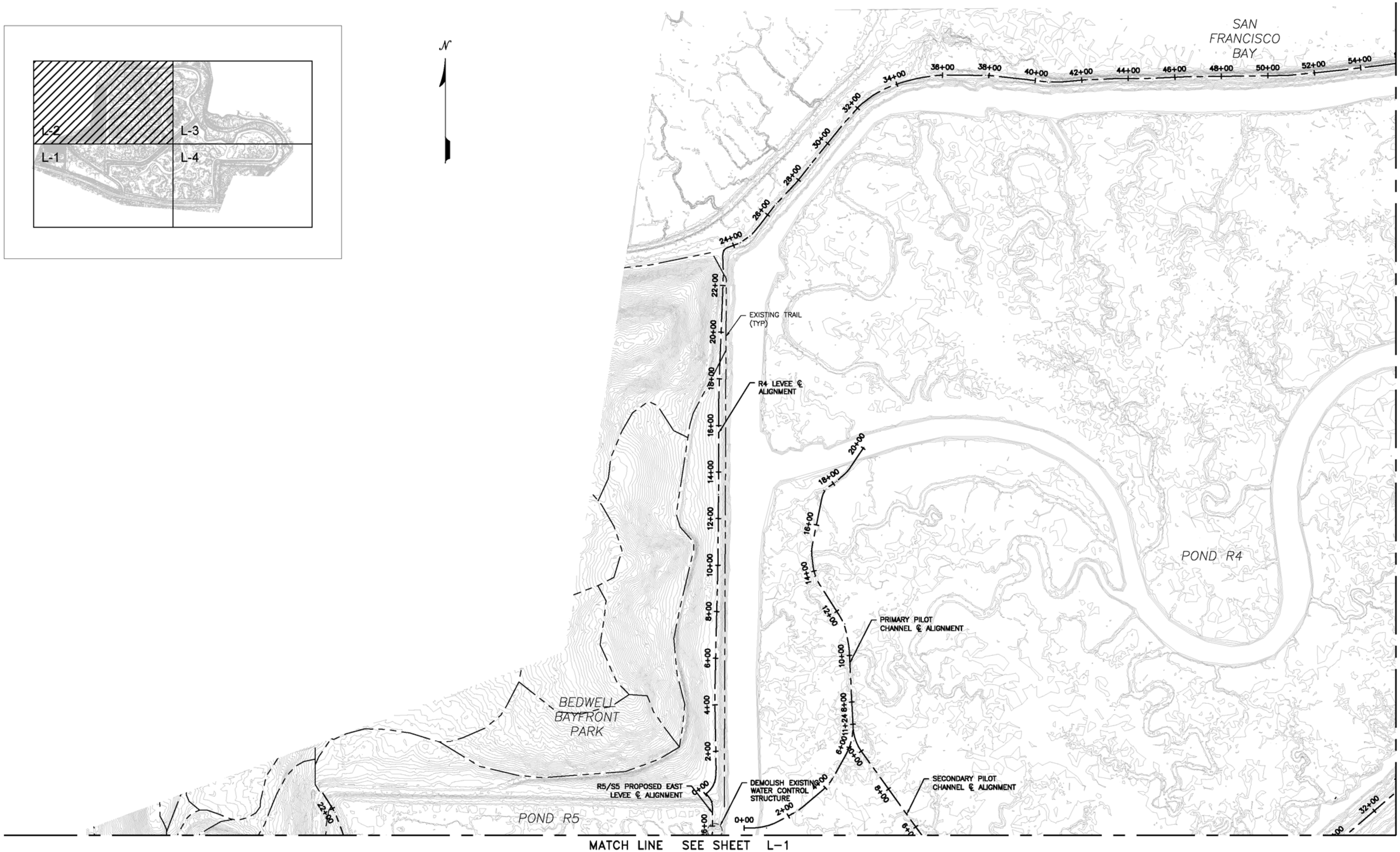
PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE RAVENSWOOD PONDS LAYOUT PLAN SHEET 1 OF 4

SHEET NO. SHT. 6 OF 40 SHTS.

DWG NO. L-1

REV



PLAN
1"=200'

0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
LAYOUT PLAN
SHEET 2 OF 4

SHEET NO. SHT. 7 OF 40 SHTS.
REV
DWG NO.
L-2

Dec 13, 2016 - 7:30am

PLAN
1"=200'

0 200 400 600
HORIZ 1" = 200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

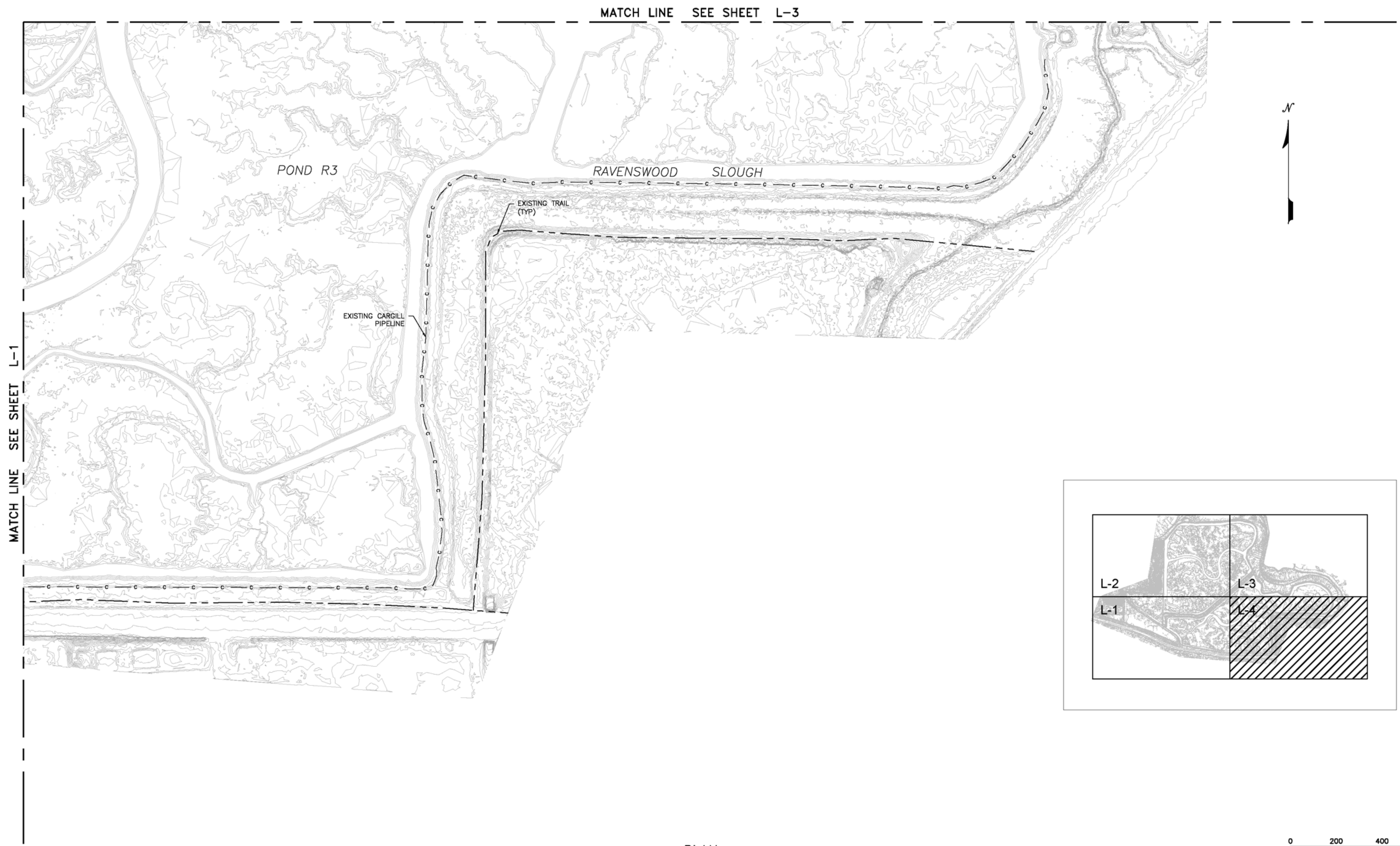
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
LAYOUT PLAN
SHEET 3 OF 4

SHEET NO. SHT. 8 OF 40 SHTS.
REV
DWG NO. L-3



0 200 400 600
HORIZ 1" = 200'

PLAN
1"=200'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

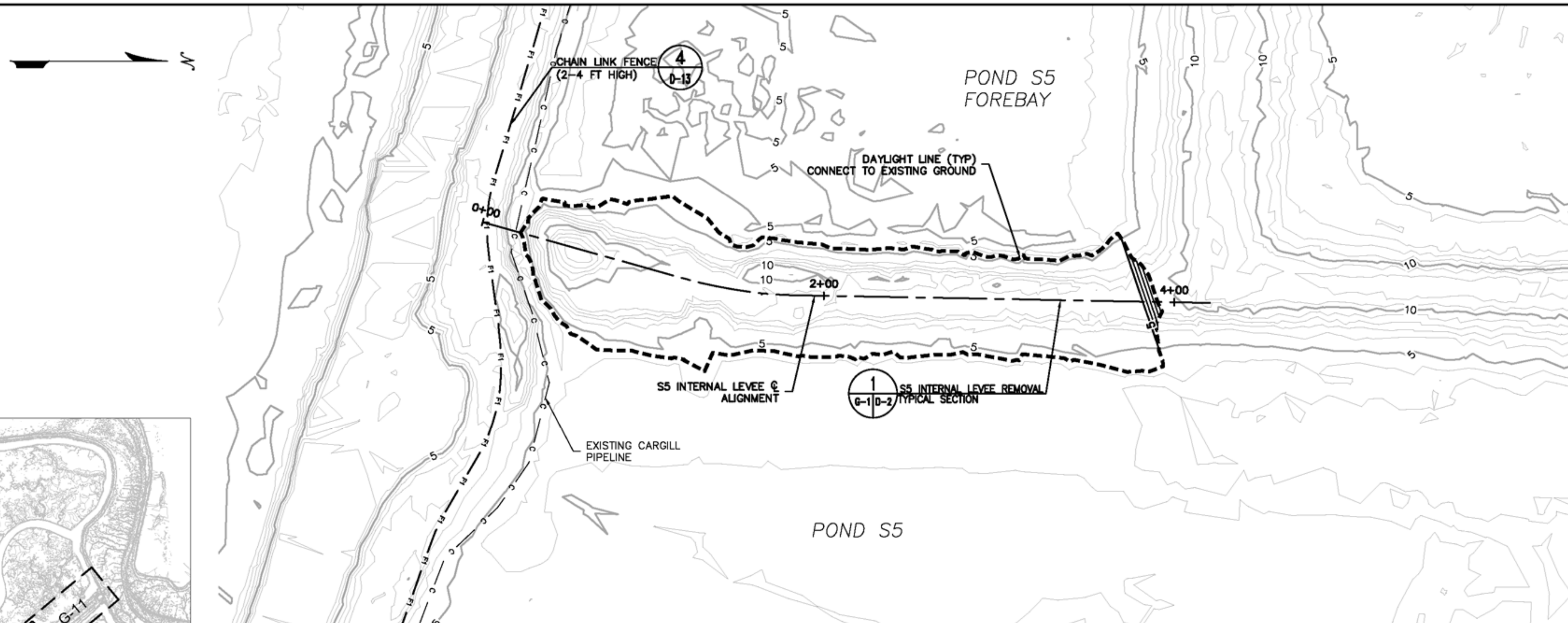
PROJECT No. 60422372 DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

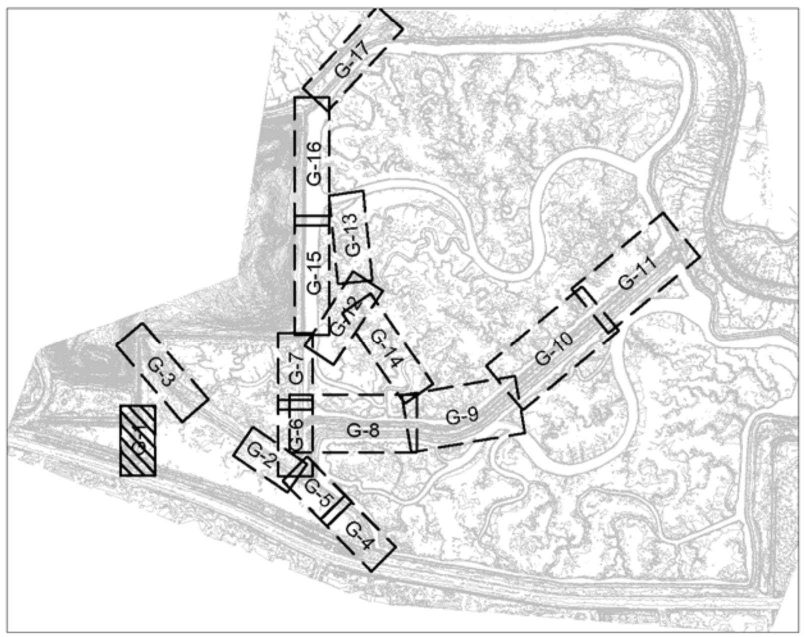
SHEET TITLE
RAVENSWOOD PONDS
LAYOUT PLAN
SHEET 4 OF 4

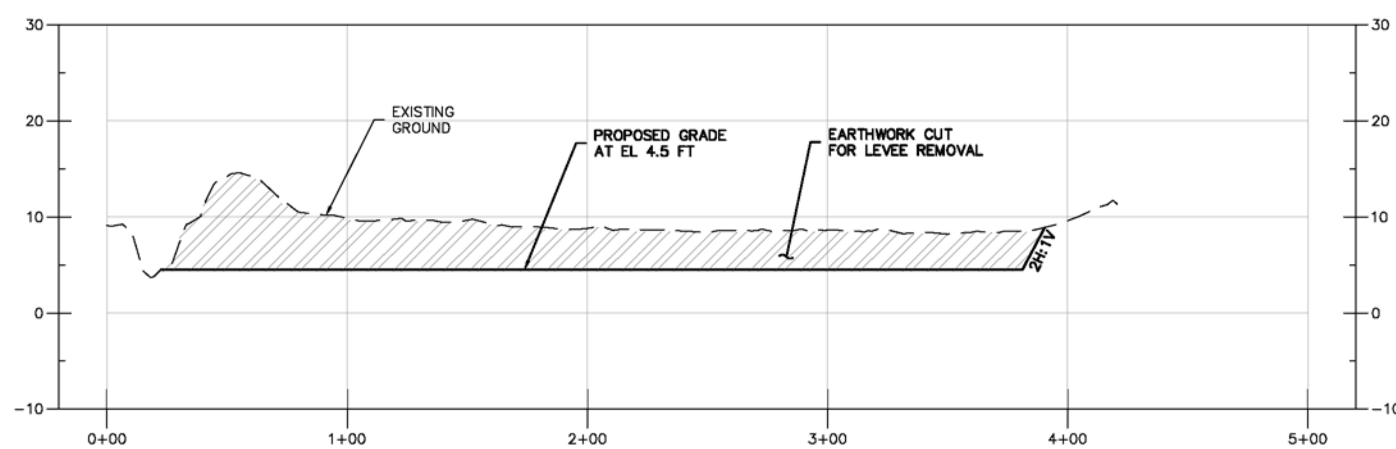
SHEET NO. SHT. 9 OF 40 SHTS.
REV
DWG NO. L-4

Dec 13, 2016 - 8:03am



PLAN
1"=40'





S5 INTERNAL LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

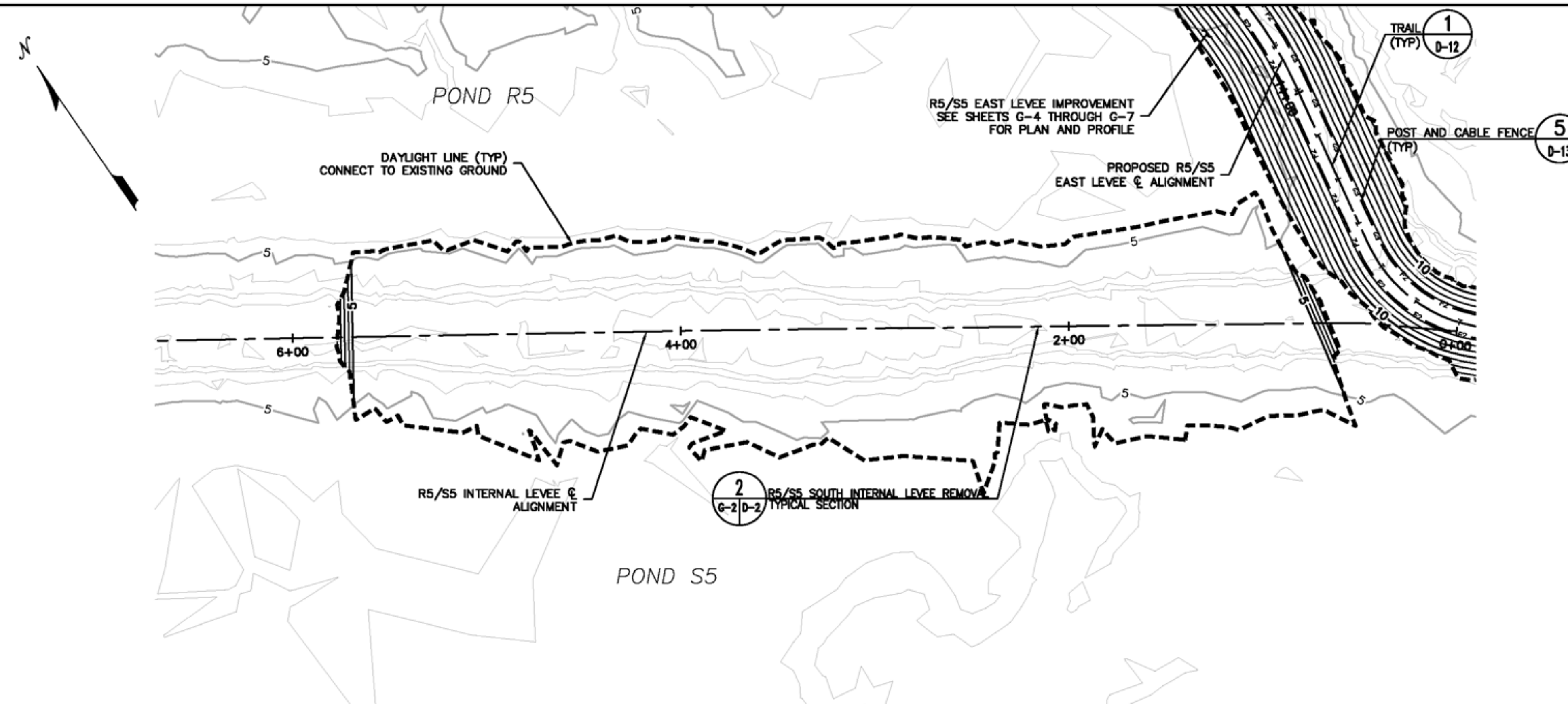
PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE: RAVENSWOOD PONDS
POND S5 INTERNAL LEVEE REMOVAL
PLAN AND PROFILE

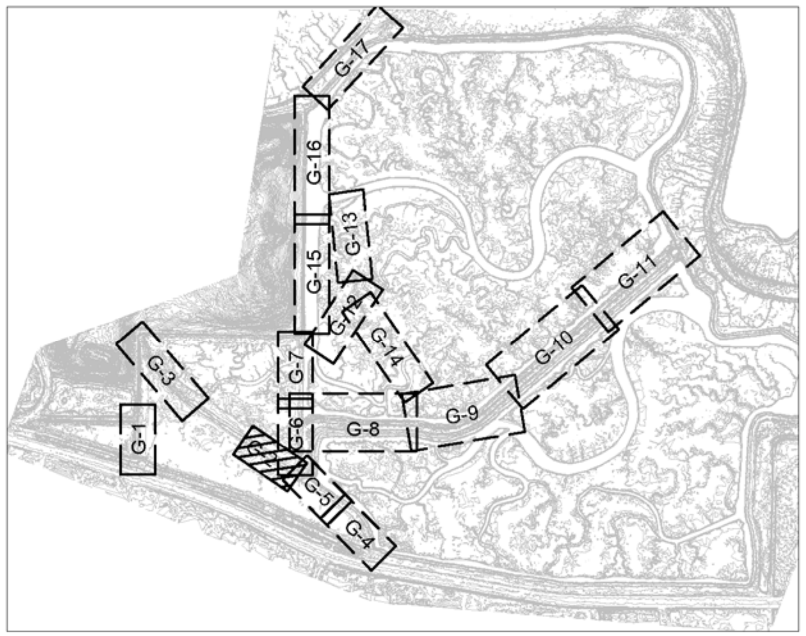
SHEET NO. SHT. 10 OF 40 SHTS.

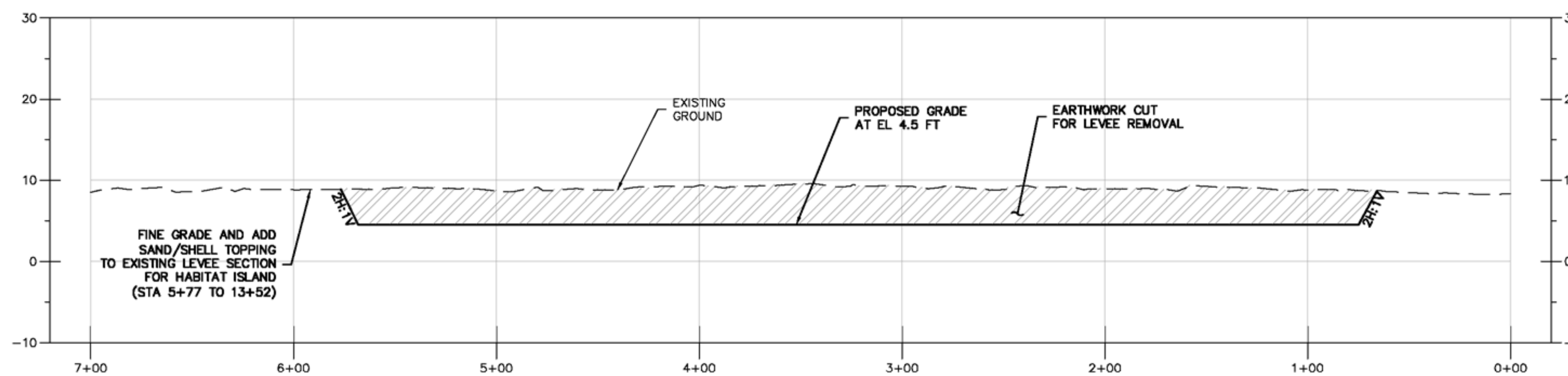
DWG NO. G-1

Dec 14, 2016 - 10:57am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_G-1.dwg



PLAN
1"=40'





R5/S5 INTERNAL LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40' (0 40 80 120)
VERT 1" = 10' (0 10 20 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

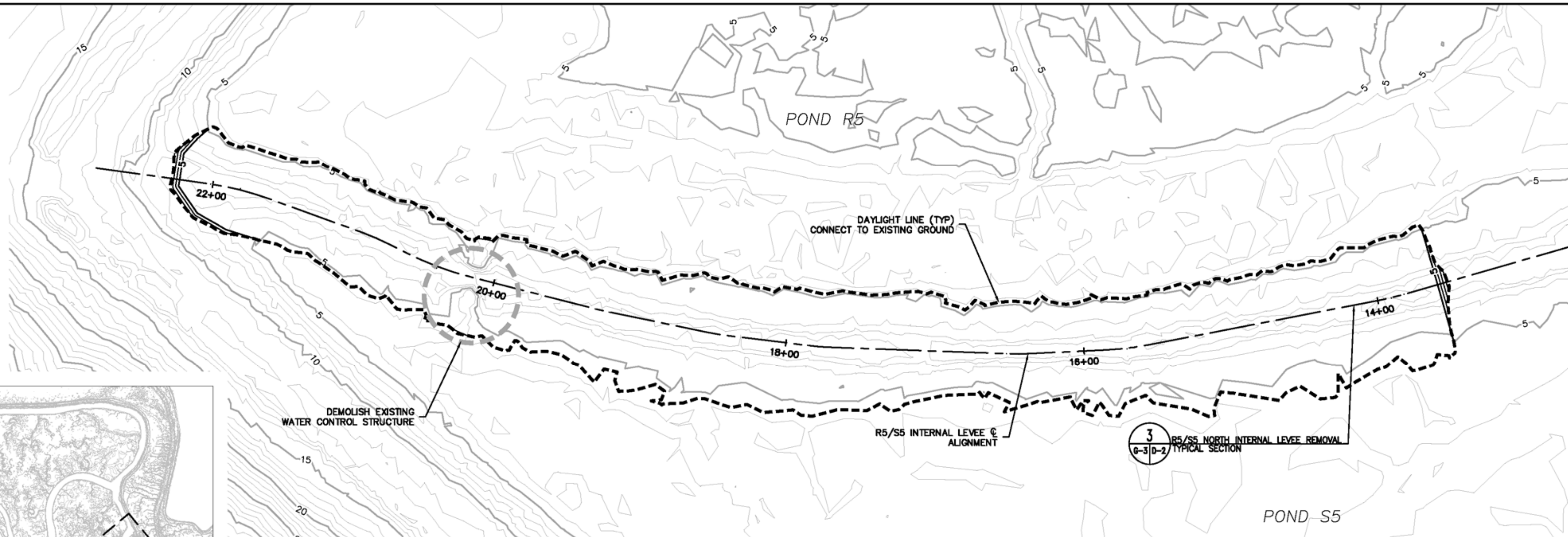
PROJECT No. 60422372
DATE 12-13-2016

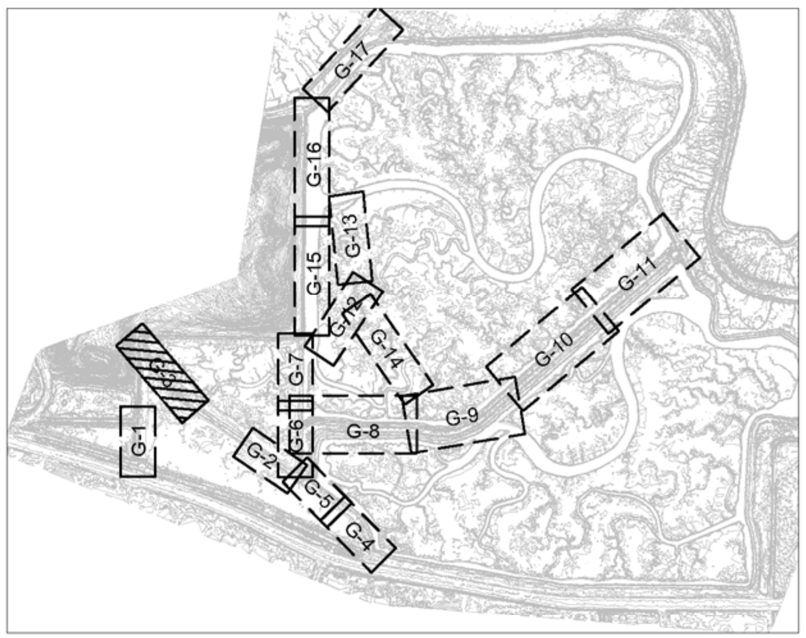
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
POND R5/S5 INTERNAL LEVEE REMOVAL
PLAN AND PROFILE - SHEET 1 OF 2

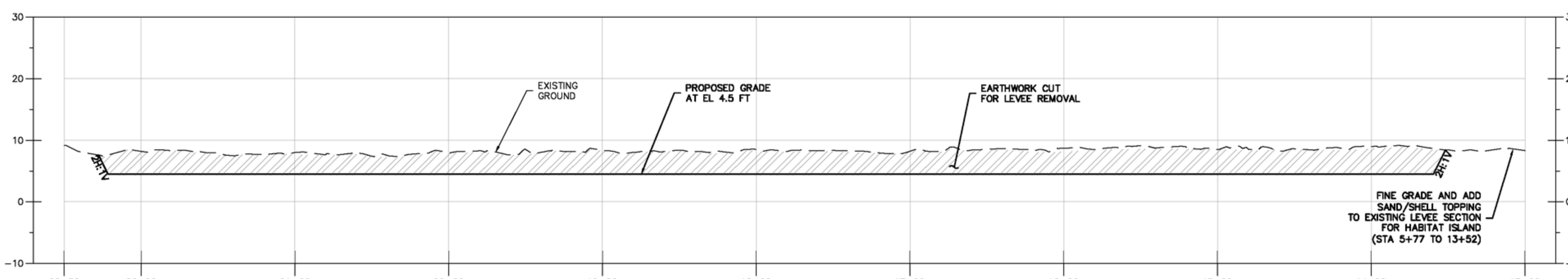
SHEET NO. SHT. 11 OF 40 SHTS.
REV
DWG NO. G-2

Dec 15, 2016 - 9:53am





PLAN
1"=40'



R5/S5 INTERNAL LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'

0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

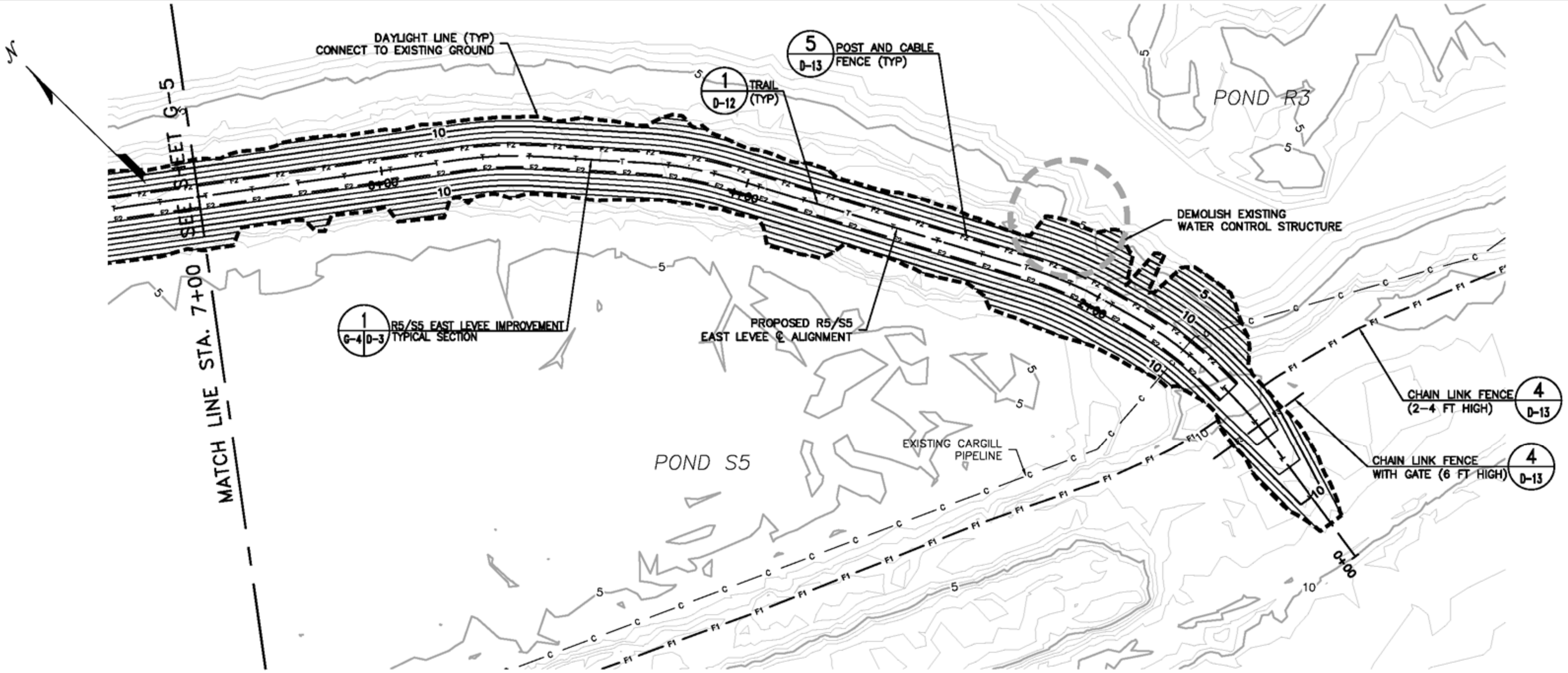
PROJECT No. 60422372
DATE 12-13-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

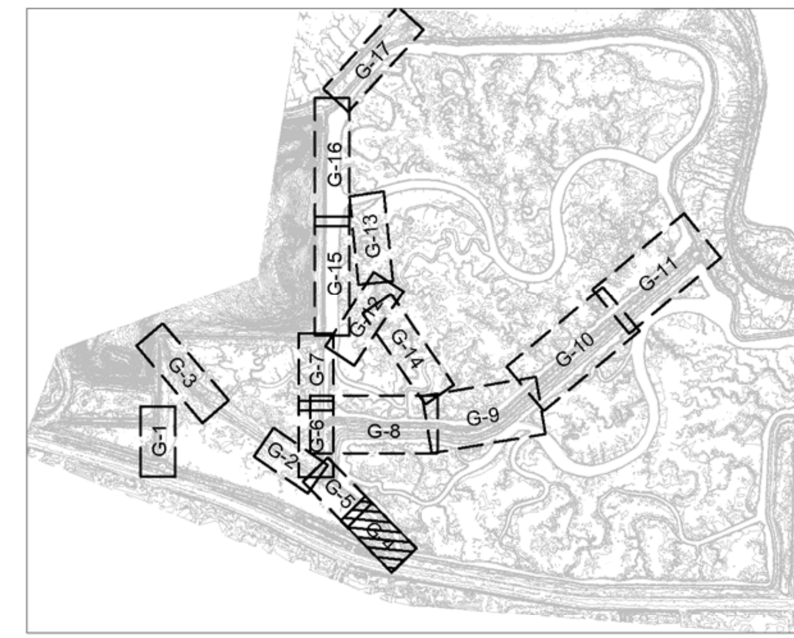
SHEET TITLE RAVENSWOOD PONDS
POND R5/S5 INTERNAL LEVEE REMOVAL
PLAN AND PROFILE - SHEET 2 OF 2

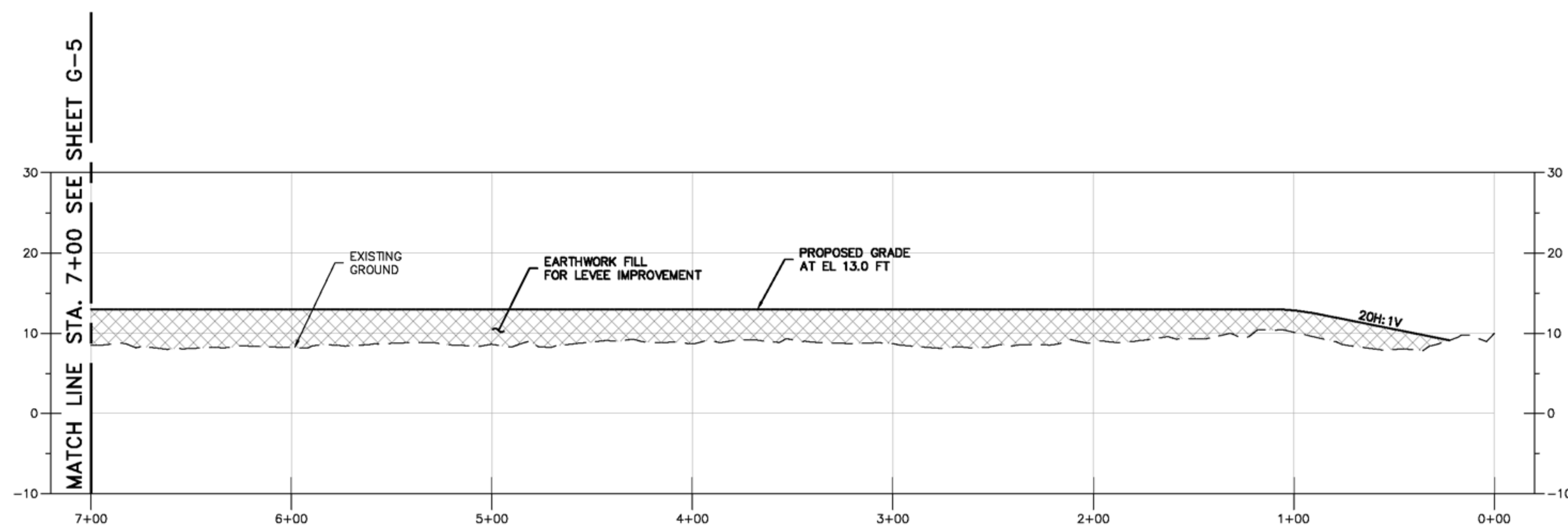
SHEET NO. SHT. 12 OF 40 SHTS.
REV
DWG NO. G-3

Dec 14, 2016 - 11:07am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_G-3.dwg



PLAN
1"=40'





PROPOSED R5/S5 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40' (0 40 80 120)
VERT 1" = 10' (0 10 20 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

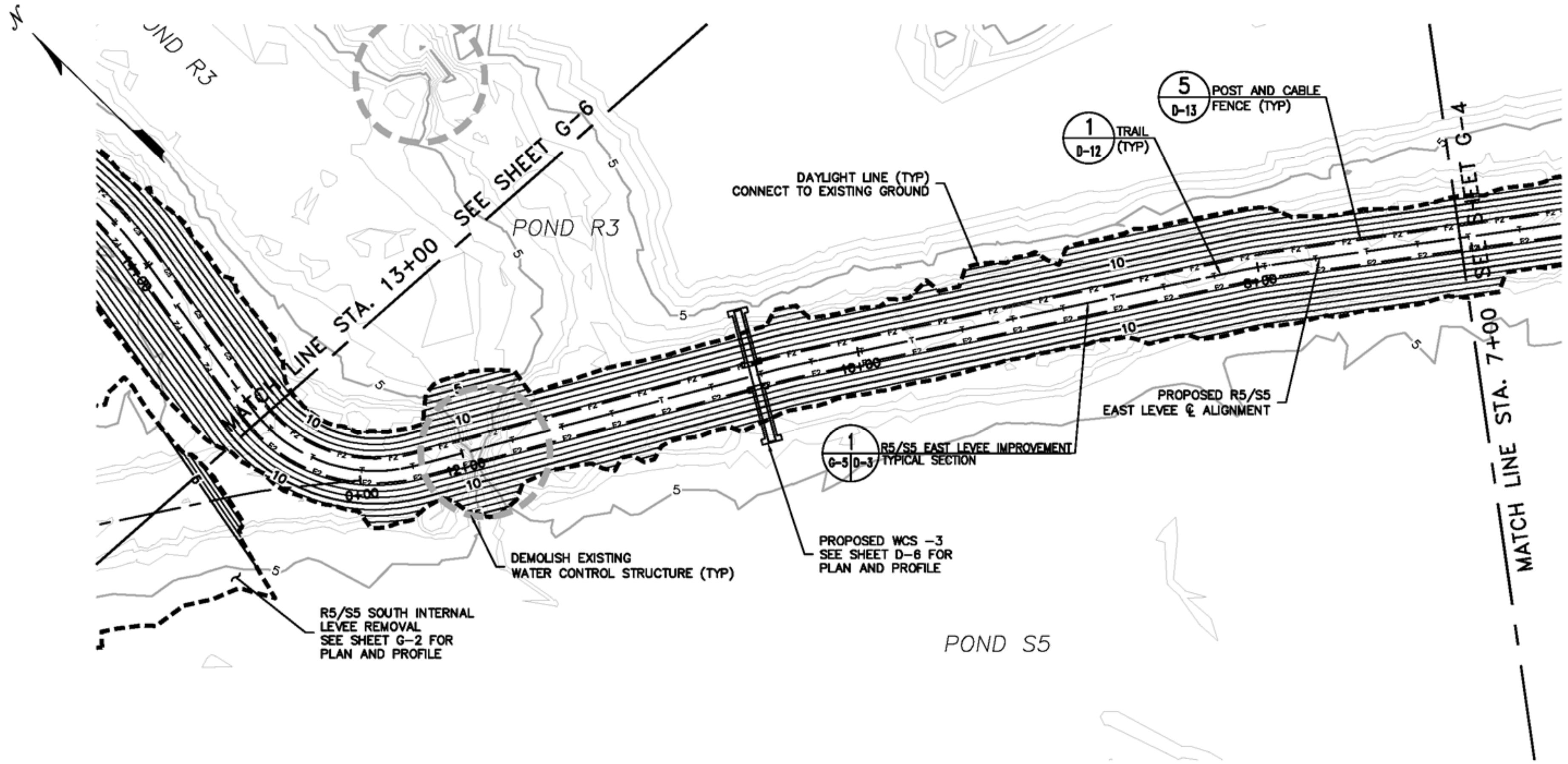
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

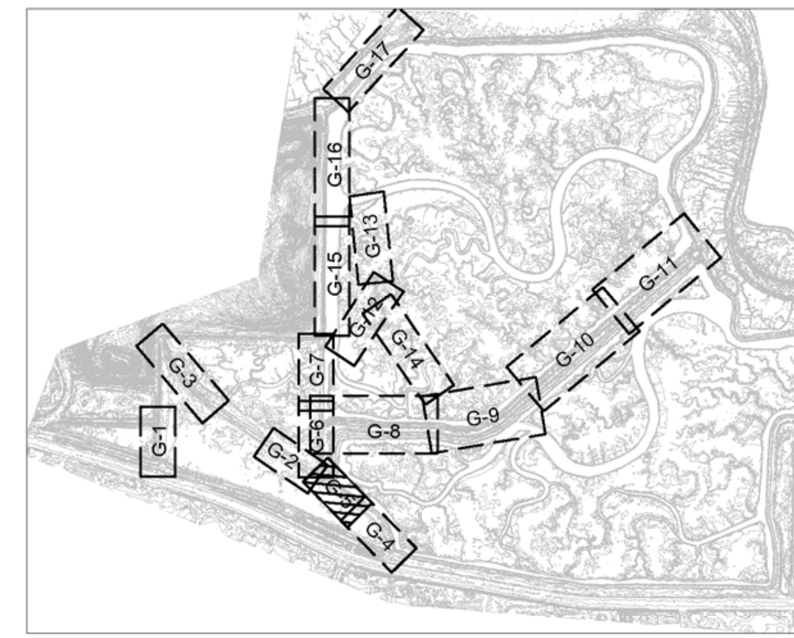
SHEET TITLE
RAVENSWOOD PONDS
POND R5/S5 EAST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 1 OF 4

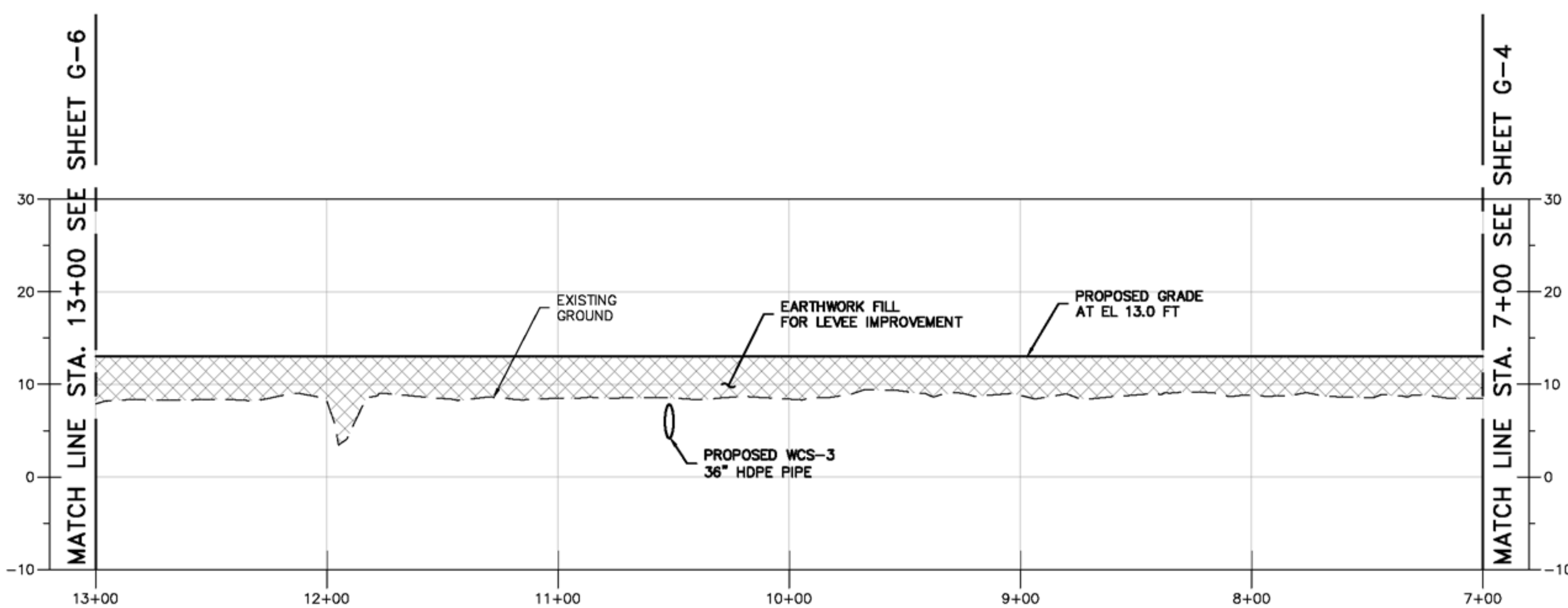
SHEET NO. SHT 13 OF 40 SHTS
REV
DWG NO. G-4

Dec 14, 2016 - 11:10am



PLAN
1"=40'





PROPOSED R5/S5 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

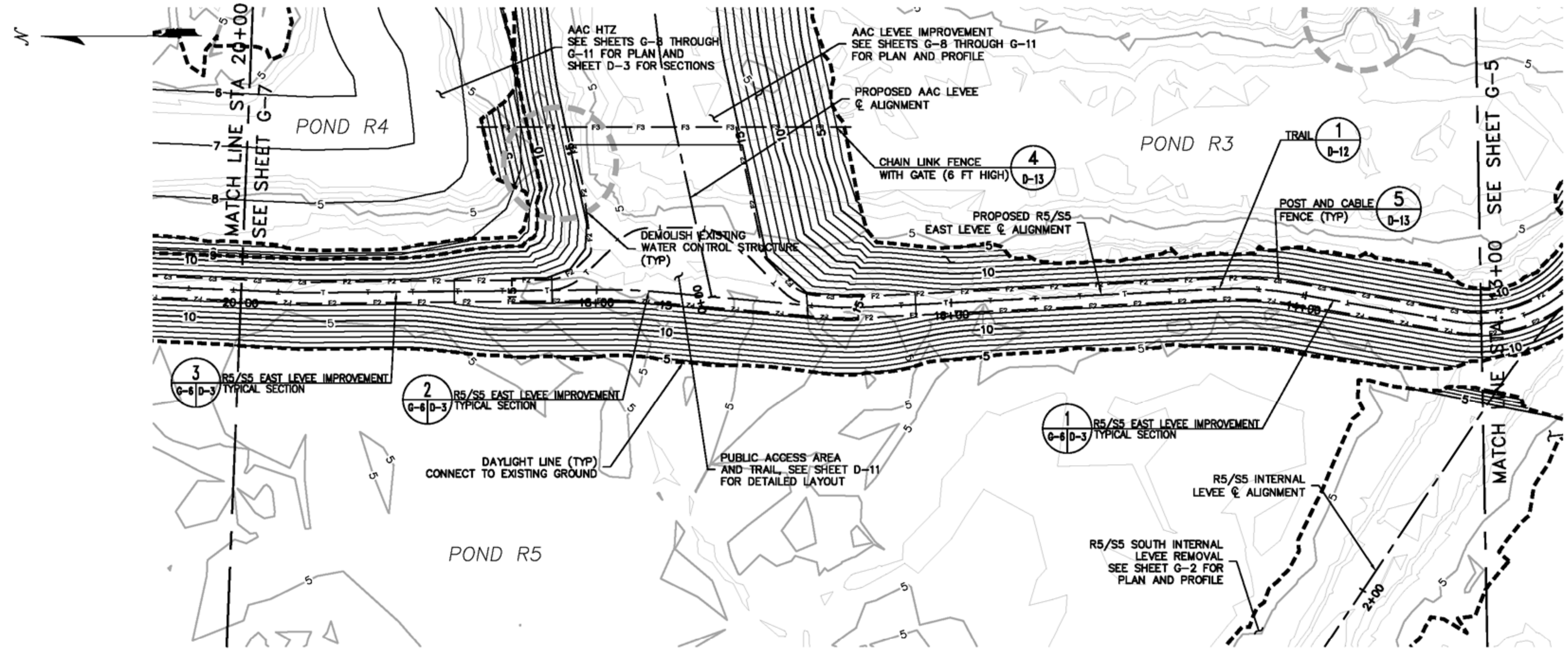
PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

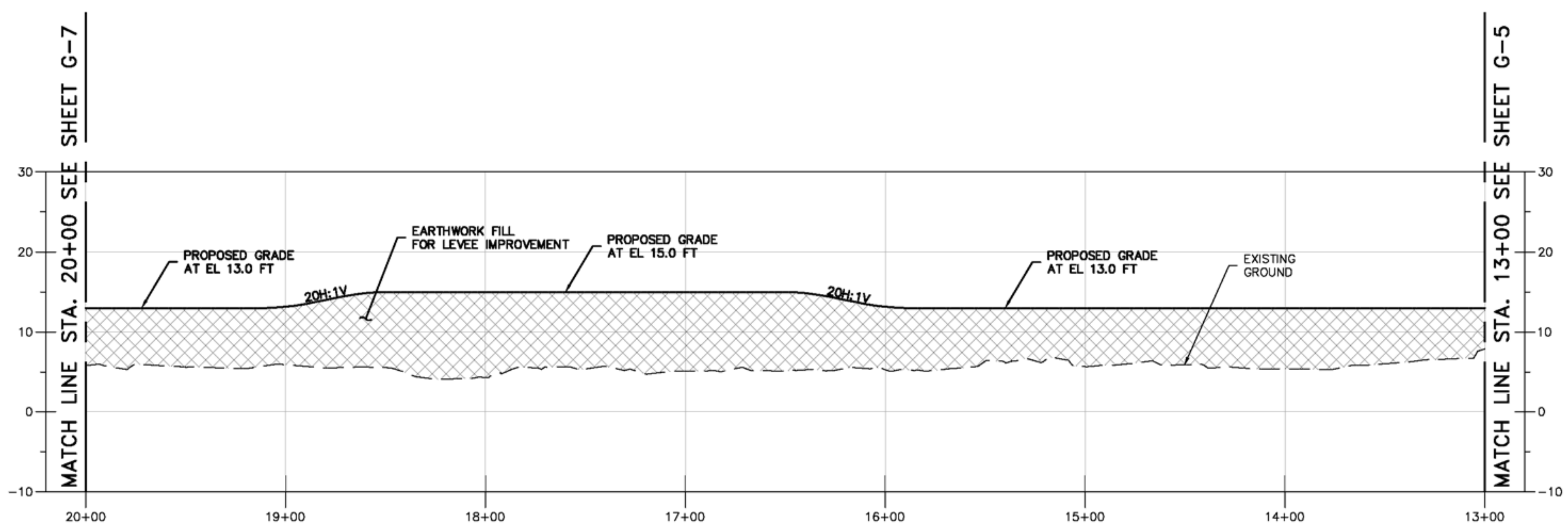
STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
RAVENSWOOD PONDS
POND R5/S5 EAST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 2 OF 4

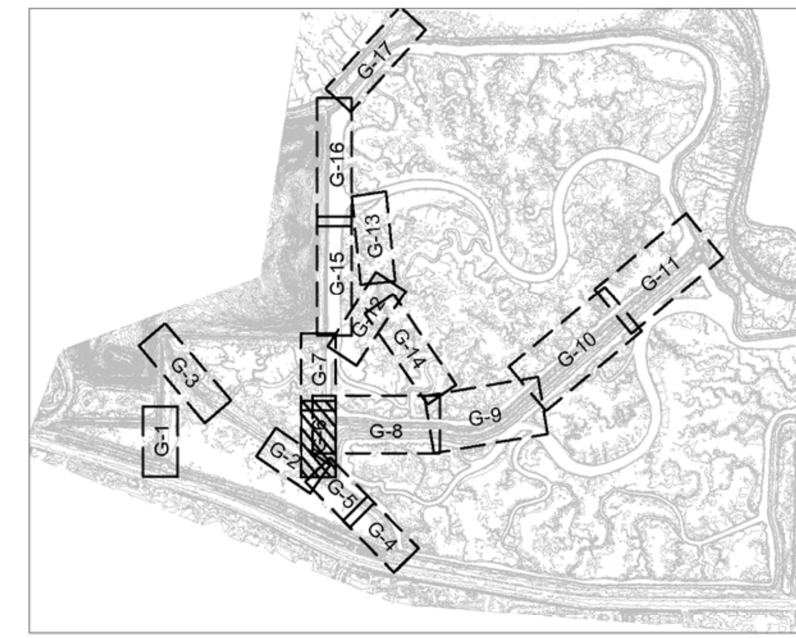
SHEET NO. SHT. 14 OF 40 SHTS.
REV
DWG NO. G-5



PLAN
1"=40'



PROPOSED R5/S5 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'



0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

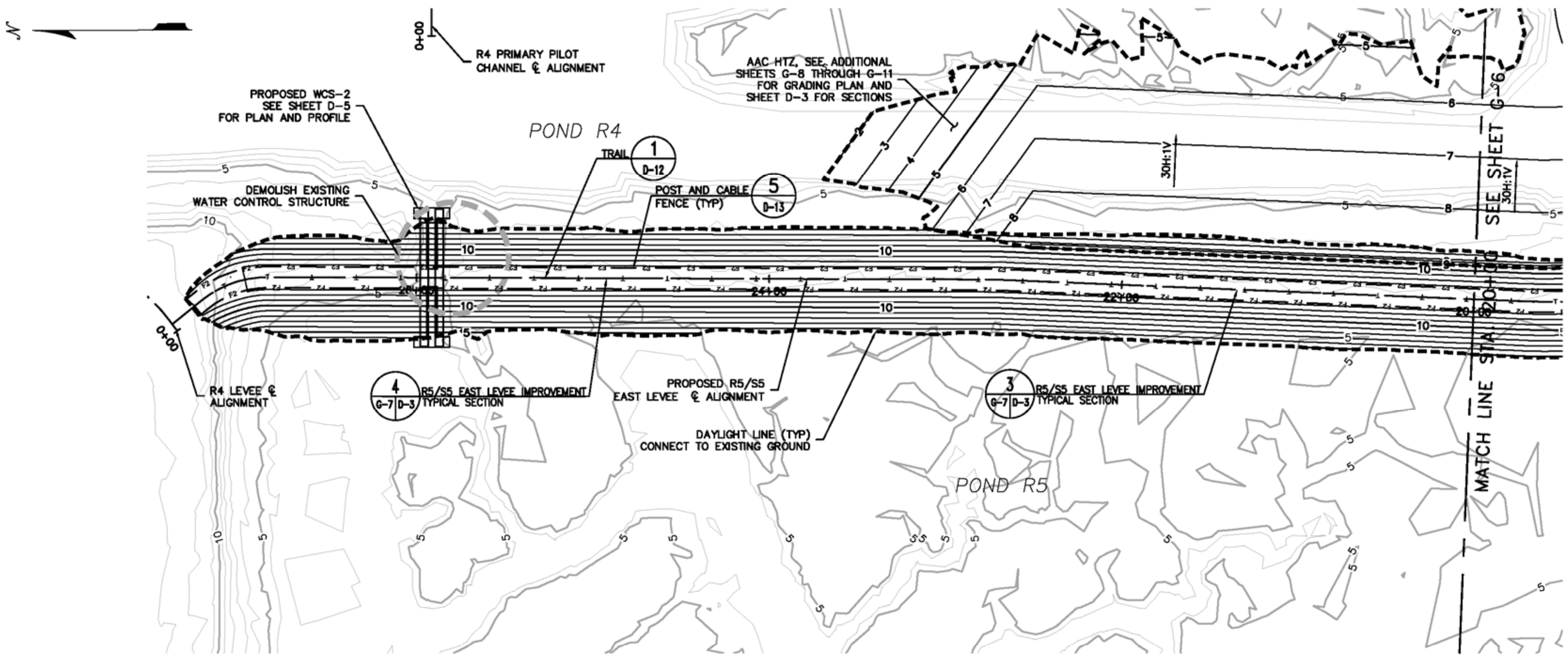
PROJECT No. 60422372 DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

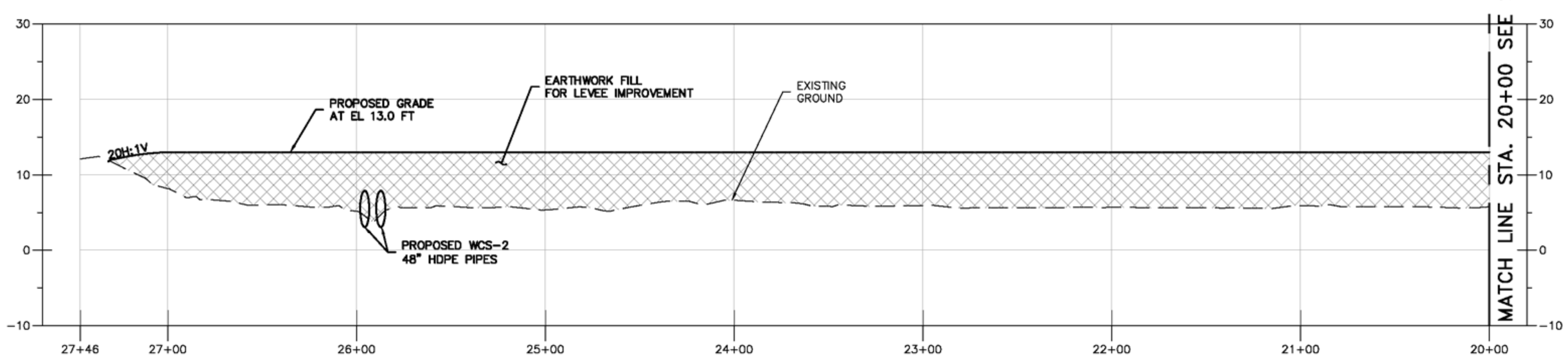
SHEET TITLE
RAVENSWOOD PONDS
POND R5/S5 EAST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 3 OF 4

SHEET NO. SHT 15 OF 40 SHTS
REV
DWG NO. G-6

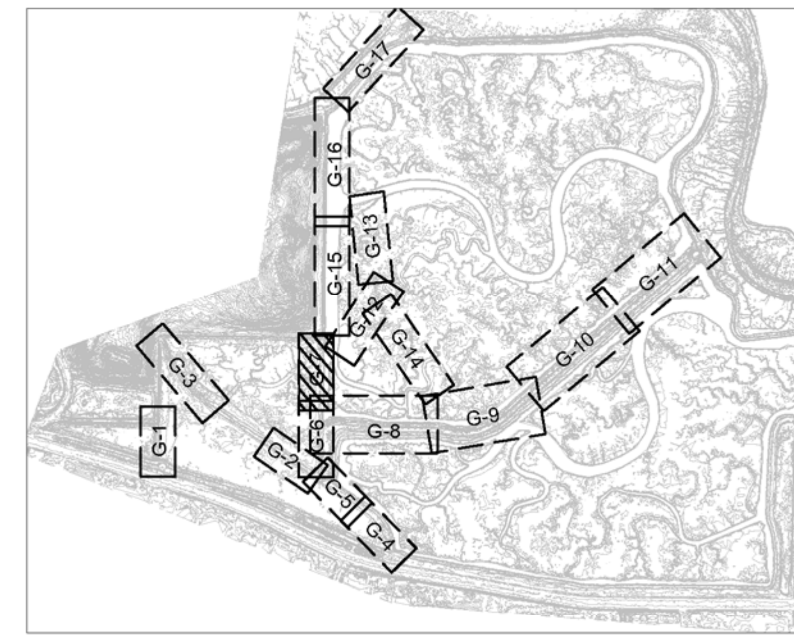
Dec 15, 2016 - 11:35am



PLAN
1"=40'



PROPOSED R5/S5 EAST LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'



HORIZ 1" = 40' (0 40 80 120)
VERT 1" = 10' (0 10 20 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: AECOM, 300 Lakeside Drive, Suite 400, Oakland, CA 94612, Tel: (510) 893-3600, aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

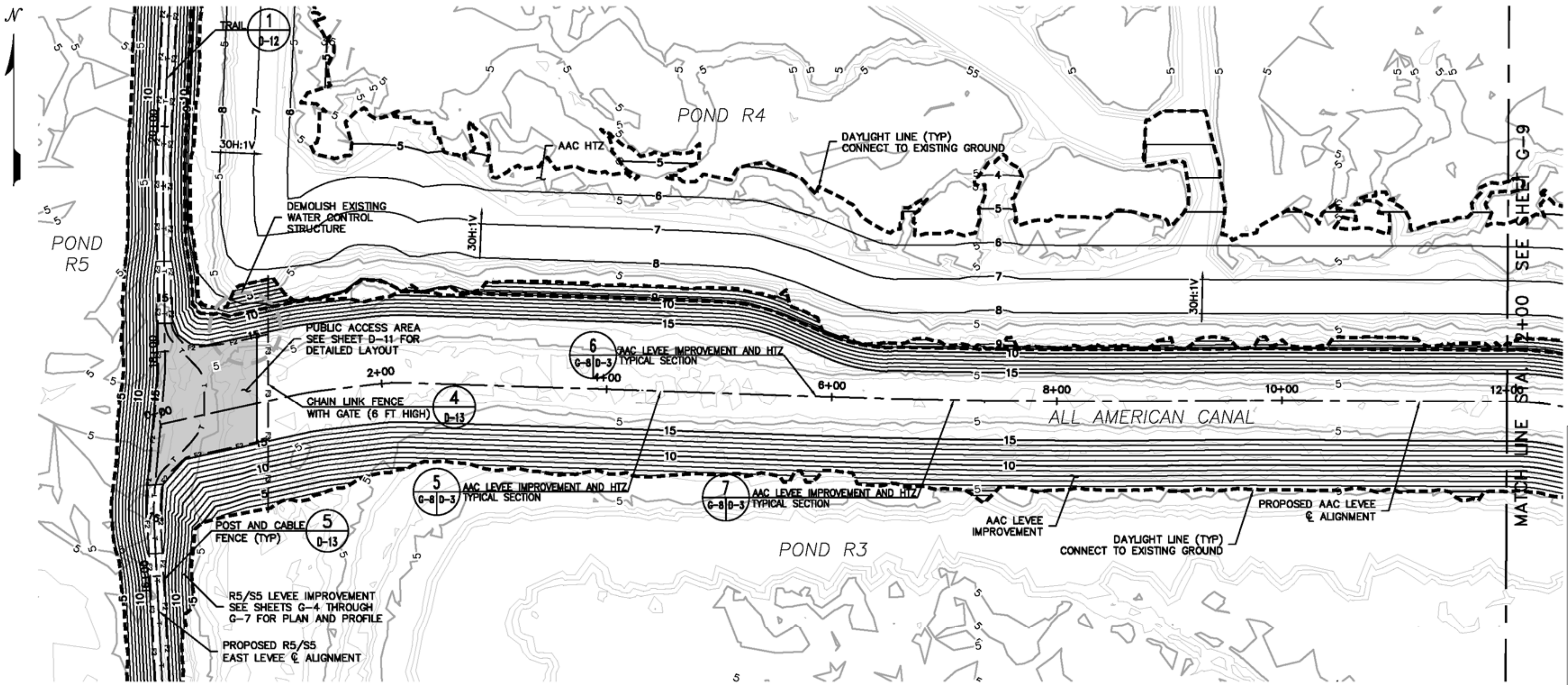
PROJECT No. 60422372 DATE 12-13-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

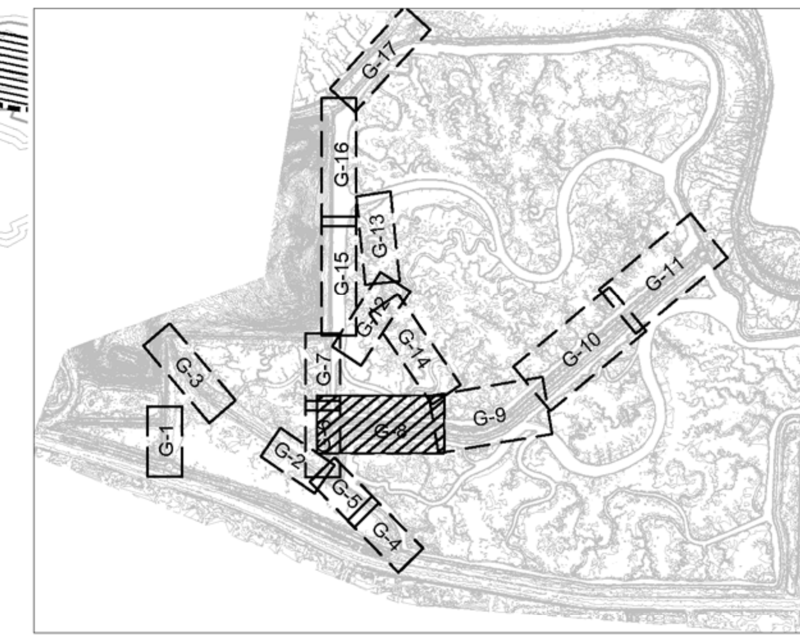
SHEET TITLE: RAVENSWOOD PONDS
POND R5/S5 EAST LEVEE IMPROVEMENT
PLAN AND PROFILE - SHEET 4 OF 4

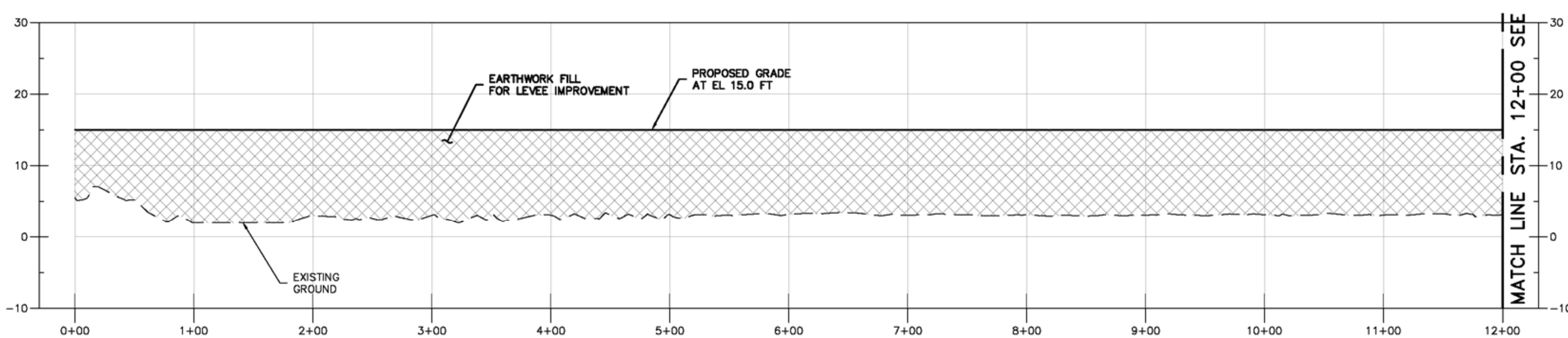
SHEET NO. SHT 16 OF 40 SHTS
DWG NO. G-7

Dec 15, 2016 - 11:45am



PLAN
1"=60'





PROPOSED AAC LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=60', VERT 1"=10'

HORIZ 1" = 60' (0, 60, 120, 180)
VERT 1" = 10' (0, 10, 20, 30)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

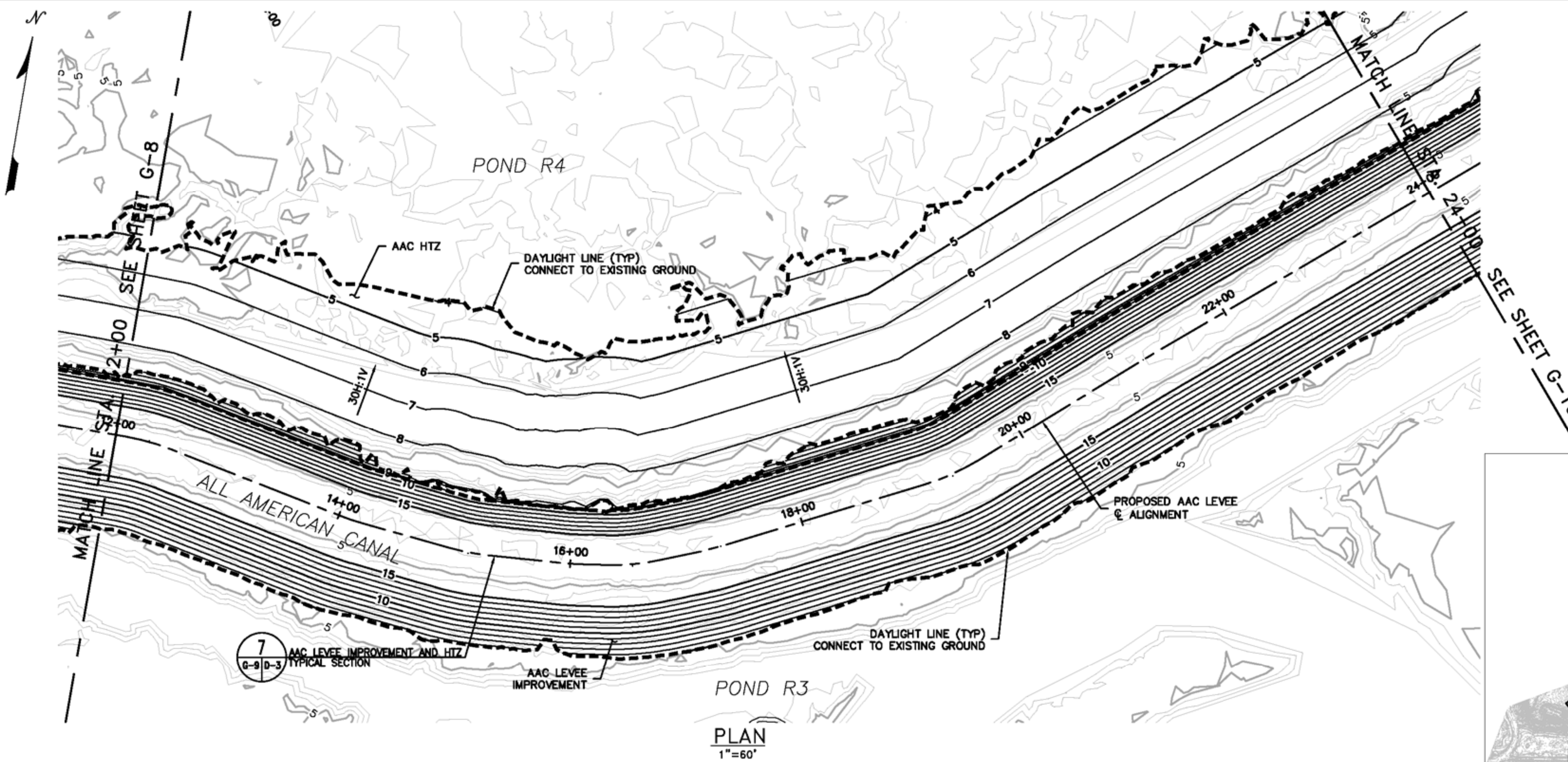
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

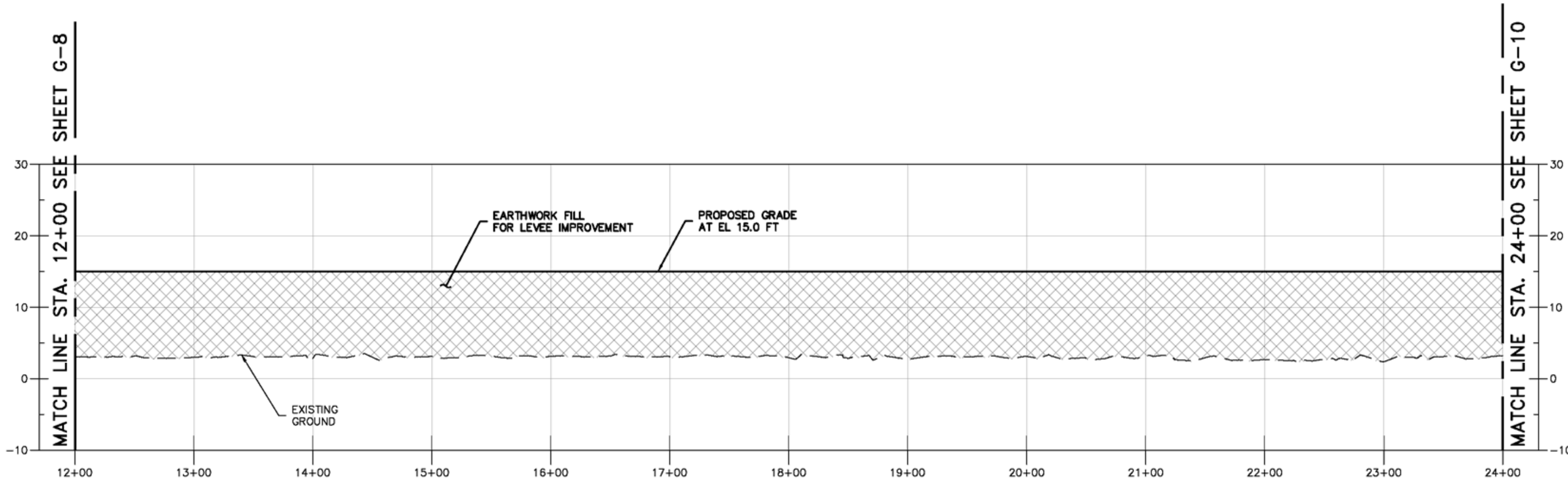
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
RAVENSWOOD PONDS
AAC LEVEE IMPROVEMENT AND HTZ
PLAN AND PROFILE - SHEET 1 OF 4

SHEET NO. SHT 17 OF 40 SHTS.
REV
DWG NO. G-8

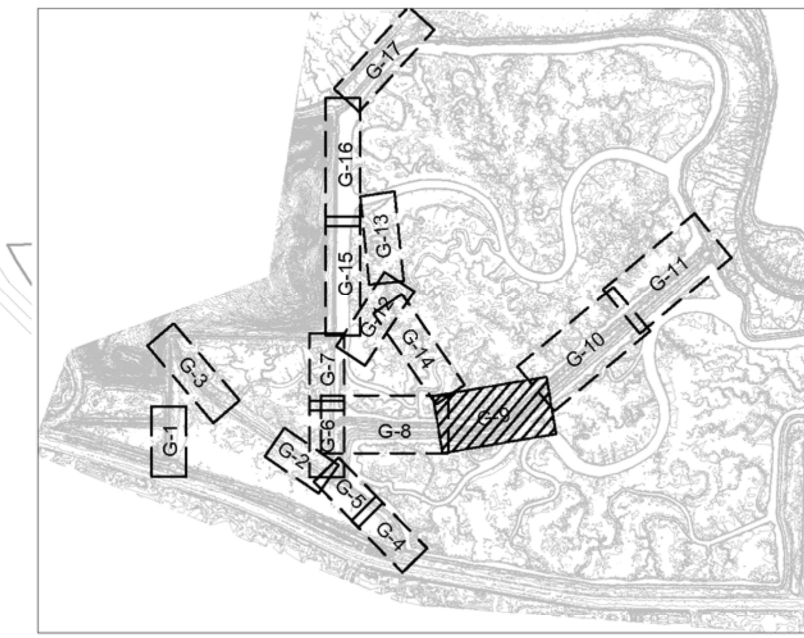
Dec 15, 2016 - 9:10am
C:\pwworking\aecom_na\chandrasekaranl\dms75834\RW_G-8.dwg



PLAN
1"=60'



PROPOSED AAC LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=60', VERT 1"=10'



HORIZ 1" = 60'

VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

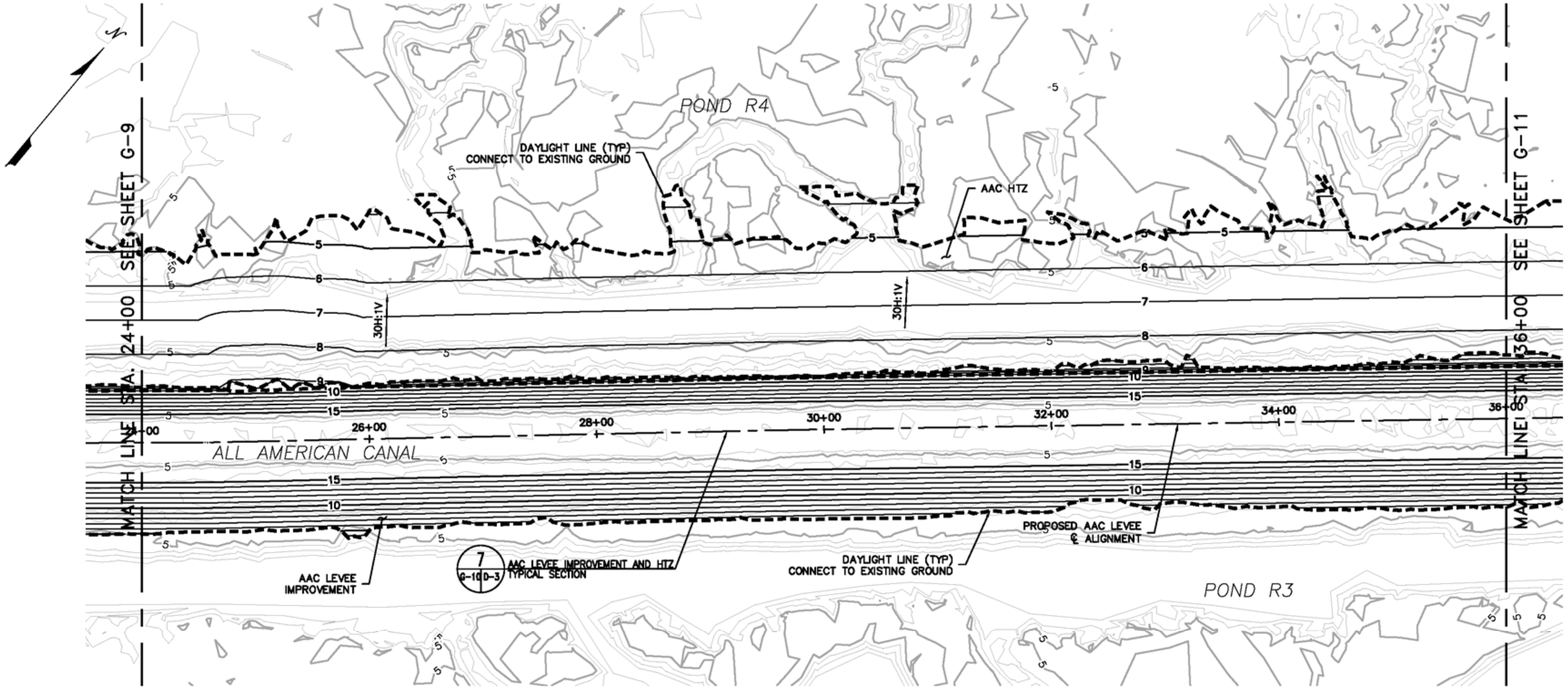
PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE: RAVENSWOOD PONDS
AAC LEVEE IMPROVEMENT AND HTZ
PLAN AND PROFILE - SHEET 2 OF 4

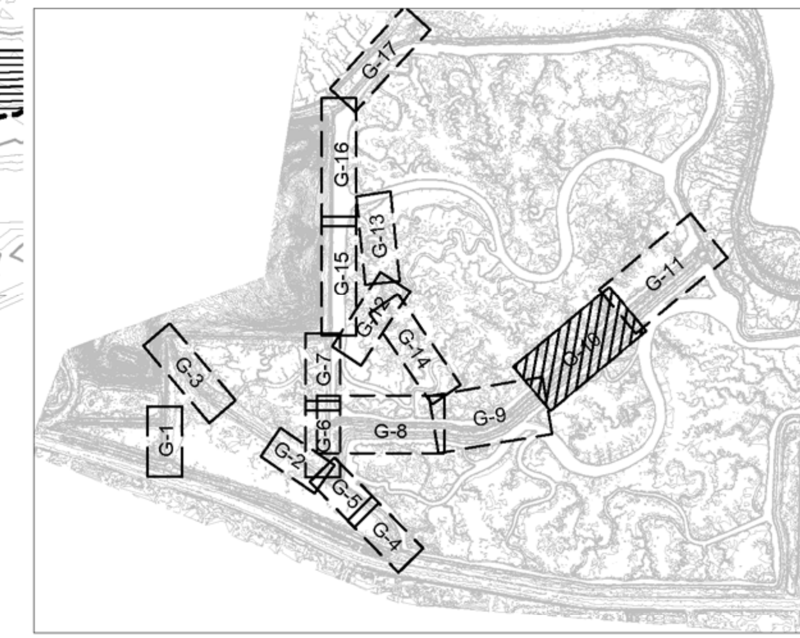
SHEET NO. SHT 18 OF 40 SHTS.

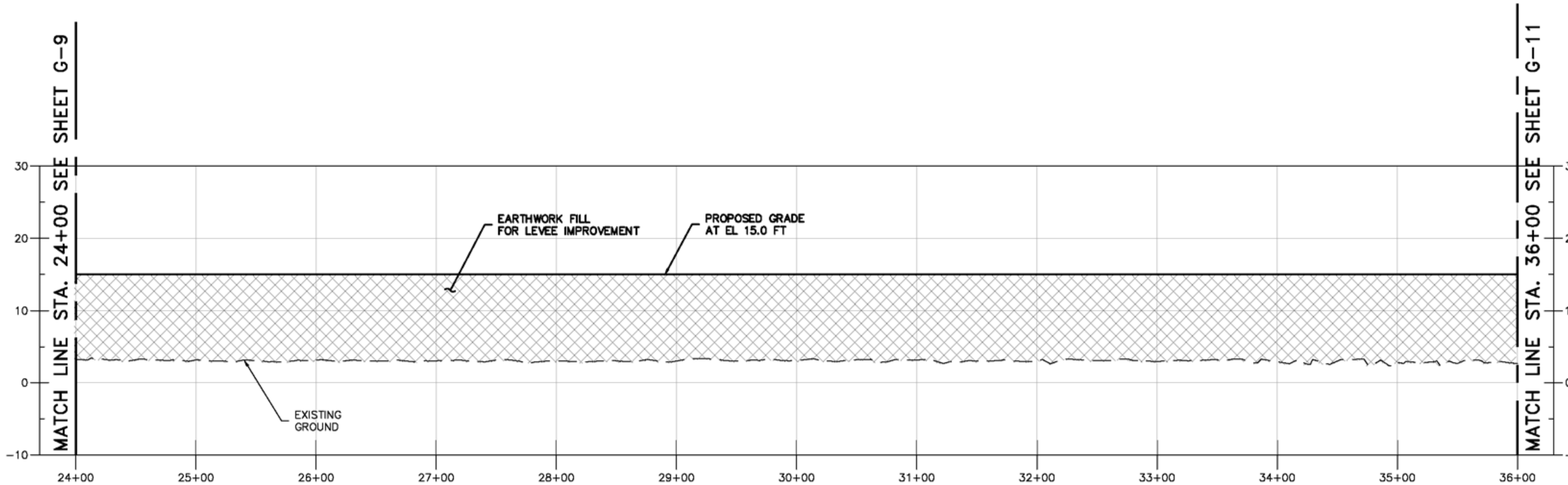
DWG NO. G-9

REV | DESCRIPTION | BY | CHK | APP | DATE



PLAN
1"=60'





PROPOSED AAC LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=60', VERT 1"=10'

0 60 120 180
HORIZ 1" = 60'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

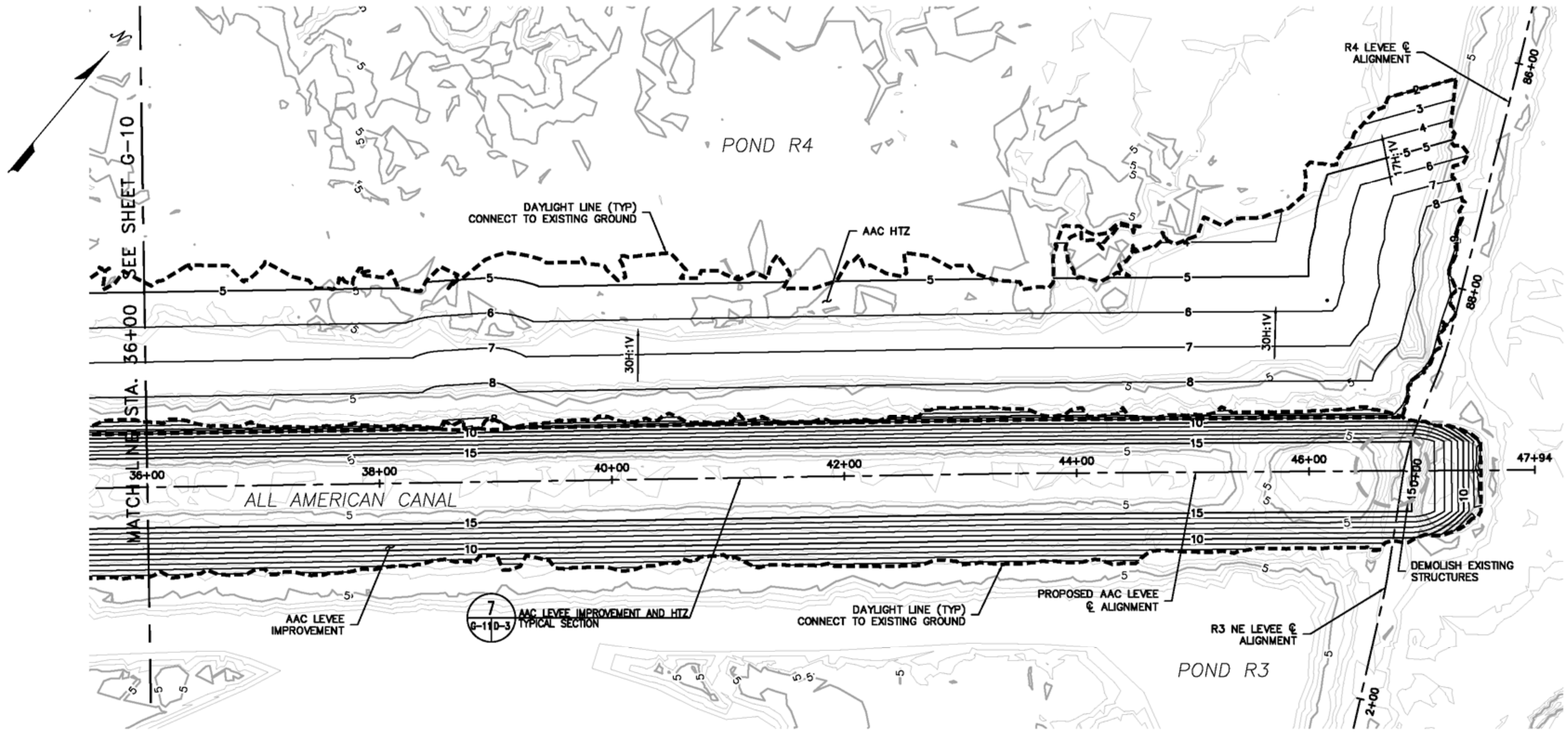
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

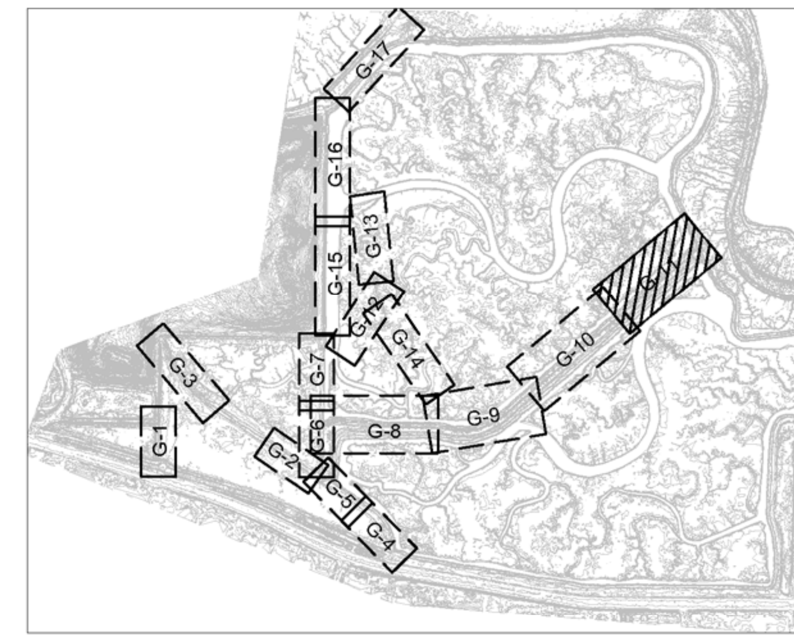
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

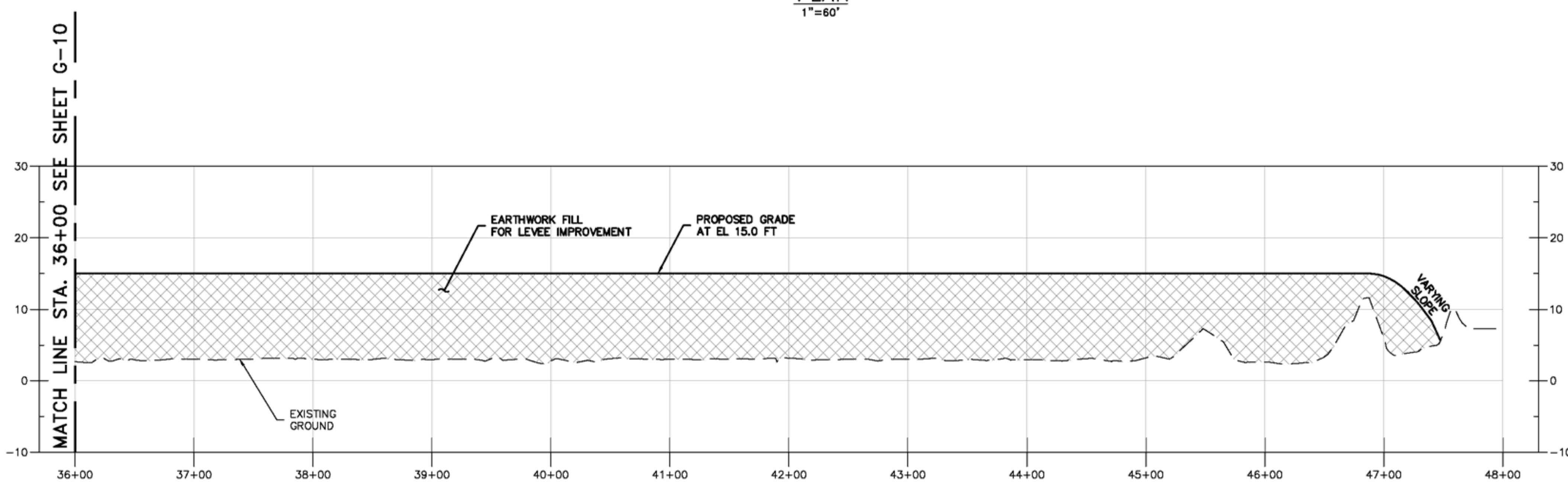
SHEET TITLE
RAVENSWOOD PONDS
AAC LEVEE IMPROVEMENT AND HTZ
PLAN AND PROFILE - SHEET 3 OF 4

SHEET NO. SHT. 19 OF 40 SHTS.
REV
DWG NO. G-10



PLAN
1"=60'





PROPOSED AAC LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=60', VERT 1"=10'

0 60 120 180
HORIZ 1" = 60'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

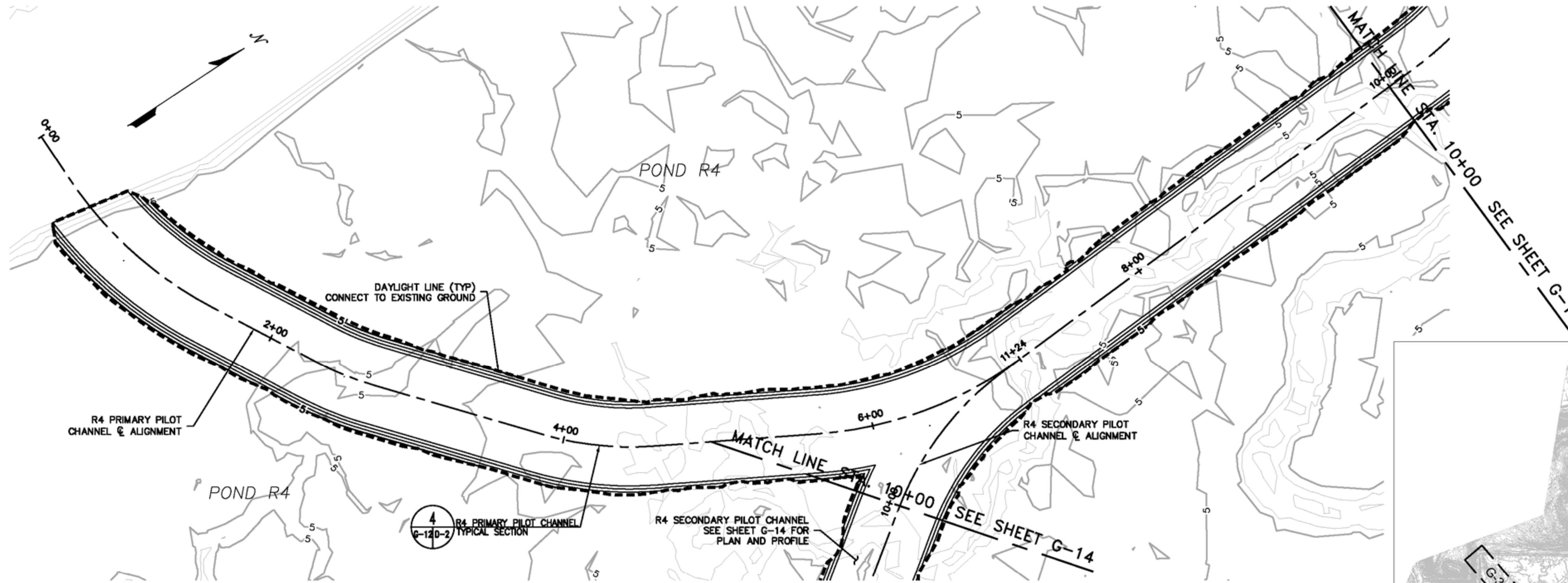
DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

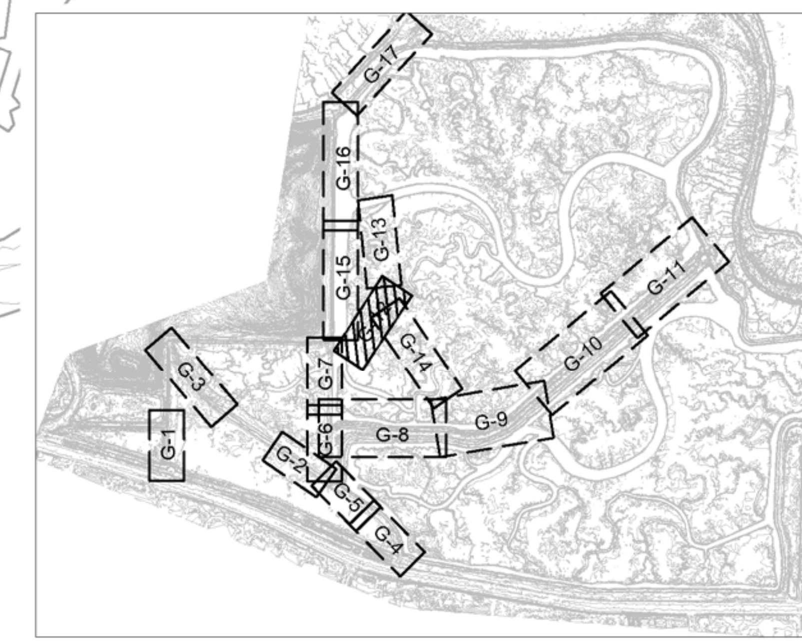
PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE: RAVENSWOOD PONDS
AAC LEVEE IMPROVEMENT AND HTZ
PLAN AND PROFILE - SHEET 4 OF 4

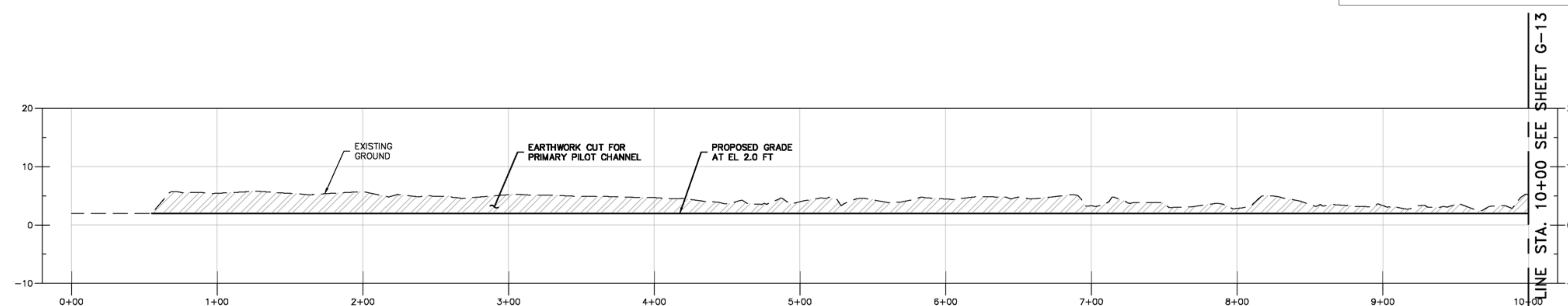
SHEET NO. SHT 20 OF 40 SHTS
REV
DWG NO. G-11

Dec 15, 2016 - 1:50pm
C:\pwworking\aecom_na\chandrasekaranl\dms75624\RW_G-11.dwg



PLAN
1"=40'





R4 PRIMARY PILOT CHANNEL ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

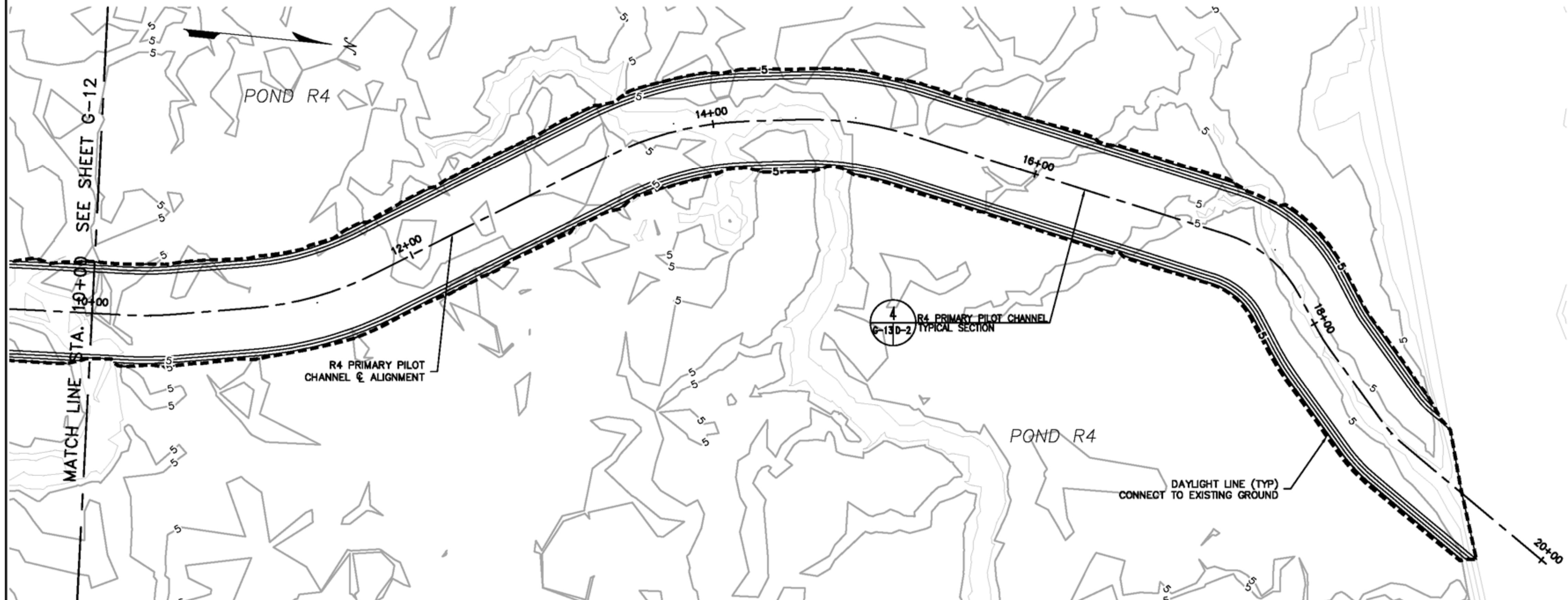
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

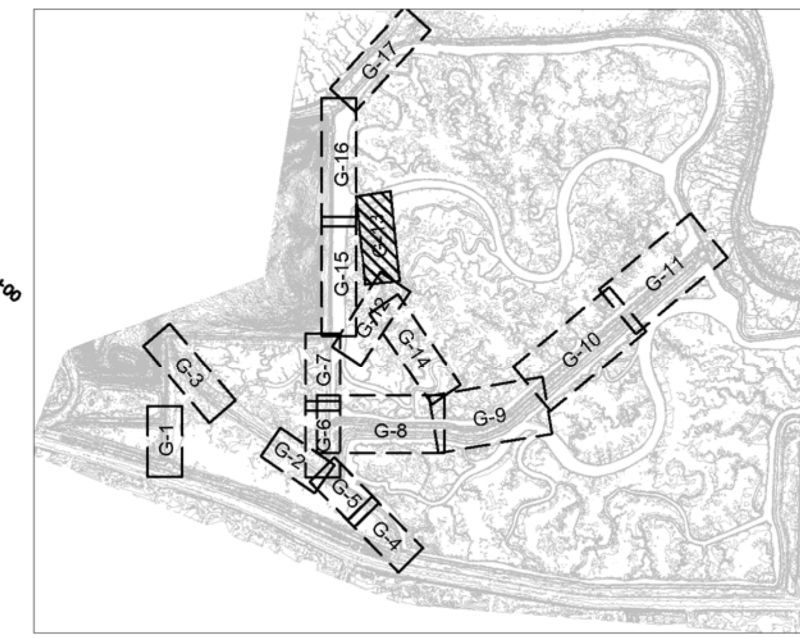
SHEET TITLE
RAVENSWOOD PONDS
POND R4 PRIMARY PILOT CHANNEL
PLAN AND PROFILE - SHEET 1 OF 2

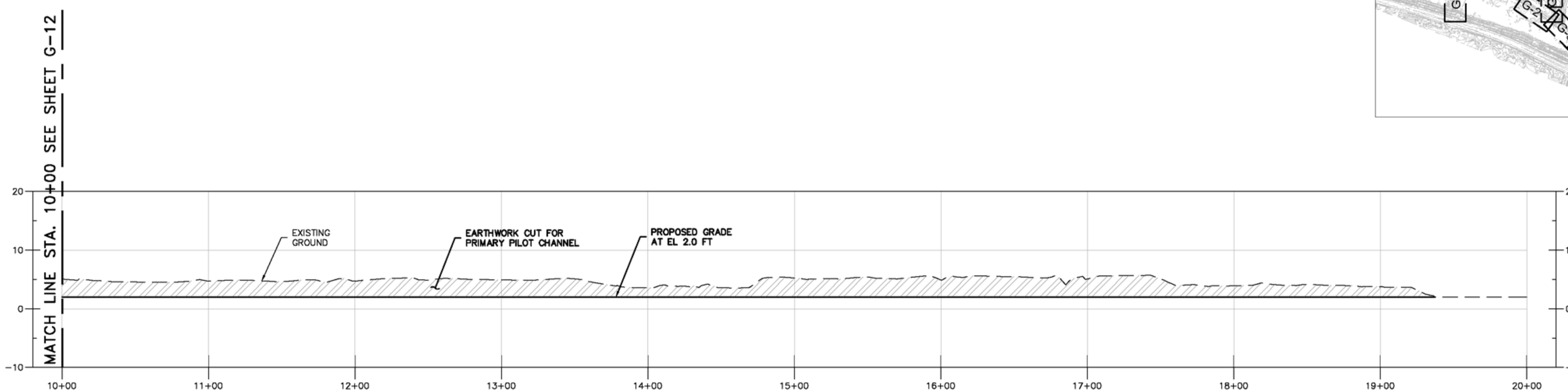
SHEET NO. SHT. 21 OF 40 SHTS.
REV
DWG NO. G-12

Dec 19, 2016 - 8:54am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_G-12.dwg



PLAN
1"=40'





R4 PRIMARY PILOT CHANNEL ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120 HORIZ 1" = 40'

0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

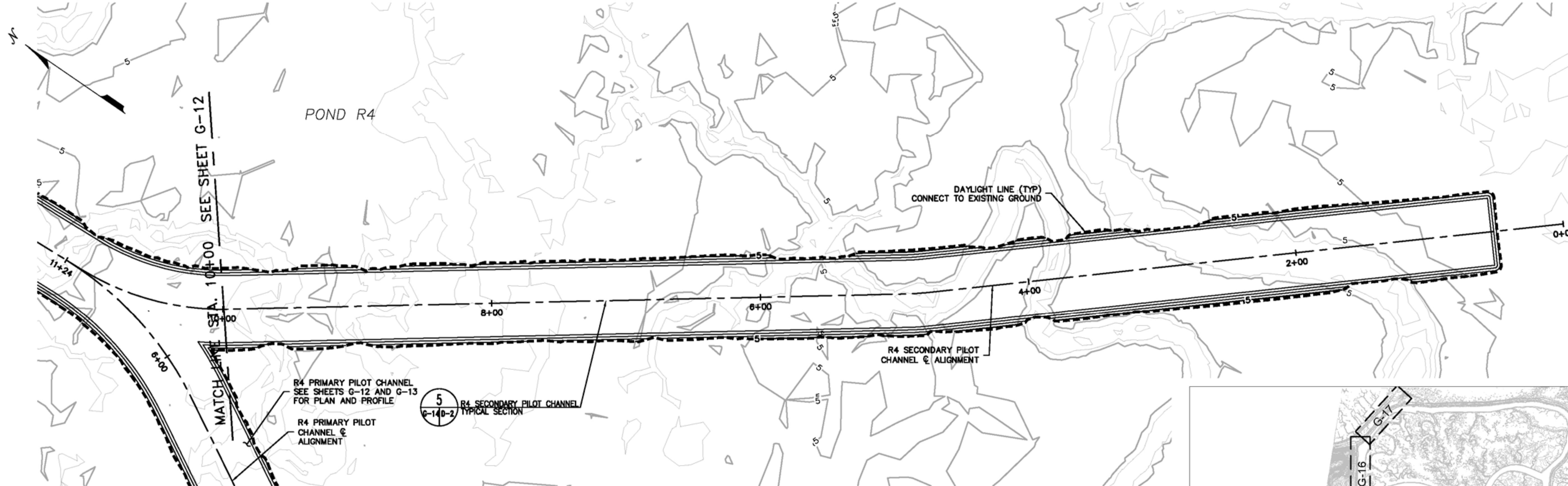
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

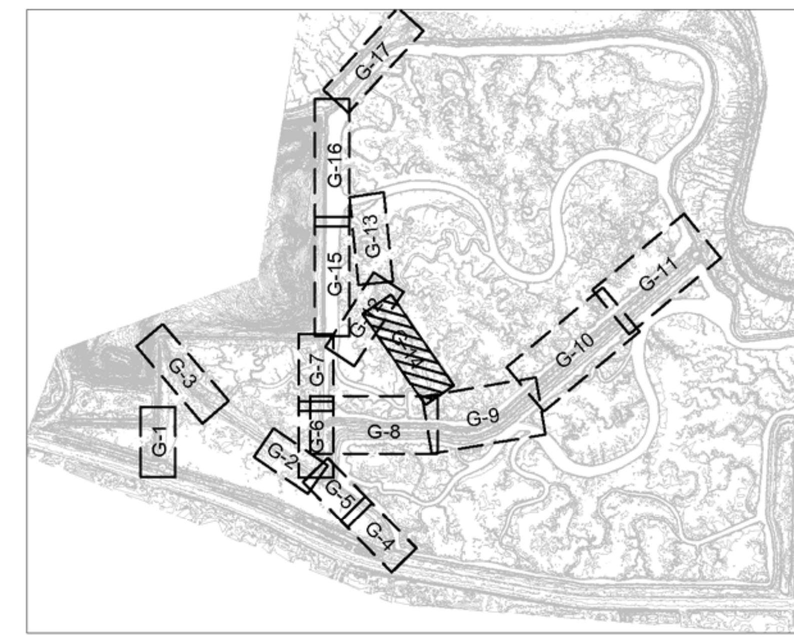
SHEET TITLE
RAVENSWOOD PONDS
POND R4 PRIMARY PILOT CHANNEL
PLAN AND PROFILE - SHEET 2 OF 2

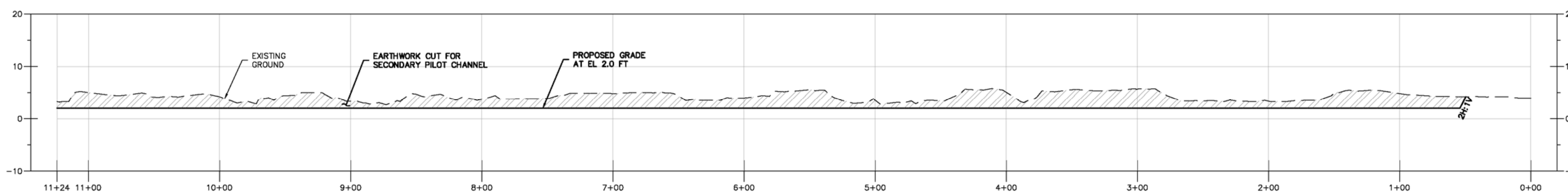
SHEET NO. SHT 22 OF 40 SHTS
REV
DWG NO. G-13

Dec 15, 2016 - 12:40pm C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_G-13.dwg



PLAN
1"=40'





R4 SECONDARY PILOT CHANNEL ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

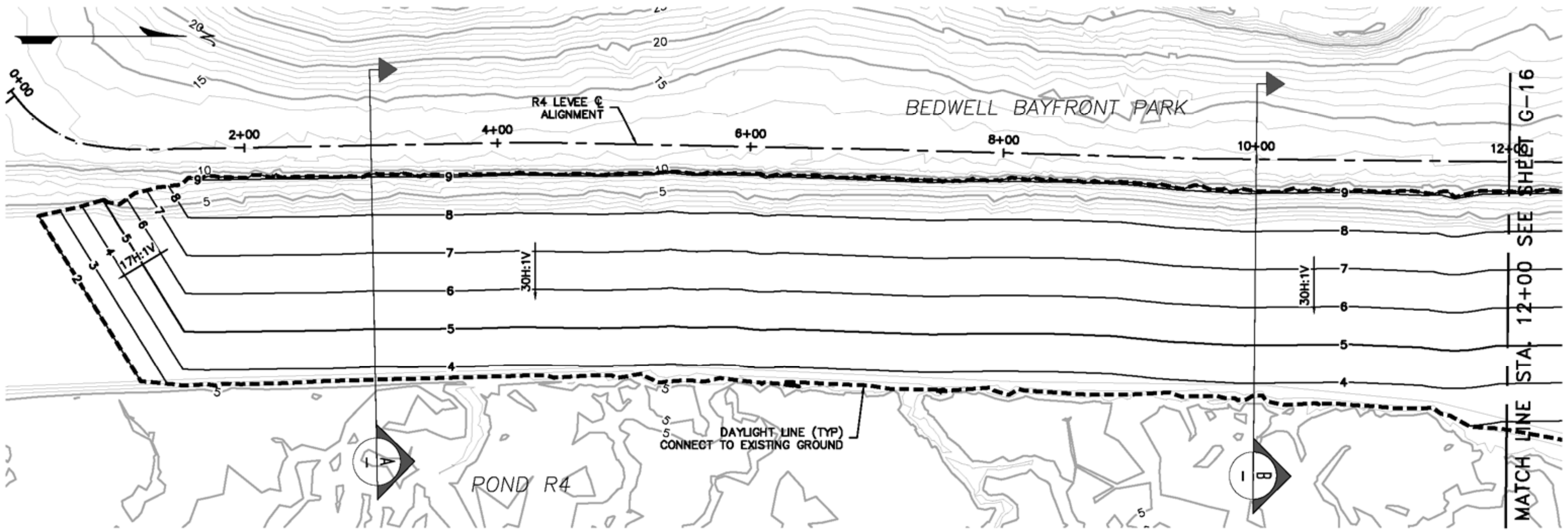
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

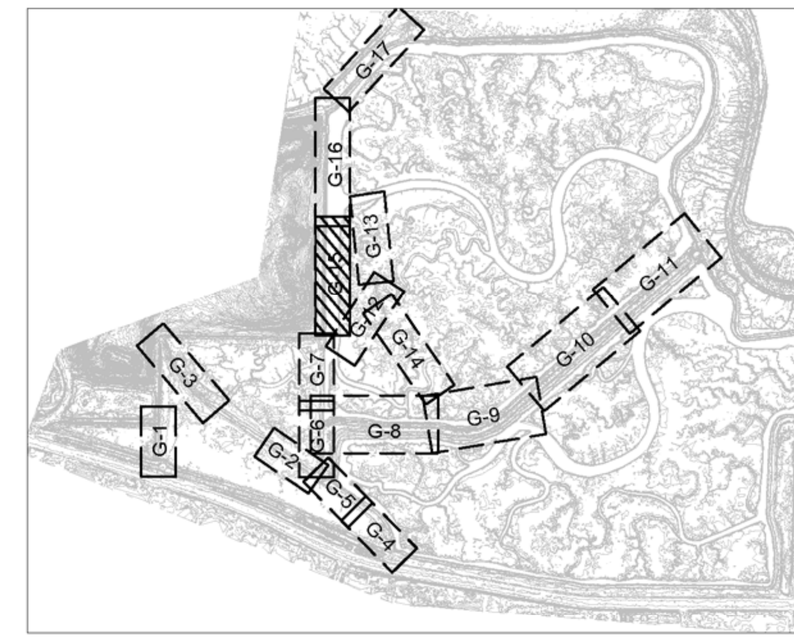
SHEET TITLE
RAVENSWOOD PONDS
POND R4 SECONDARY PILOT CHANNEL
PLAN AND PROFILE

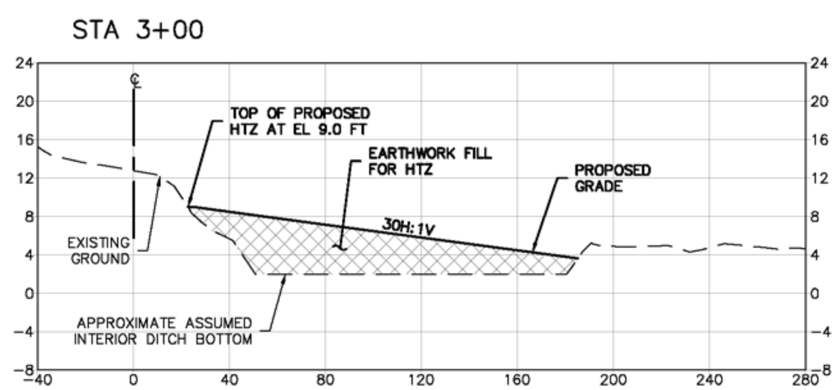
SHEET NO. SHT 23 OF 40 SHTS
REV
DWG NO. G-14

Dec 15, 2016 - 12:46pm

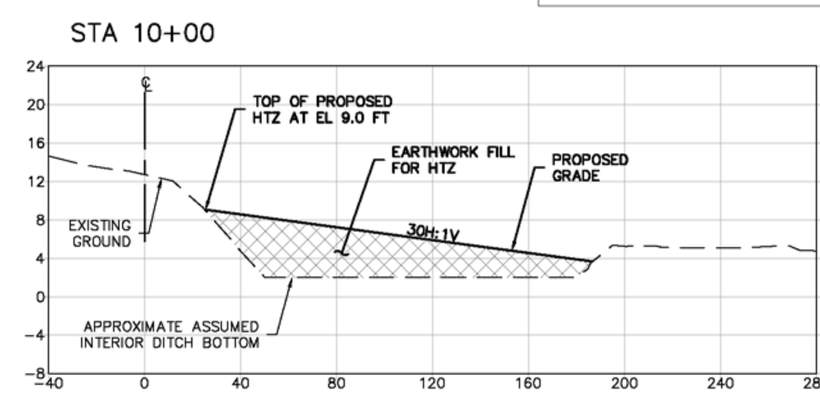


PLAN
1"=60'





(A) BEDWELL BAYFRONT PARK HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10



(B) BEDWELL BAYFRONT PARK HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

HORIZ 1" = 60' | HORIZ 1" = 40' | VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV | DESCRIPTION | BY | CHK | APP | DATE

PREPARED BY: AECOM, 300 Lakeside Drive, Suite 400, Oakland, CA 94612, Tel: (510) 893-3600, aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

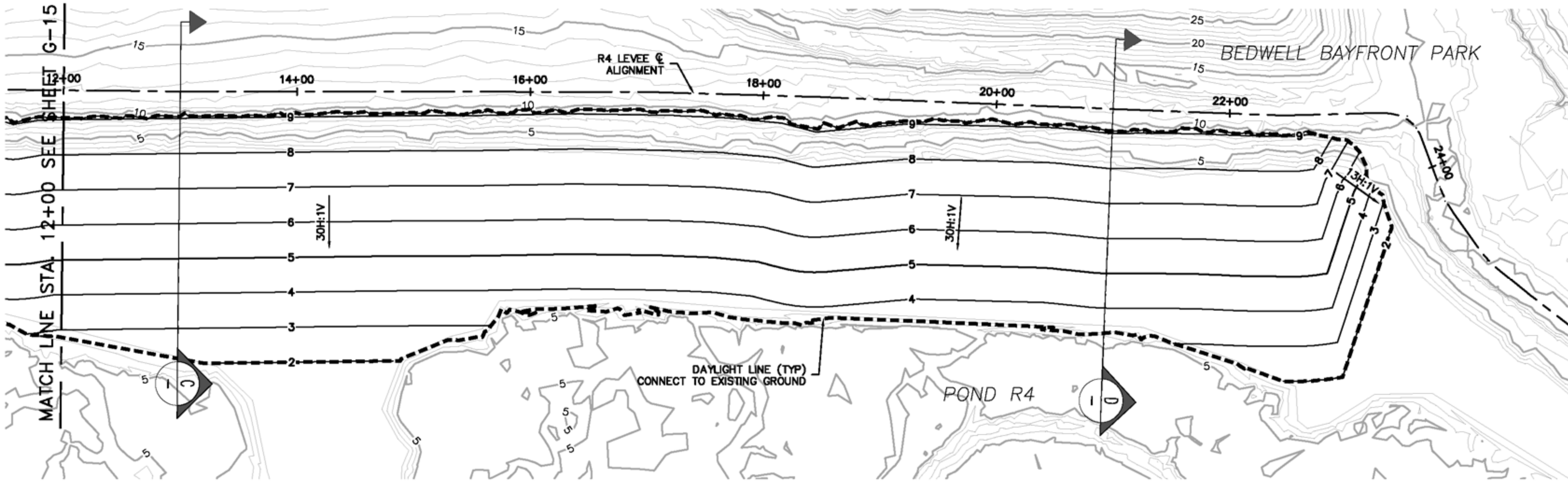
PROJECT No. 60422372 DATE 12-13-2016

PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT

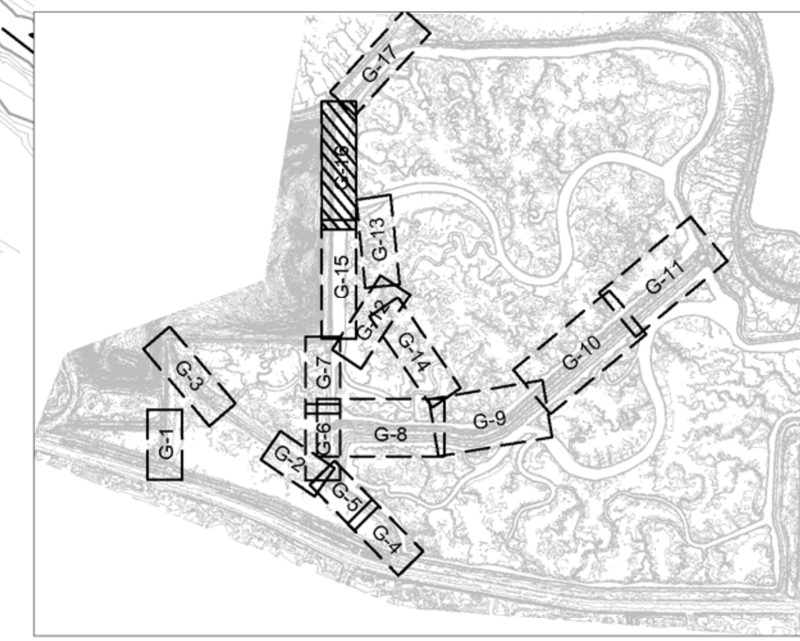
SHEET TITLE: RAVENSWOOD PONDS BEDWELL BAYFRONT PARK HTZ GRADING PLAN - SHEET 1 OF 2

SHEET NO. SHT 24 OF 40 SHTS.

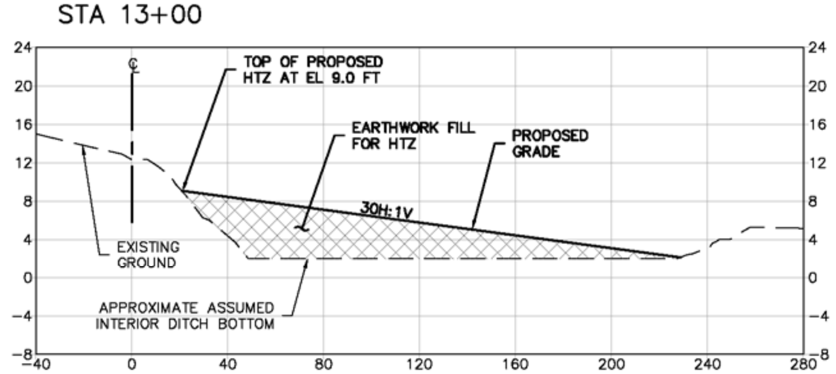
DWG NO. G-15



PLAN
1"=60'

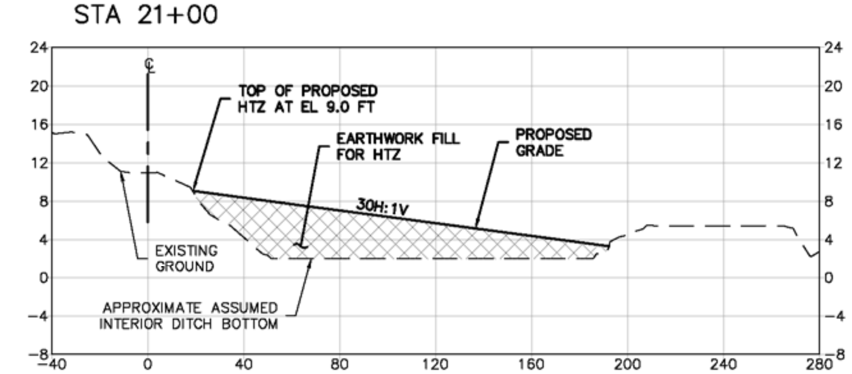


STA 13+00



C BEDWELL BAYFRONT PARK HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

STA 21+00



D BEDWELL BAYFRONT PARK HTZ – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10

0 60 120 180 HORIZ 1" = 60'
0 40 80 120 HORIZ 1" = 40'
0 10 20 30 VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

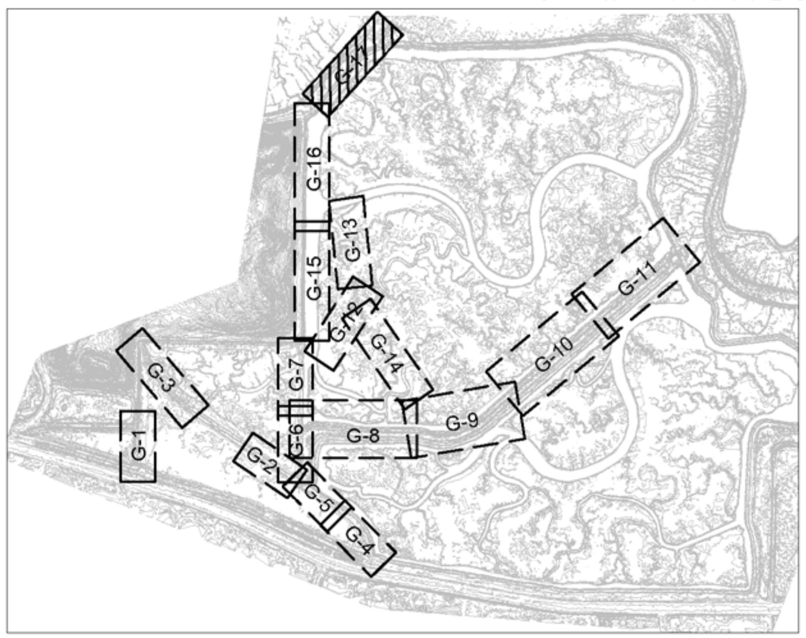
PROJECT No. 60422372
DATE 12-13-2016

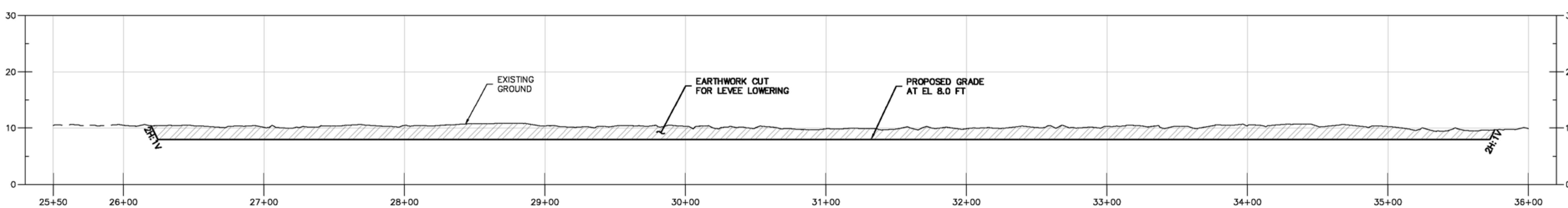
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
BEDWELL BAYFRONT PARK HTZ
GRADING PLAN - SHEET 2 OF 2

SHEET NO. SHT 25 OF 40 SHTS
DWG NO. G-16
REV

PLAN
1"=40'





R4 LEVEE ℄ ALIGNMENT PROFILE
HORIZ 1"=40', VERT 1"=10'

HORIZ 1" = 40'

VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED: L. CHANDRASEKARAN
DRAWN: L. DIFUNTORUM
CHECKED: G. OROZCO / I. ZARCHI
PEER REVIEWED: S. GENTZLER
APPROVED: S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

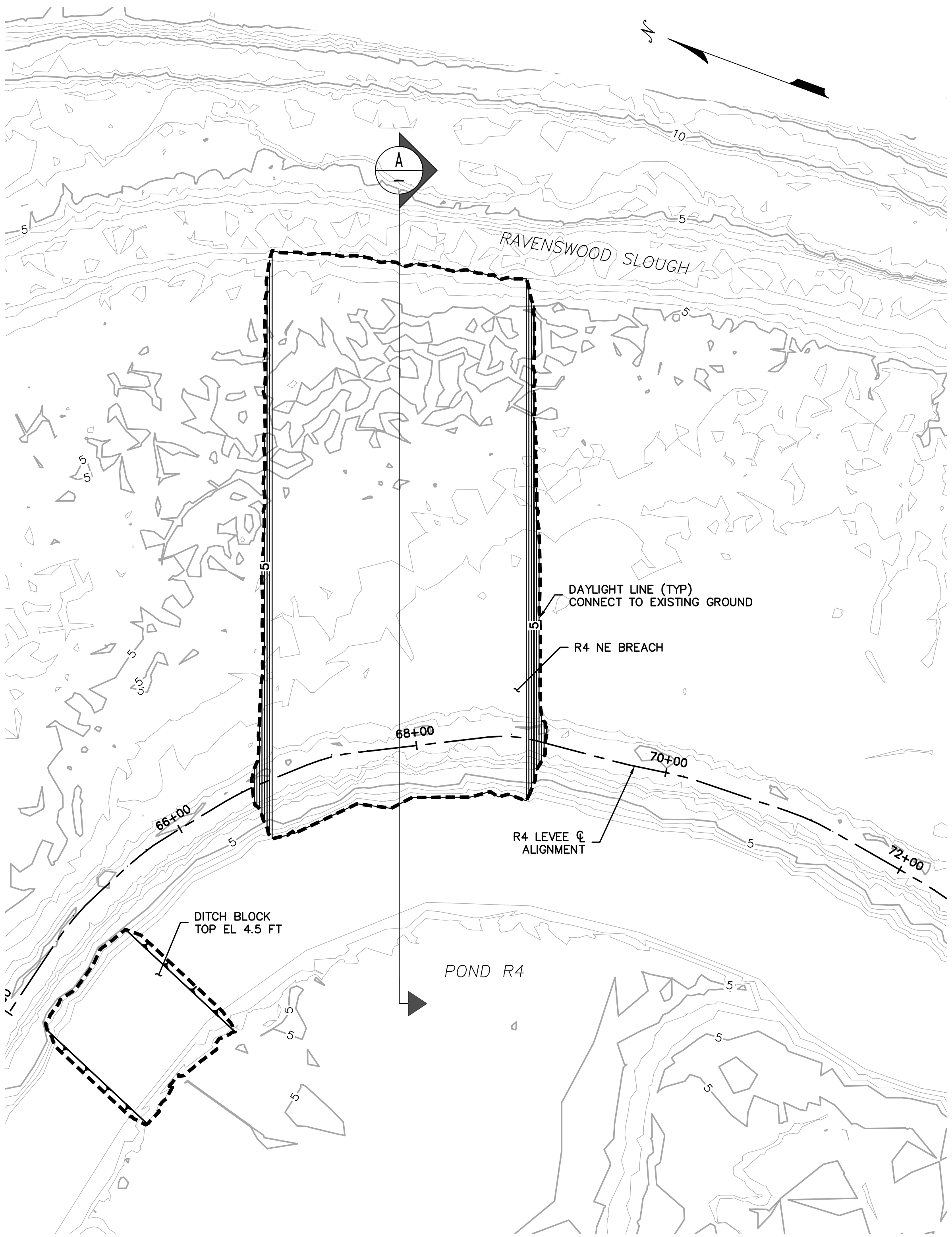
PROJECT No. 60422372
DATE 12-13-2016

PROJECT: **SOUTH BAY SALT POND RESTORATION PROJECT**

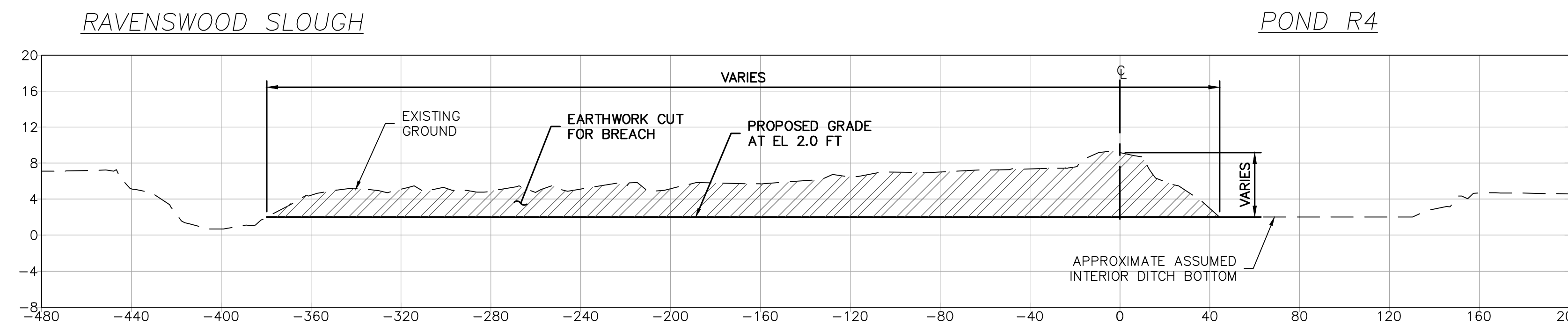
SHEET TITLE: RAVENSWOOD PONDS
POND R4 NORTHWEST LEVEE LOWERING
PLAN AND PROFILE

SHEET NO. SHT. 26 OF 40 SHTS.
REV
DWG NO. G-17

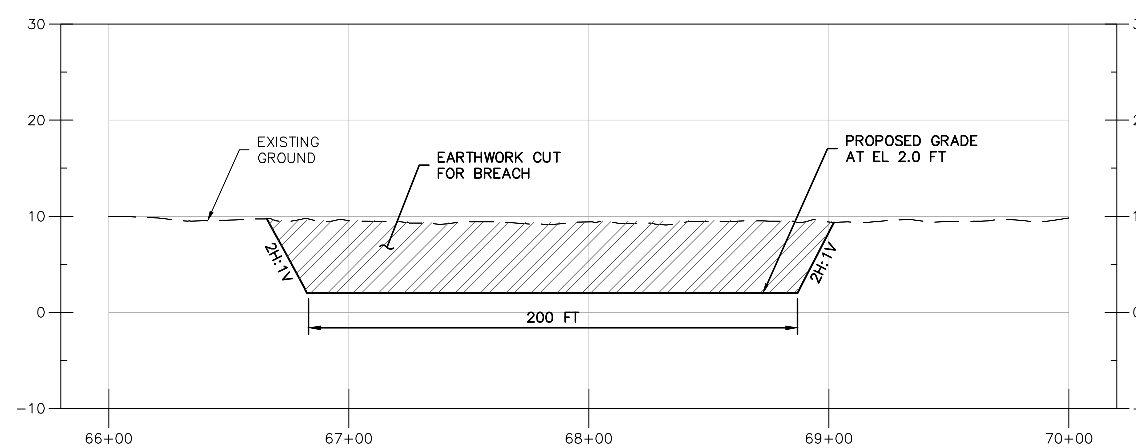
Dec 15, 2016 - 12:52pm
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_G-17.dwg



PLAN
1"=60'



A – R4 NORTHEAST BREACH – TYPICAL SECTION
HORIZ 1"=40', VERT 1"=10'



R4 NORTHEAST BREACH – PROFILE
HORIZ 1"=40', VERT 1"=10'

0 60 120 180
HORIZ 1" = 60'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

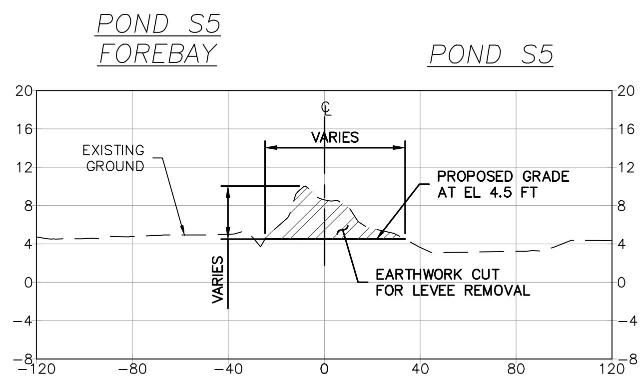
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

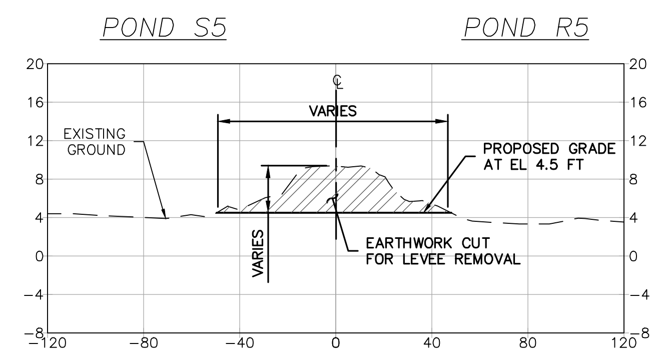
SHEET TITLE
RAVENSWOOD PONDS
POND R4 NORTHEAST BREACH
DETAILED GRADING PLAN

SHEET NO.
SHT. 27 OF 40 SHTS.
REV
DWG NO.
D-1

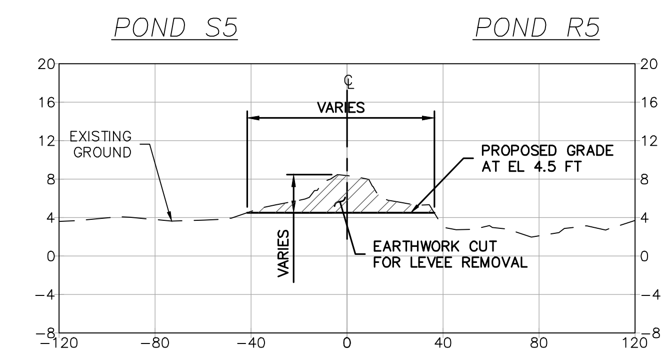
Dec 14, 2016 - 1:03pm
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-1.dwg



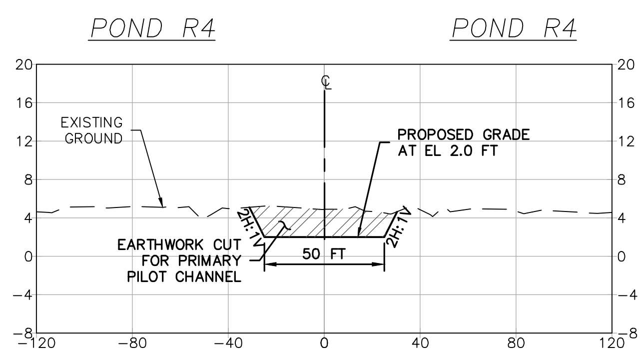
1 (G-1 | D-2) S5 INTERNAL LEVEE REMOVAL – TYPICAL SECTION
STA 0+22 TO 3+90
HORIZ 1"=40', VERT 1"=10'



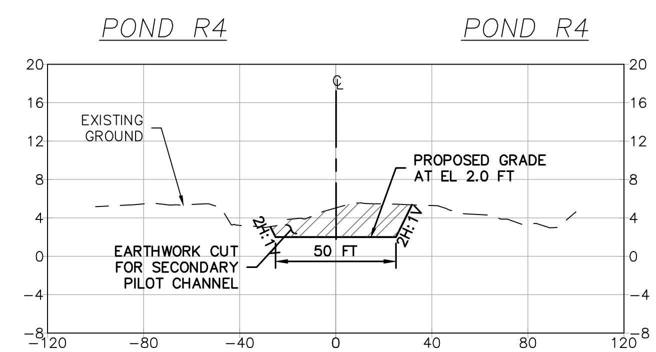
2 (G-2 | D-2) R5/S5 SOUTH INTERNAL LEVEE REMOVAL – TYPICAL SECTION
STA 0+66 TO 5+77
HORIZ 1"=40', VERT 1"=10'



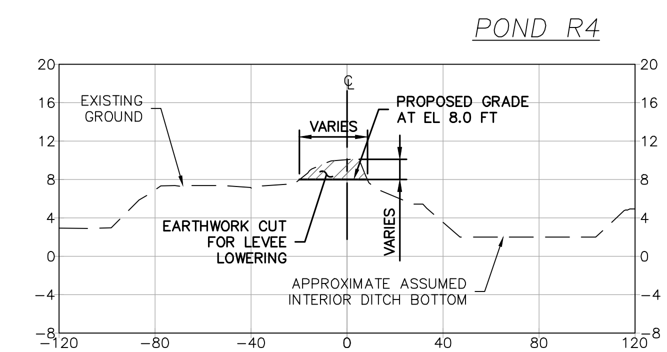
3 (G-3 | D-2) R5/S5 NORTH INTERNAL LEVEE REMOVAL – TYPICAL SECTION
STA 13+52 TO 22+28
HORIZ 1"=40', VERT 1"=10'



4 (G-12 | D-2, G-13) R4 PRIMARY PILOT CHANNEL – TYPICAL SECTION
STA 0+55 TO 19+37
HORIZ 1"=40', VERT 1"=10'



5 (G-14 | D-2) R4 SECONDARY PILOT CHANNEL – TYPICAL SECTION
STA 0+50 TO 11+24
HORIZ 1"=40', VERT 1"=10'



6 (G-17 | D-2) R4 NORTHWEST LEVEE LOWERING – TYPICAL SECTION
STA 26+20 TO 35+76
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

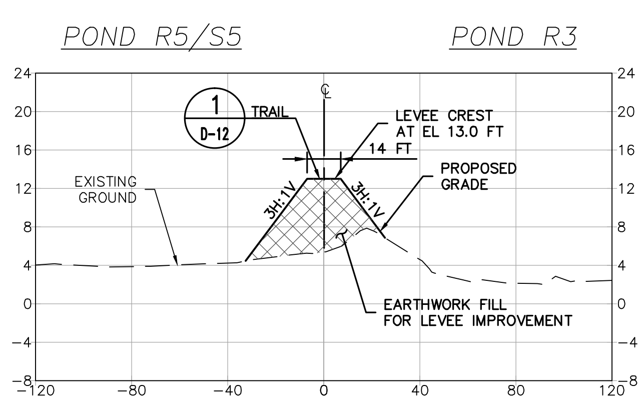
DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

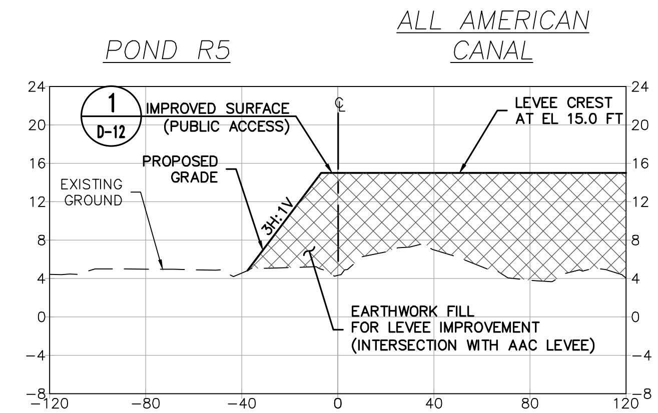
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
RAVENSWOOD PONDS
TYPICAL GRADING SECTIONS
SHEET 1 OF 2

SHEET NO. SHT. 28 OF 40 SHTS.
REV
DWG NO. D-2

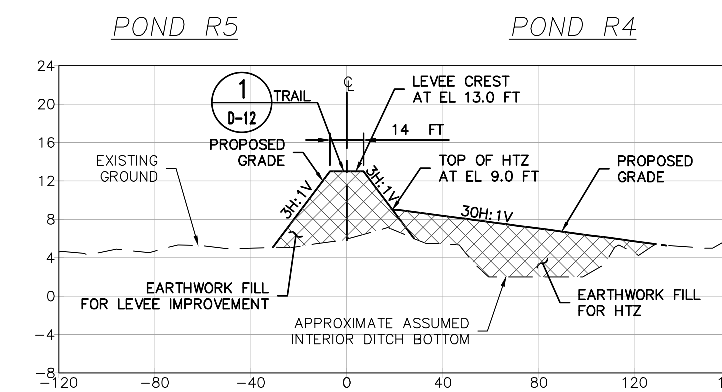
Dec 14, 2016 - 1:09pm
C:\pwworking\aecom_na\lchandrasekaran\dms75824\RW_D-2.dwg



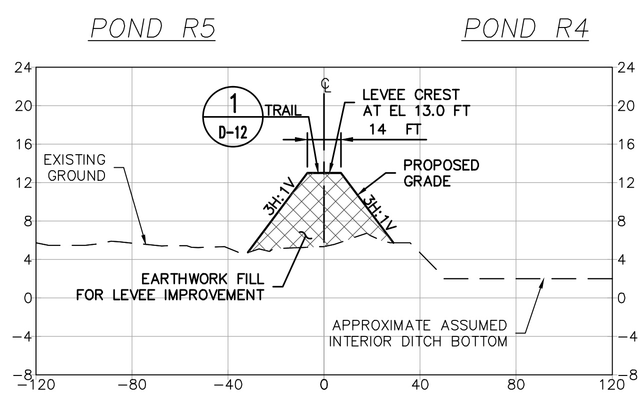
1 (G-4 | D-3; G-5, G-6) R5/S5 EAST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 0+22 TO 16+49
HORIZ 1"=40', VERT 1"=10'



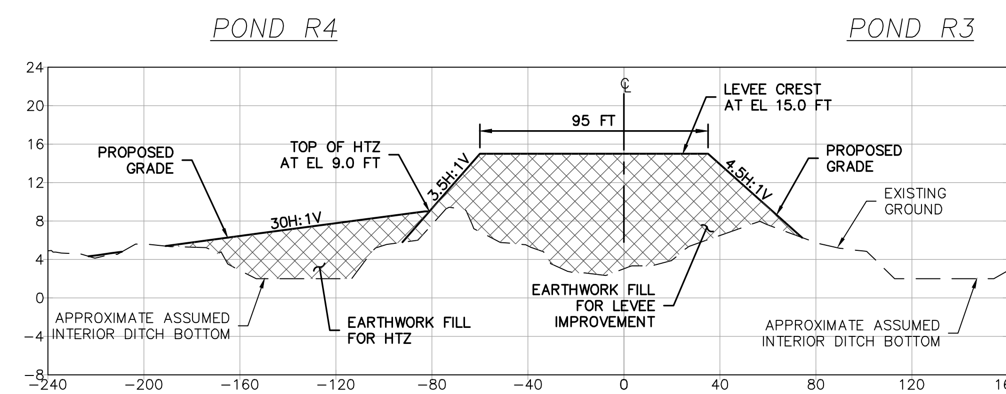
2 (G-6 | D-3) R5/S5 EAST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 16+49 TO 18+48
HORIZ 1"=40', VERT 1"=10'



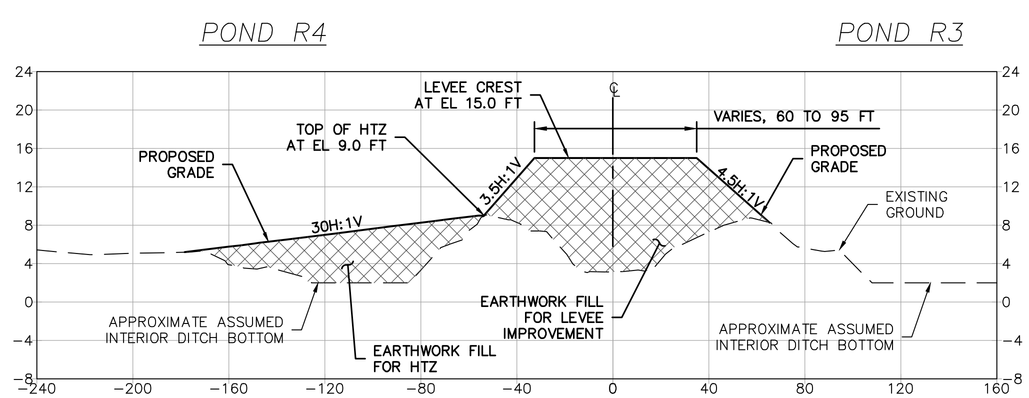
3 (G-6 | D-3; G-7) R5/S5 EAST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 18+48 TO 23+69
HORIZ 1"=40', VERT 1"=10'



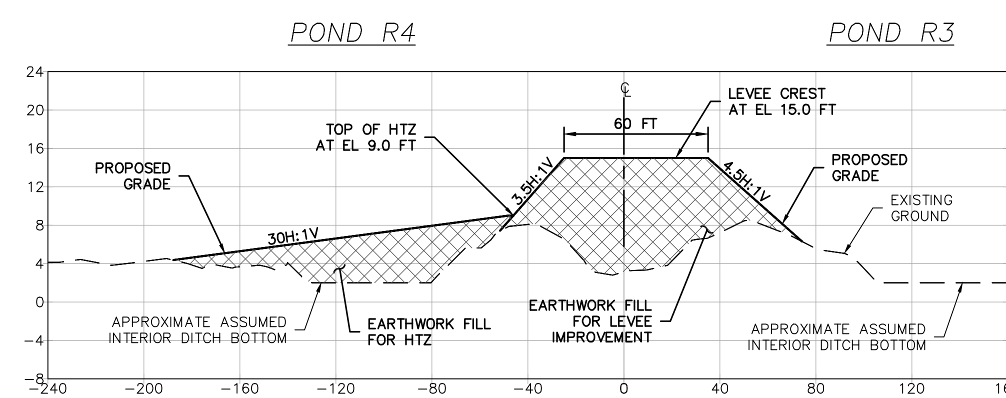
4 (G-7 | D-3) R5/S5 EAST LEVEE IMPROVEMENT – TYPICAL SECTION
STA 23+69 TO 27+31
HORIZ 1"=40', VERT 1"=10'



5 (G-8 | D-3) AAC LEVEE IMPROVEMENT – TYPICAL SECTION
STA 0+00 TO 5+00
HORIZ 1"=40', VERT 1"=10'



6 (G-8 | D-3) AAC LEVEE IMPROVEMENT – TYPICAL SECTION
STA 5+00 TO 6+36
HORIZ 1"=40', VERT 1"=10'



7 (G-8 | D-3; G-9, G-10, G-11) AAC LEVEE IMPROVEMENT – TYPICAL SECTION
STA 6+36 TO 47+48
HORIZ 1"=40', VERT 1"=10'

0 40 80 120
HORIZ 1" = 40'

0 10 20 30
VERT 1" = 10'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

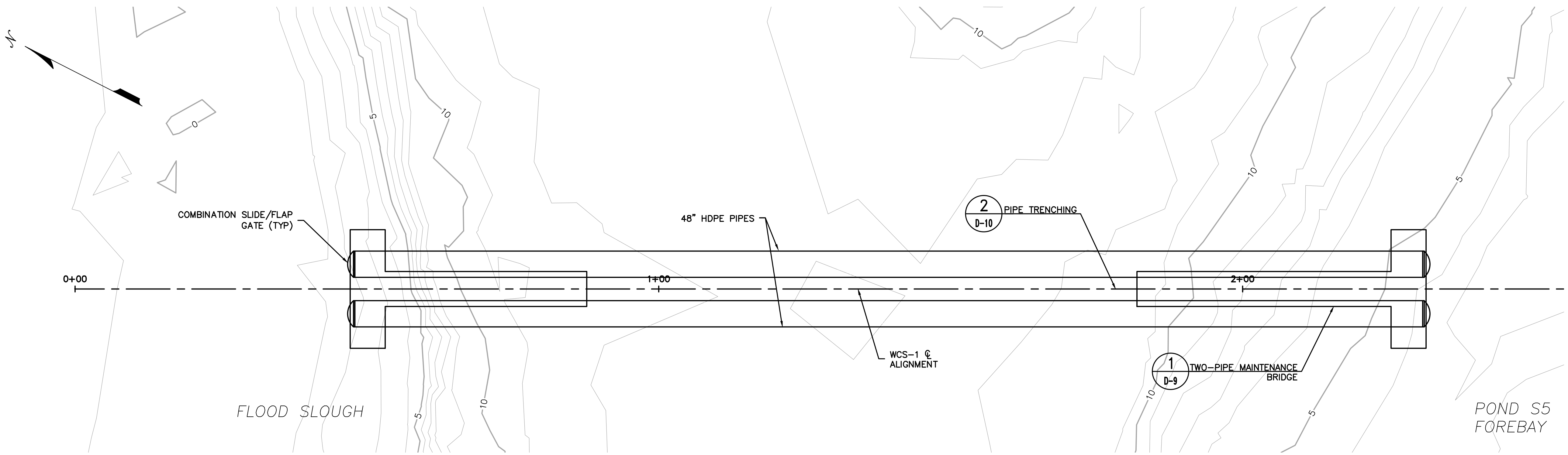
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

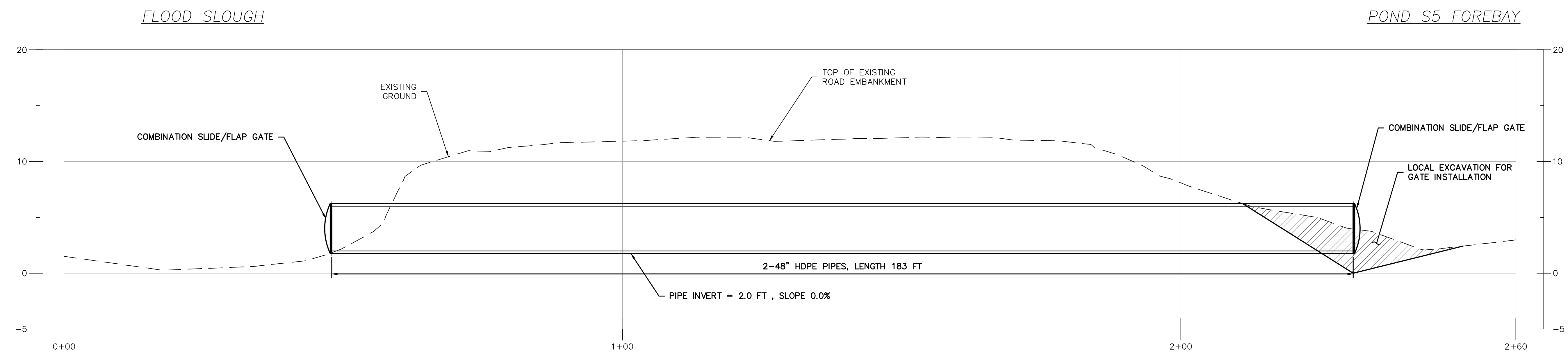
SHEET TITLE
RAVENSWOOD PONDS
TYPICAL GRADING SECTIONS
SHEET 2 OF 2

SHEET NO. SHT. 29 OF 40 SHTS.
REV
DWG NO. D-3

Dec 14, 2016 - 1:32pm
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-3.dwg



PLAN
1"=10'



WCS-1 ℄ ALIGNMENT PROFILE
HORIZ 1"=10', VERT 1"=5'

HORIZ 1" = 10'

VERT 1" = 5'

Dec 19, 2016 - 9:03am
C:\pwworking\aecom_na\lchandrasekaran\dms75824\RW_D-4.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

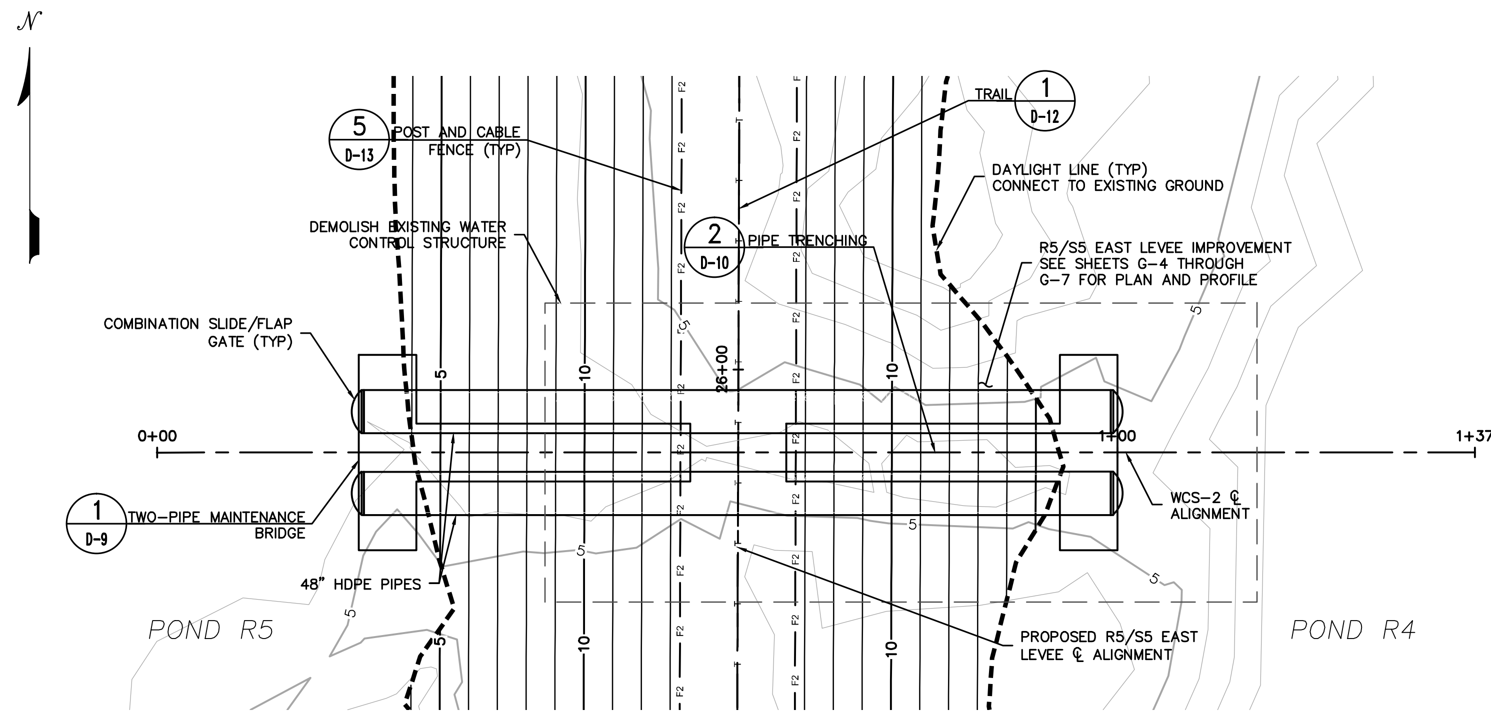
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

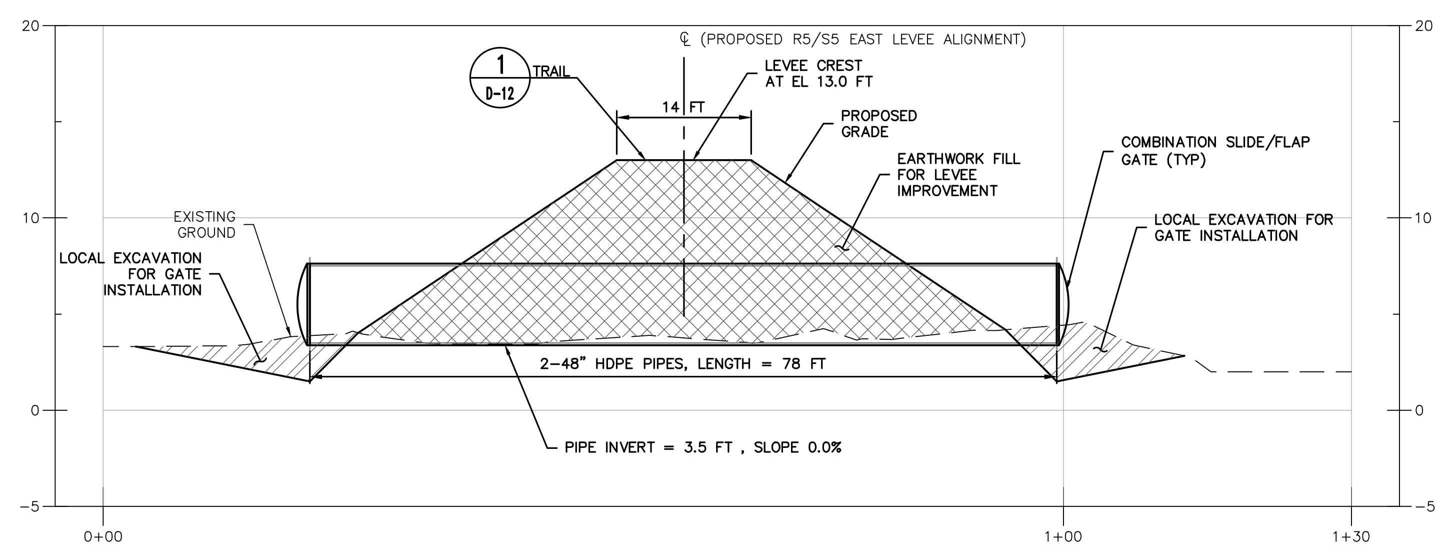
SHEET TITLE
RAVENSWOOD PONDS
WATER CONTROL STRUCTURE - 1
PLAN AND PROFILE

SHEET NO. SHT. 30 OF 40 SHTS.
REV
DWG NO. D-4



PLAN
1"=10'

POND R5 POND R4



WCS-2 ℄ ALIGNMENT PROFILE
HORIZ 1"=10', VERT 1"=5'

0 10 20 30
HORIZ 1" = 10'

0 5 10 15
VERT 1" = 5'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	L. CHANDRASEKARAN
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

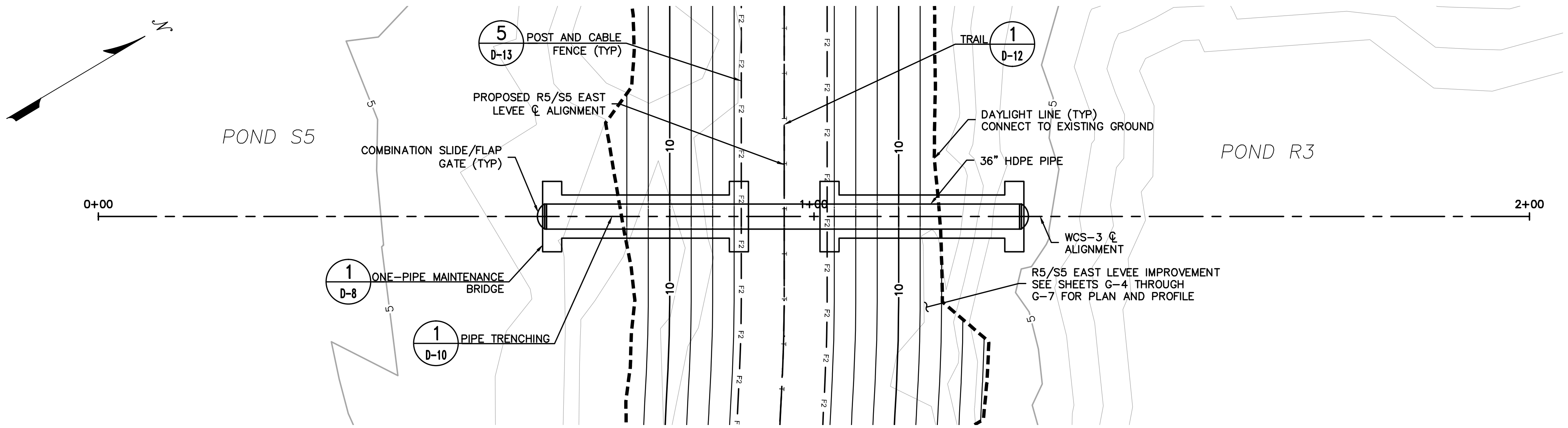
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
WATER CONTROL STRUCTURE - 2
PLAN AND PROFILE

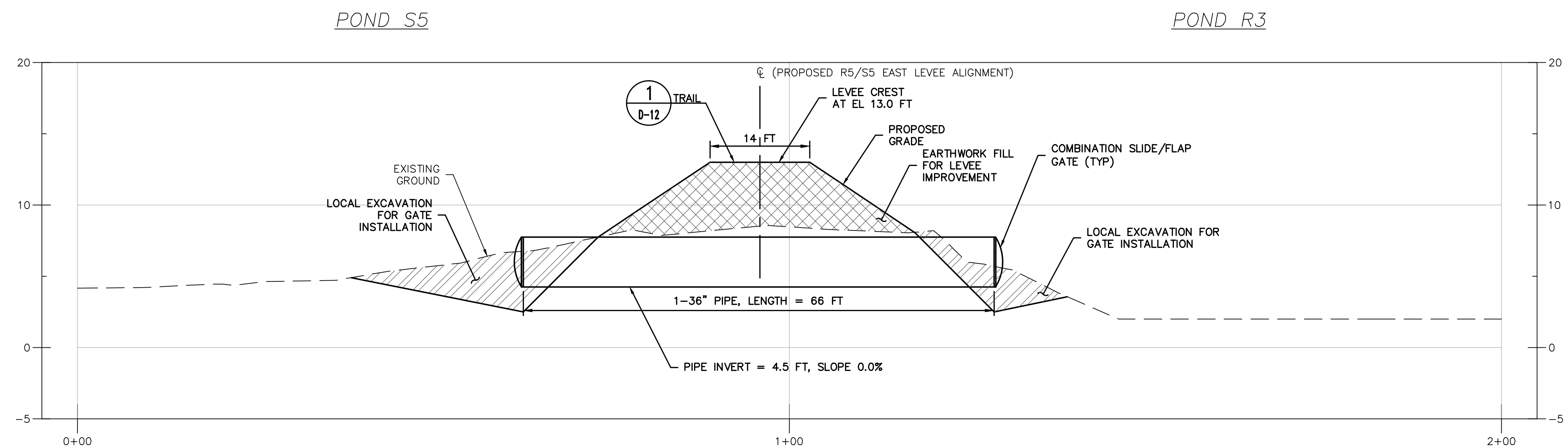
SHEET NO. SHT. 31 OF 40 SHTS. REV

DWG NO. D-5

Dec 19, 2016 - 9:06am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-5.dwg



PLAN
1"=10'



WCS-3 ℄ ALIGNMENT PROFILE
HORIZ 1"=10', VERT 1"=5'

HORIZ 1" = 10' (0, 10, 20, 30)
VERT 1" = 5' (0, 5, 10, 15)

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

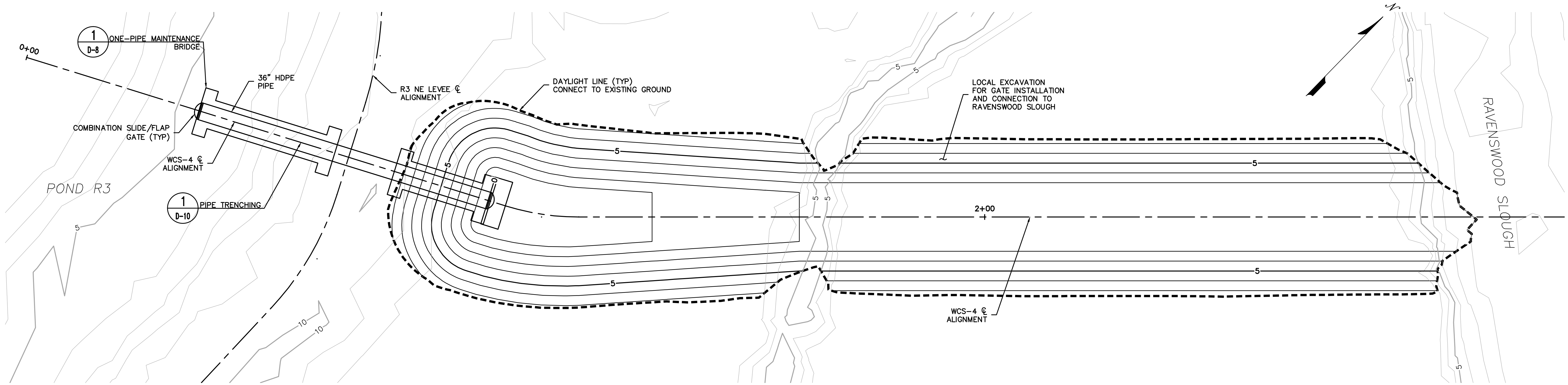
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

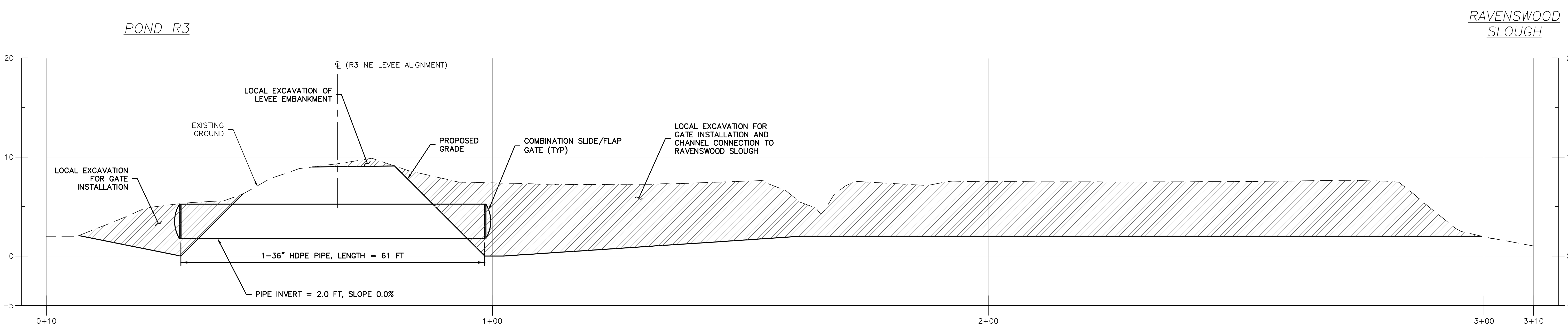
SHEET TITLE
RAVENSWOOD PONDS
WATER CONTROL STRUCTURE - 3
PLAN AND PROFILE

SHEET NO. SHT. 32 OF 40 SHTS.
REV
DWG NO. D-6

Dec 19, 2016 - 9:10am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-6.dwg



PLAN
1"=10'



WCS–4 ℄ ALIGNMENT PROFILE
HORIZ 1"=10', VERT 1"=5'

0 10 20 30 HORIZ 1" = 10'

0 5 10 15 VERT 1" = 5'

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

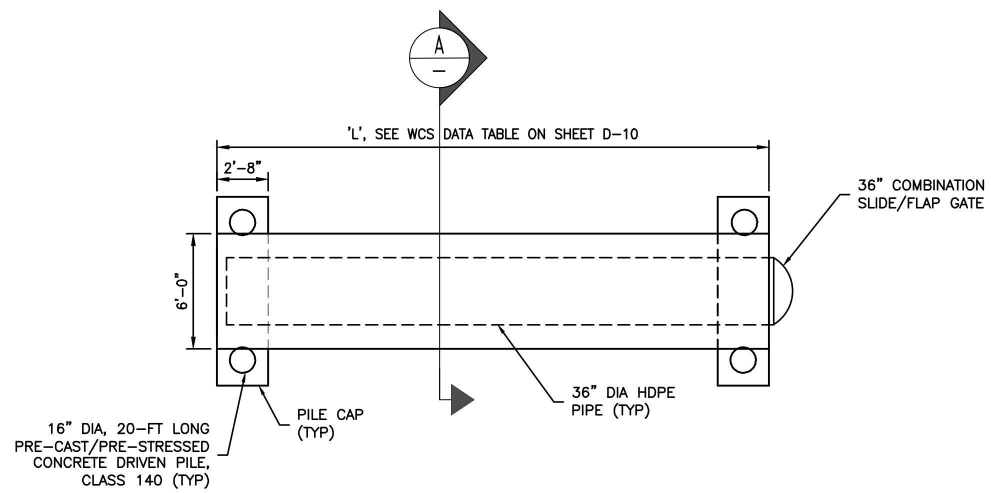
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

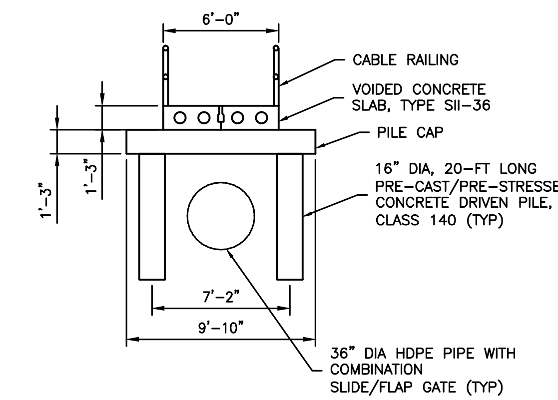
SHEET TITLE
RAVENSWOOD PONDS
WATER CONTROL STRUCTURE - 4
PLAN AND PROFILE

SHEET NO. SHT. 33 OF 40 SHTS.
REV
DWG NO. D-7

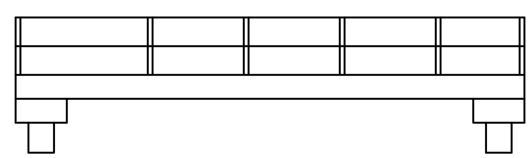
Dec 19, 2016 - 9:12am
C:\pwworking\aecom_na\chandrasekarandms75824\RW_D-7.dwg



BRIDGE PLAN
NTS



A BRIDGE TYPICAL SECTION
NTS



BRIDGE ELEVATION
NTS

NOTES

1. SEE SHEETS D-6 AND D-7 FOR PLAN AND PROFILE OF THE ONE-PIPE MAINTENANCE BRIDGES OF WCS-3 AND WCS-4, RESPECTIVELY.
2. FOR BRIDGE LENGTH INFORMATION, SEE WATER CONTROL STRUCTURE DATA TABLE, DETAIL 3 ON SHEET D-10.

Dec 16, 2016 - 11:07am
C:\pwworking\aecom_na\chandrasekarandms75824\RW_D-8.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

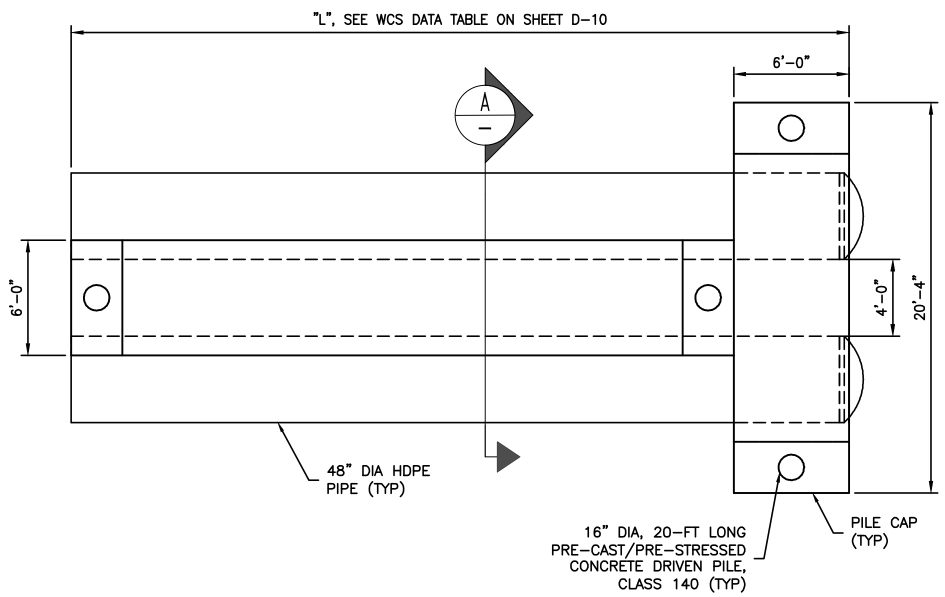
PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED B. CARTER
DRAWN L. DIFUNTORUM
CHECKED L. CHANDRASEKARAN
PEER REVIEWED S. KAZMI
APPROVED S. GENTZLER

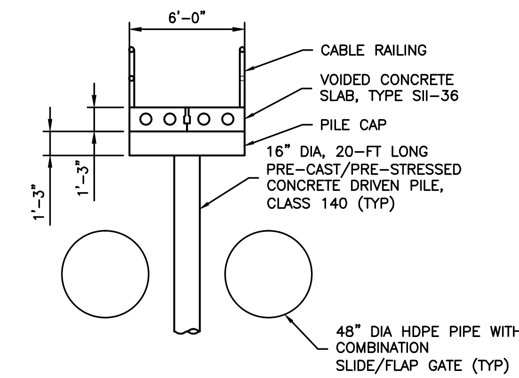
STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE RAVENSWOOD PONDS ONE-PIPE MAINTENANCE BRIDGE TYPICAL STRUCTURAL DETAILS

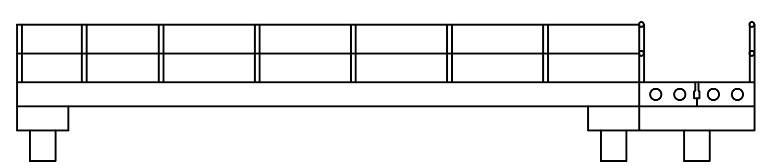
SHEET NO. SHT. 34 OF 40 SHTS.
REV
DWG NO. D-8



BRIDGE PLAN
NTS



A – BRIDGE TYPICAL SECTION
NTS



BRIDGE ELEVATION
NTS

NOTES

1. SEE SHEETS D-4 AND D-5 FOR PLAN AND PROFILE OF THE TWO-PIPE MAINTENANCE BRIDGES OF WCS-1 AND WCS-2, RESPECTIVELY.
2. FOR BRIDGE LENGTH INFORMATION, SEE WATER CONTROL STRUCTURE DATA TABLE, DETAIL 3 ON SHEET D-10.

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	B. CARTER
DRAWN	L. DIFUNTORUM
CHECKED	L. CHANDRASEKARAN
PEER REVIEWED	S. KAZMI
APPROVED	S. GENTZLER

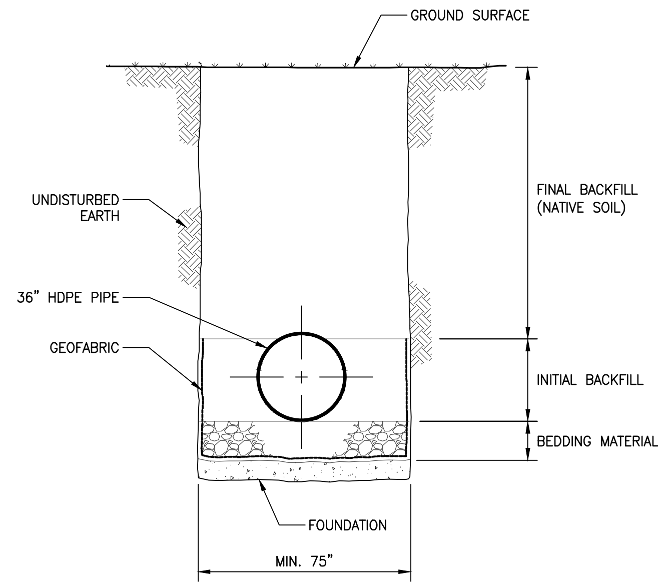
STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

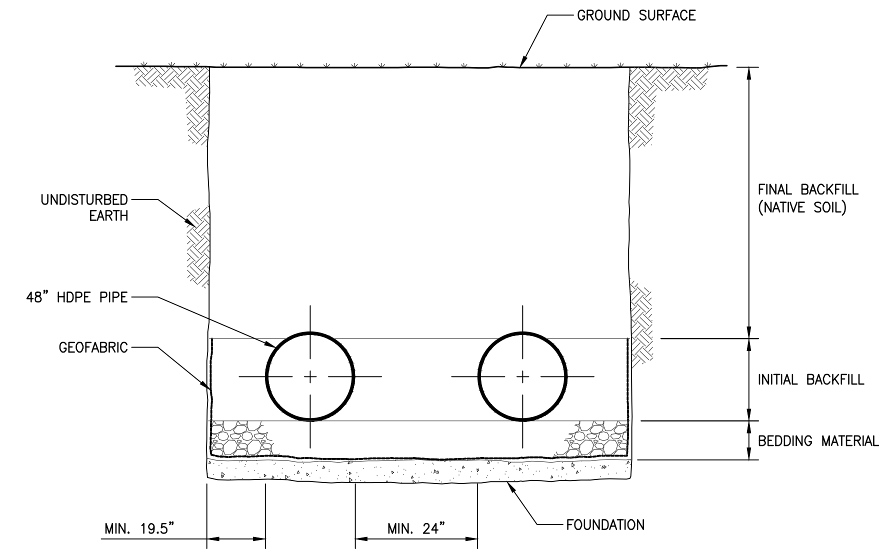
PROJECT: SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE: RAVENSWOOD PONDS TWO-PIPE MAINTENANCE BRIDGE TYPICAL STRUCTURAL DETAILS

SHEET NO. SHT. 35 OF 40 SHTS.
REV
DWG NO. D-9



TYPICAL TRENCH SECTION
1 ONE-PIPE INSTALLATION
– NTS



TYPICAL TRENCH SECTION
2 TWO-PIPE INSTALLATION
– NTS

NOTES FOR TRENCH EXCAVATION:

1. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH A FOUNDATION OF CLASS I OR II MATERIAL AS DEFINED IN ASTM* D2321. "STANDARD PRACTICE FOR INSTALLATION OF THERMOSPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY-FLOW APPLICATIONS." LATEST EDITION; AS AN ALTERNATIVE AND AT THE DISCRETION OF THE ENGINEER. THE TRENCH BOTTOM MAY BE STABILIZED USING A WOVEN GEOTEXTILE FABRIC.

*ASTM AMERICAN SOCIETY OF TESTING AND MATERIALS
**AASHTO AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

NOTES FOR PIPE INSTALLATION:

1. INSTALLATION PROCEDURES: PIPES SHALL BE INSTALLED PER LOCAL STANDARDS AND REGULATIONS IN LEIU OF LOCAL STANDARDS. REFER TO ASTM* D2321 OR AASHTO** SECTION 30 FOR INSTALLATION GUIDELINES.

WATER CONTROL STRUCTURE DATA TABLE

WATER CONTROL STRUCTURE	LOCATION	REFER TO SHEET	NO. OF PIPES	PIPE DIA	GATE, SEE NOTE 1	MAINTENANCE BRIDGE	L, SEE NOTE 2
WCS-1	CONNECTING POND R5/S5 AND FLOOD SLOUGH	D-4	2	48"	48" DIA COMBINATION GATE	WCS-1 NORTH	40'-6"
						WCS-1 SOUTH	49'-6"
WCS-2	CONNECTING POND R5/S5 AND POND R4	D-5	2	48"	48" DIA COMBINATION GATE	WCS-2 EAST	34'-5"
						WCS-2 WEST	34'-5"
WCS-3	CONNECTING POND R5/S5 AND POND R3	D-6	1	36"	36" DIA COMBINATION GATE	WCS-3 SOUTHEAST	28'-9"
						WCS-3 NORTHWEST	28'-6"
WCS-4	CONNECTING POND R3 TO RAVENSWOOD SLOUGH	D-7	1	36"	36" DIA COMBINATION GATE	WCS-4 EAST	29'-0"
						WCS-4 WEST	20'-6"

NOTES:

1. COMBINATION SLIDE/FLAP GATE, GATE FC-10 OR AFC-331 BY WATERMAN INC. OR EQUIVALENT
2. L = TOTAL STRUCTURAL LENGTH, SEE SHEETS D-8 AND D-9.

3 WATER CONTROL STRUCTURE DATA TABLE
– NTS

Dec 19, 2016 - 9:17am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-10.dwg

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED L. CHANDRASEKARAN
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

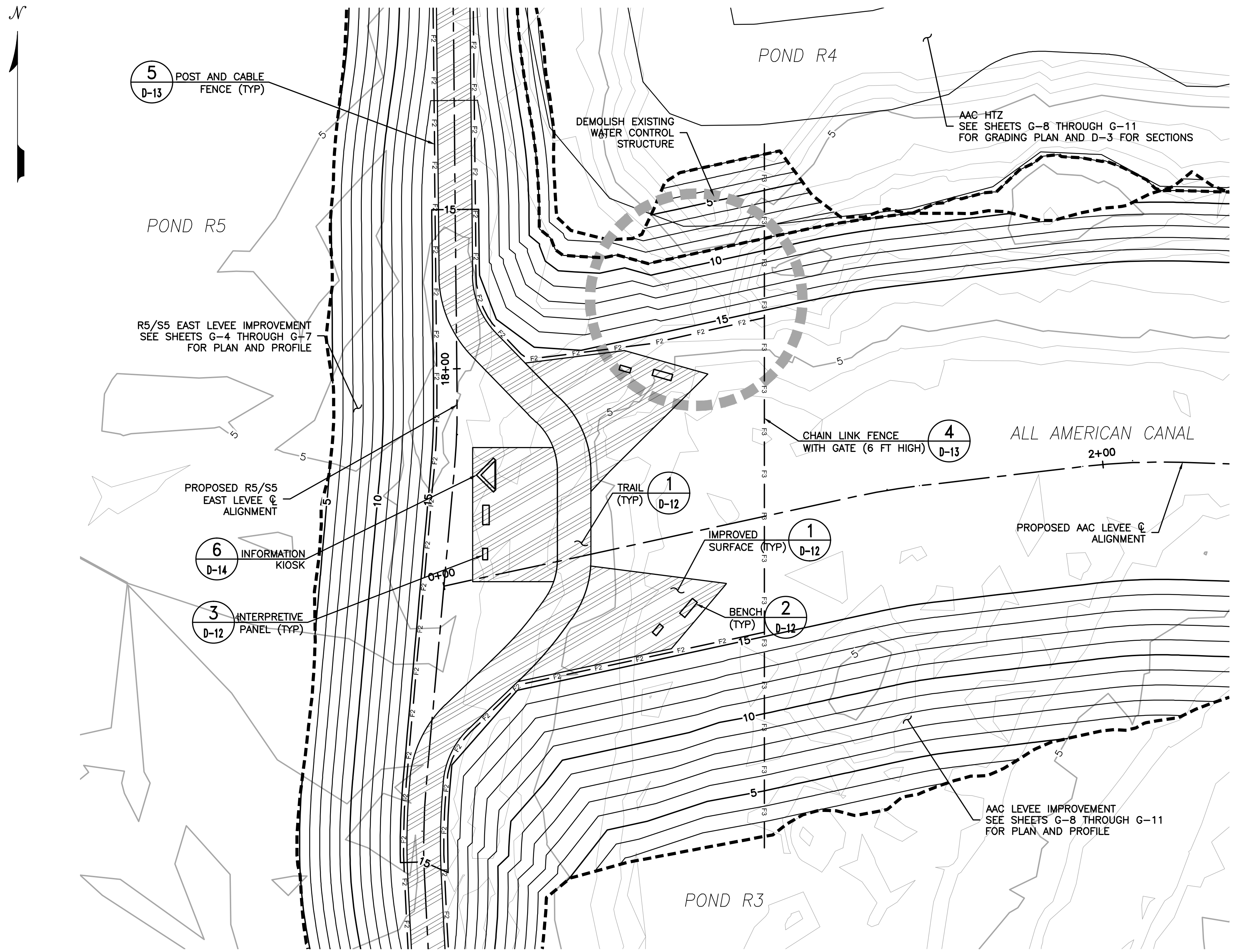
PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
WATER CONTROL STRUCTURES
INSTALLATION DETAILS

SHEET NO.
SHT. 36 OF 40 SHTS.
REV

DWG NO.
D-10



1 – PUBLIC ACCESS AREA – PLAN
1" = 20'

0 20 40 60
HORIZ 1" = 20'

QUESTA ENGINEERING CORP. Civil Environmental & Water Resources
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807
(510) 236-6114 FAX (510) 236-2423 questa@questaec.com

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

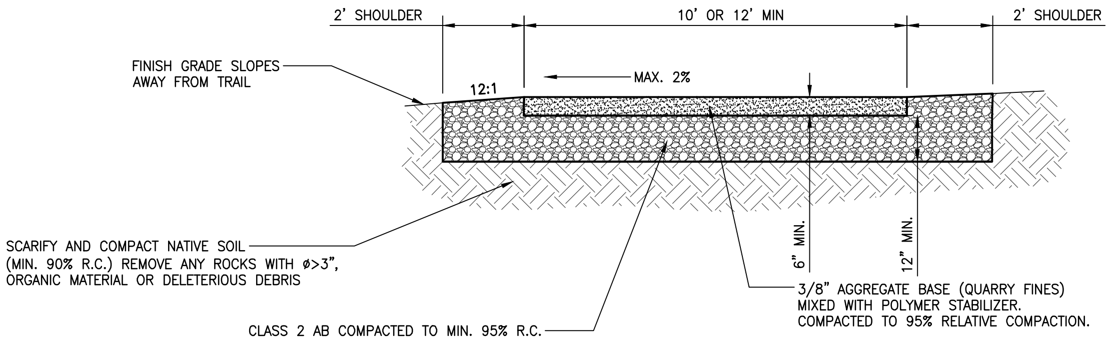
DESIGNED M. HENDERSON
DRAWN L. CHANDRASEKARAN
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy
PROJECT No. 60422372
DATE 12-13-2016

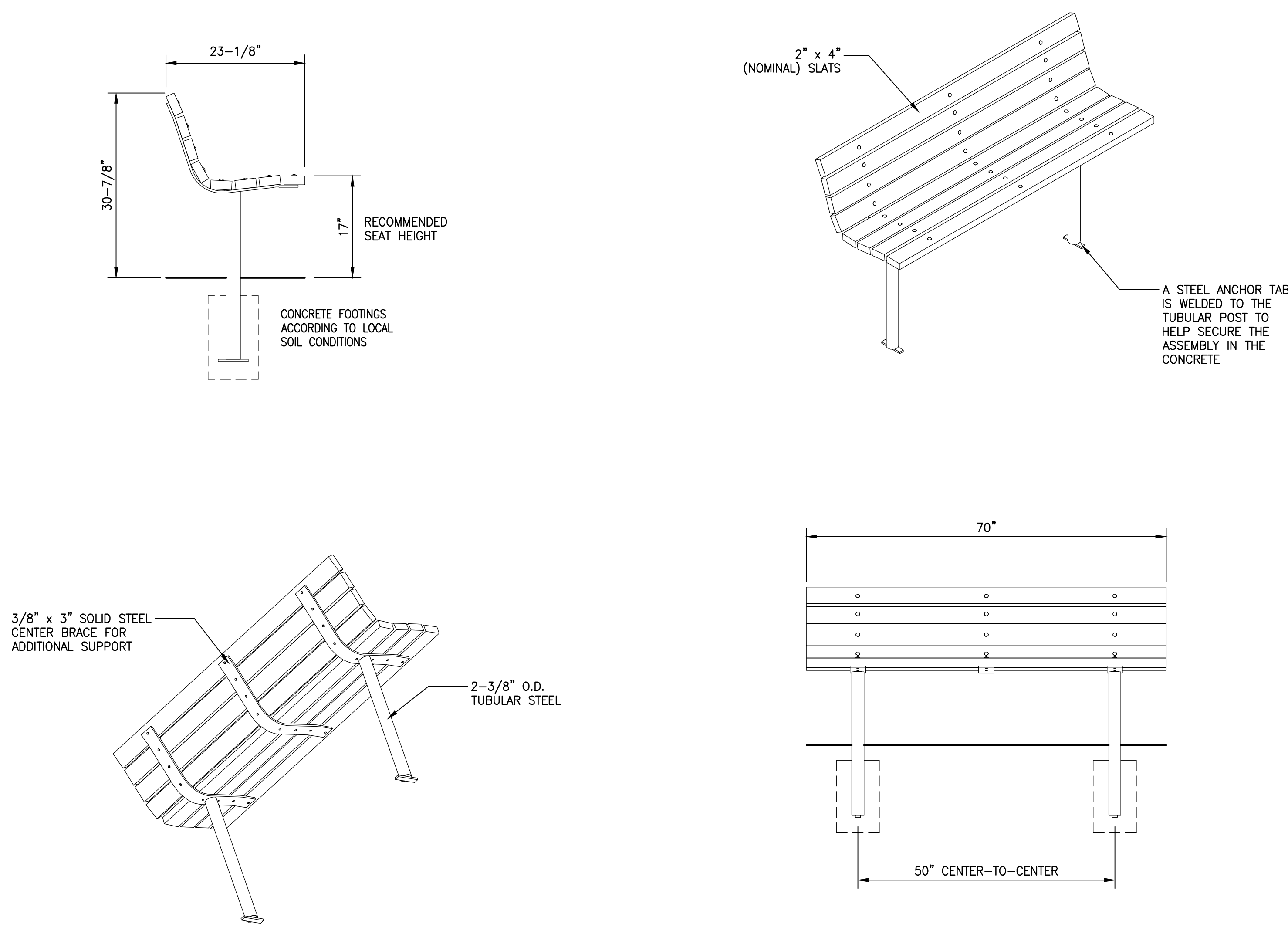
PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT
SHEET TITLE
RAVENSWOOD PONDS
PUBLIC ACCESS AREA
DETAILED LAYOUT

SHEET NO. SHT. 37 OF 40 SHTS.
REV
DWG NO. D-11

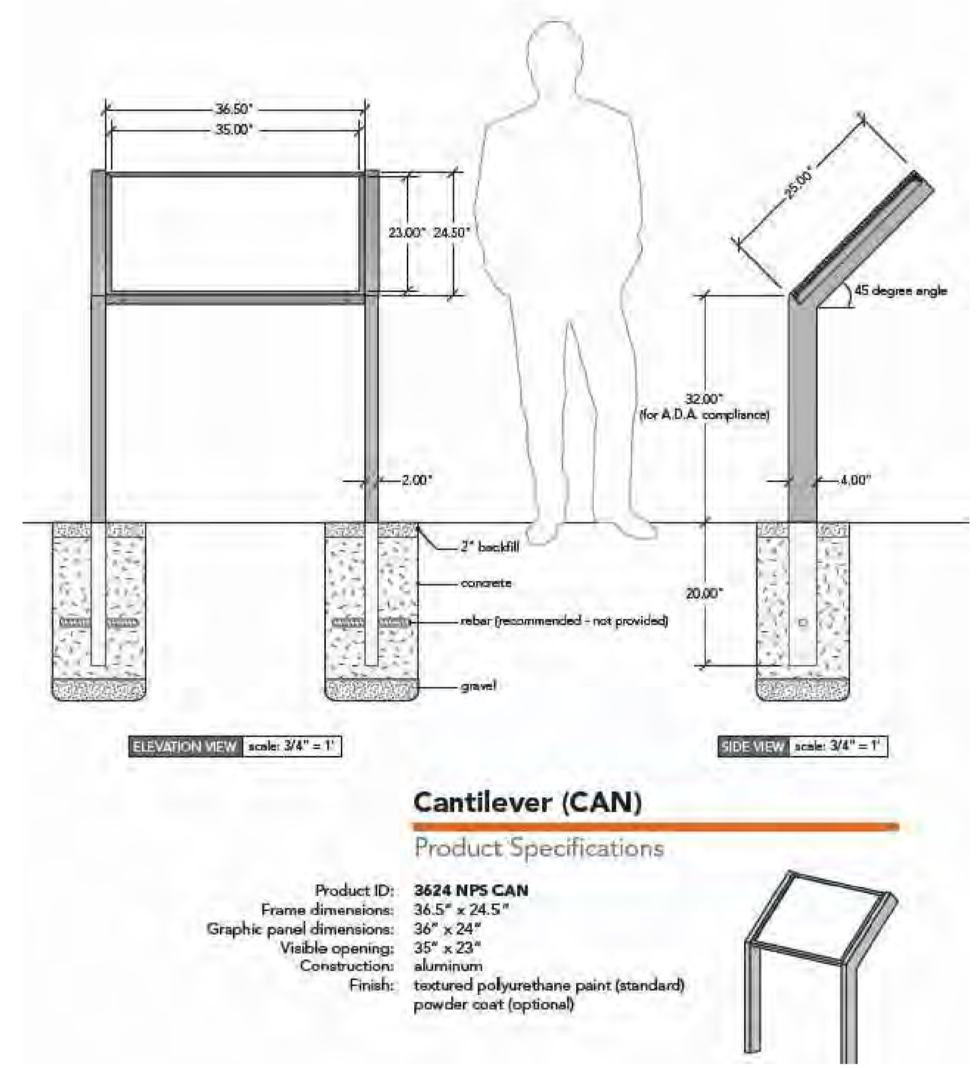
Dec 19, 2016 - 9:25am
C:\pwworking\aecom_na\chandrasekaranl\dms75824\RW_D-11.dwg



1 – TRAIL/IMPROVED SURFACE
NTS



2 – BENCH
NTS



3 – INTERPRETIVE PANEL
NTS

QUESTA ENGINEERING CORP.
Civil Environmental & Water Resources
(510) 236-6114
FAX (510) 236-2423
questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	M. HENDERSON
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

PROJECT
SOUTH BAY SALT POND RESTORATION PROJECT

SHEET TITLE
RAVENSWOOD PONDS
PUBLIC ACCESS FEATURES
DETAILS - SHEET 1 OF 3

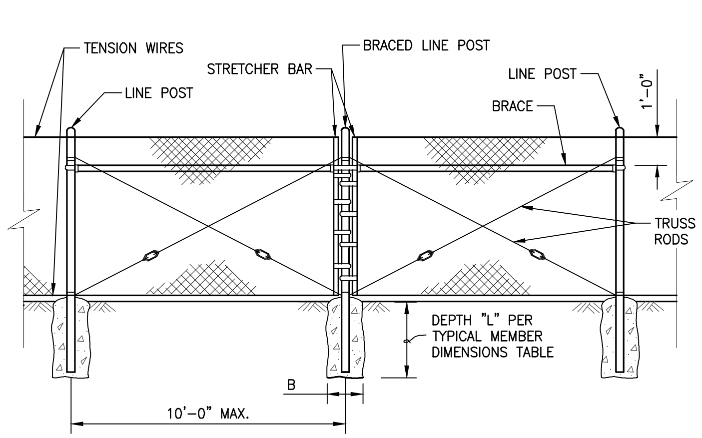
SHEET NO.
SHT. 38 OF 40 SHTS.
REV

DWG NO.
D-12

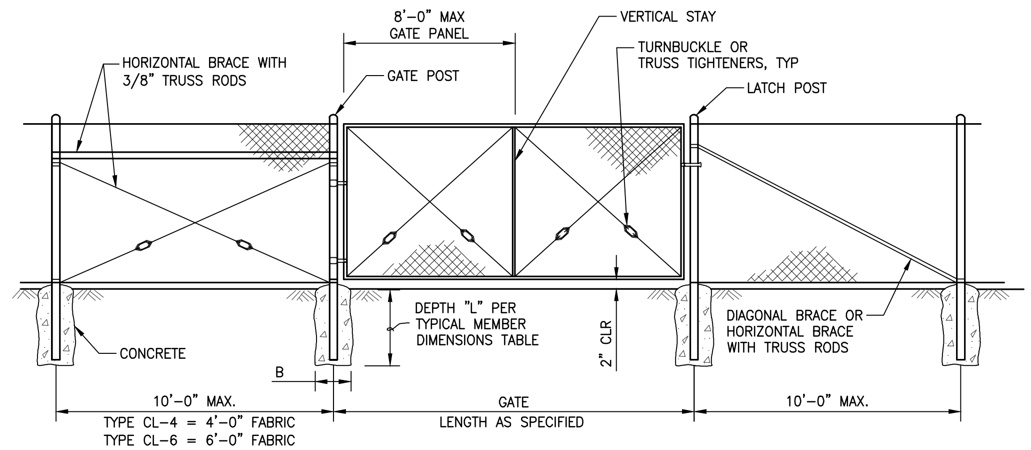
Dec 15, 2016 - 12:59pm
C:\pwworking\aecom_na\chandrasekarandms\75824\RW_D-12.dwg

BRACED LINE POST INSTALLATION

BRACED LINE POST AT INTERVALS NOT EXCEEDING 1000'



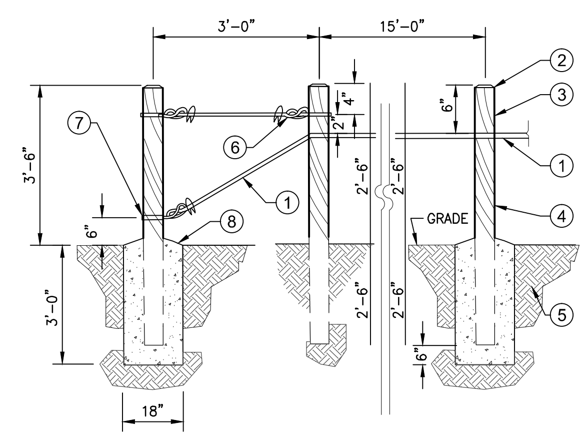
CHAIN LINK GATE INSTALLATION



TYPICAL MEMBER DIMENSIONS						
FENCE HEIGHT (Max)	SLATTED	B (in)	L (ft)	ROUND PIPE GATE/LINE POST		
				SECTION	ROUND OD PIPE	WEIGHT (lb/ft)
5'-0"	NO	12"	2'-6"	3 Std	3.50"	7.58
6'-0"	NO	12"	2'-6"	3 Std	3.50"	7.58
8'-0"	NO	12"	3'-0"	3 Std	3.50"	7.58
10'-0"	NO	14"	3'-6"	3 Std	3.50"	7.58
5'-0"	YES	12"	3'-0"	31/2 Std	4.00"	9.12
6'-0"	YES	14"	3'-6"	4 Std	4.50"	10.80
8'-0"	YES	18"	3'-6"	5 Std	5.56"	14.60
10'-0"	YES	20"	4'-0"	6 Std	6.63"	19.00

Above post dimensions and weights are minimums.
Larger sizes may be used upon approval.
Maximum Gate Width is 24'-0".

4 CHAIN LINK FENCE WITH GATE
– NTS



TERMINAL POST ANCHOR DETAIL

NOTES:

(1) 3/8" DIA. 7 STRAND GALVANIZED WIRE ROPE

(2) 1" BEVEL 45°

(3) 1/2" DIA. DRILLED HOLE.
HOLE TO BE FILLED WITH GREASE FOR CORROSION PROTECTION.
GREASE SHALL NOT MELT OR RUN AT A TEMPERATURE OF 65°C.

(4) 6" X 6" X 5' – 0" REDWOOD POST ROUGH CONSTRUCTION GRADE
(FIELD TREAT POST WHERE EMBEDDED IN GROUND)

(5) SUBGRADE COMPACTED TO 90% RELATIVE DENSITY

LINE POST DETAIL

(6) USE 3/8" X 2" GALVANIZED WIRE ROPE CLIP FOR COMMECTION AND SPLICES.
ALL CLIPS TO BE PLACED WITH NUTS FACING DOWNWARD.

(7) RECESSED 3/8" X 8" GALV. EYE BOLT 1" I.D. EYE, PLUS GREASE.

(8) CONCRETE FOOTING, SLOPE TO DRAIN

*WIRE CLIP TO BE INSTALLED EVERY 8TH POST TO MAINTAIN CABLE TENSION

5 POST AND CABLE FENCE
– NTS

QUESTA ENGINEERING CORP. Civil Environmental & Water Resources
(510) 236-6114 FAX (510) 236-2423 questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED	M. HENDERSON
DRAWN	L. DIFUNTORUM
CHECKED	G. OROZCO / I. ZARCHI
PEER REVIEWED	S. GENTZLER
APPROVED	S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372 DATE 12-13-2016

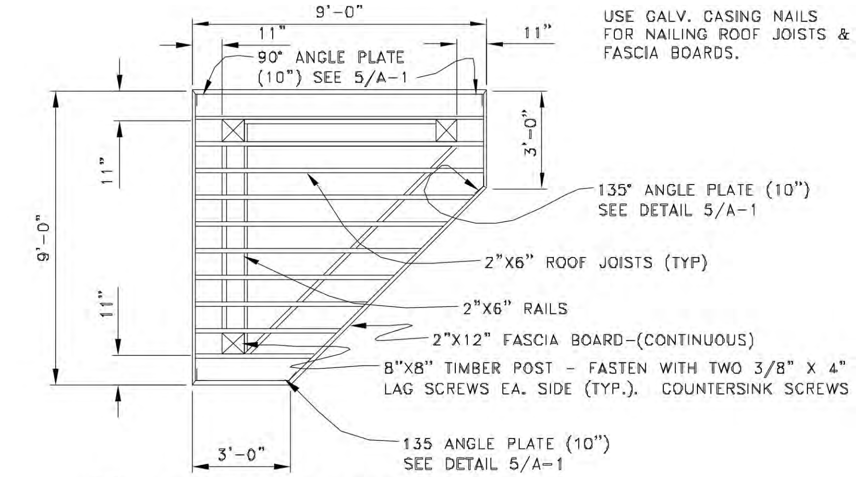
PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**

SHEET TITLE RAVENSWOOD PONDS PUBLIC ACCESS FEATURES DETAILS - SHEET 2 OF 3

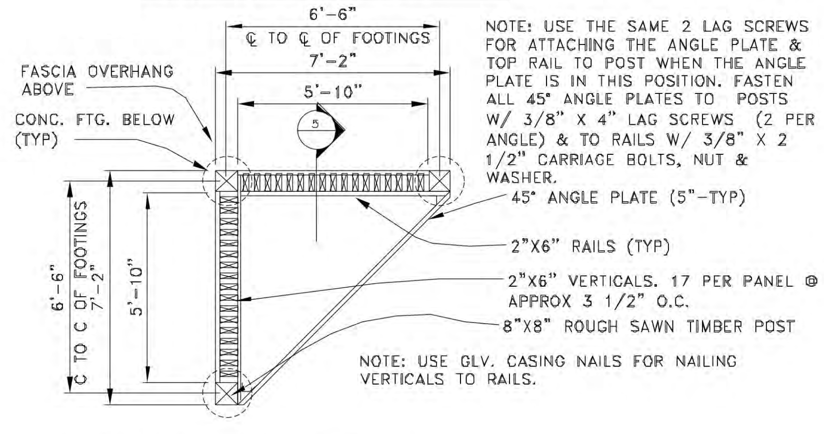
SHEET NO. SHT. 39 OF 40 SHTS.

REV

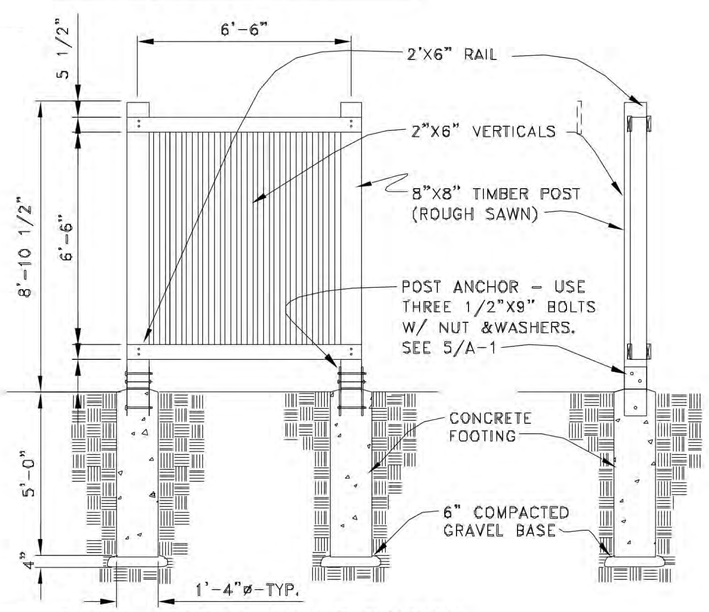
DWG NO. D-13



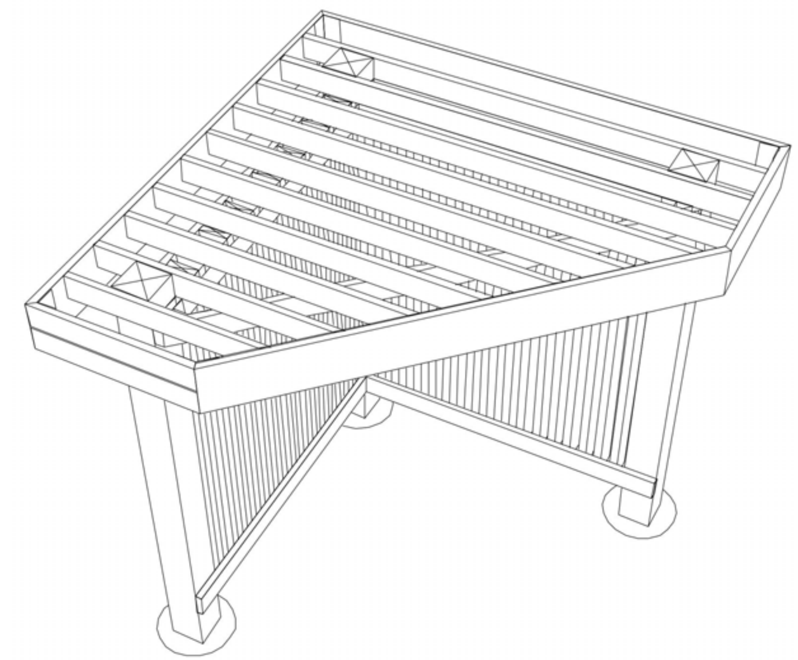
ROOF FRAMING PLAN



PANEL LAYOUT PLAN



PANEL SECTION AND ELEVATION



BIRDS EYE PERSPECTIVE

6 / – INFORMATION KIOSK (USFWS)
NTS

QUESTA ENGINEERING CORP.
Civil Environmental & Water Resources
(510) 236-6114 FAX (510) 236-2423 questa@questaec.com
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612
Tel: (510) 893-3600
aecom.com

DESIGNED M. HENDERSON
DRAWN L. DIFUNTORUM
CHECKED G. OROZCO / I. ZARCHI
PEER REVIEWED S. GENTZLER
APPROVED S. GENTZLER

STATE OF CALIFORNIA
Coastal Conservancy

PROJECT No. 60422372
DATE 12-13-2016

PROJECT **SOUTH BAY SALT POND RESTORATION PROJECT**
SHEET TITLE RAVENSWOOD PONDS PUBLIC ACCESS FEATURES DETAILS - SHEET 3 OF 3

SHEET NO. SHT. 40 OF 40 SHTS.
REV
DWG NO. D-14

Dec 15, 2016 - 3:00pm
C:\pwworking\aecom_na\chandrasekarandms75824\RW_D-14.dwg

Appendix B.
PG&E Infrastructure

1. Summary

As part of the SBSP Restoration Project Phase 2 work, Pacific Gas and Electric (PG&E) would restore existing access boardwalks, construct new boardwalks and raise concrete foundations on existing towers in the Alviso – Mountain View Ponds. The following summarizes the proposed PG&E work based on information provided to the Refuge by PG&E.

2. PG&E Access Boardwalks

All existing boardwalks would be raised a maximum of 4 feet, utilizing the existing boardwalk pillars. The existing boardwalks in Pond A2W are made of wooden planks on wooden frames that rest on concrete foundations set into the pond bottom. The decking is approximately 6,700 feet long, two to three feet wide, and only intermittently used by PG&E for pedestrian access to the towers. These boardwalks would be removed and replaced with higher ones to retain PG&E access to the towers. The replacement would increase the width of the boardwalks by approximately two feet and thus increase the shaded area of the Bay. The exact amount of added surface area would not exceed 13,500 square feet (0.31 acre). In addition to raising the boardwalks within the pond, a new section of boardwalk would be added to connect the end of the Pond A2W boardwalk with the end of an existing one that lies northwest of Pond A1. The additional boardwalk would be approximately 2,350 feet long and 3 feet wide (7,050 square feet [0.16 acre]). This area the area of new shade added to the Bay. The total cross-sectional area of the piles to support this new boardwalk is less than 700 square feet (under 0.15 acre). The total volume of the piles to support the new boardwalk would be approximately 280 cubic yards, of which approximately 186 cubic yards would be below the Bay floor (piles must be placed 12 vertical feet below the Bay floor), and the remaining 93 cubic yards would be in the water column. The various access points to the boardwalks would be gated to protect against unauthorized human entry and would be designed to exclude terrestrial predators of marsh wildlife species that may use them.

2.1 PG&E Boardwalk Improvement and Addition.

The new boardwalks would be placed within the existing PG&E right-of-way (ROW), adjacent to the towers. All new sections of boardwalk would be built approximately 4 feet above the height of the existing boardwalk. The boardwalk spans would be 3-foot-wide sections and would include a double handrail. The boardwalk spans would be built in 20-foot-long sections supported by 4-inch by 4-inch vertical plastic lumber posts, known as support footings, which would be spaced 10 feet apart along the boardwalk spans. The boardwalks would parallel the transmission line towers and would include additional lateral boardwalks, which would be used to access each tower from the main boardwalk. Construction details for PG&E operations can be found in the 2016 SBSP Restoration Project's Final Environmental Impact Statement/Report (2016 FEIS/R) Appendix D.

Using hand tools, PG&E crews would manually drive the support footings into the Bay floor to an approximate depth of 12 feet. A small amount of mud would be displaced by the support footings. PG&E is proposing to use only plastic lumber or untreated wood for boardwalk installation. Plastic lumber would last longer than wood, and the use of untreated wood would ensure that the least amount of potential long-term environmental impacts will result. All work would be conducted by hand, and equipment used to install the boardwalks, including generators and chainsaws, will be mobilized to the boardwalk locations on foot.

Working from the land-side end of the existing boardwalk at the southern end of Pond A2W, the decking/planks of the existing boardwalk would be removed, and the old piles pulled. Rebuilding each removed segment of the boardwalk would proceed before the next segment is removed, so that crews would be working from newly built segments. Some of this work may be done by a crew working from the existing boardwalk, but much of the demolition and removal would be done from a small boat and the use of an 8-foot by 10-foot floating device such as a raft. Some of the old piles and decking would be placed on the floating device and hauled out, and some would be transported on special hand-built and hand-powered dollies/wheelbarrows. In the areas closest to shore, where water may be too shallow for a barge, some work may also be done while standing on temporary trellises or other work platforms, which would be placed on the pond bottoms. This would involve some foot traffic on the pond bottom and along the edge of the pond.

Wooden safety railings would be added in a similar manner. As is the current condition, gates and fences with razor wire would be placed on each end of the boardwalk to prevent public access and entry to the boardwalks; it would also deter mammalian predators. All boardwalks would be constructed according to PG&E specifications.

The two replacement boardwalks inside of Pond A2W would extend approximately 6,700 feet combined, from the border with Mountain View Shoreline Park through the pond to the outer Bay-facing levee or to the levee bordering Stevens Creek. On the other side of the outer Bay-facing levee, the new length of boardwalk (approximately 2,350 feet long) would extend west-northwest from the Pond A2W levee to connect with the existing PG&E boardwalk to the north of Pond A1.

This boardwalk would be built in a similar, stepwise manner as the one inside of Pond A2W, with each new segment of boardwalk being built from the segment most recently constructed. This outer section of boardwalk would be in deeper water that is not expected to eventually become tidal marsh but rather to remain open Bay.

These tasks would require small crews, typically less than a dozen people. Construction monitoring will be conducted as directed by PG&E's Environmental Compliance Management Plan (ECMP).

3. Raise Concrete Foundations of PG&E Towers in Pond A2W

Sixteen (16) transmission towers are within Pond A2W. Conversion of this pond to tidal marsh habitat would require PG&E to upgrade the tower foundations to account for the introduced tidal flux and to raise the maintenance/service boardwalks that run under the power lines and provide PG&E access to the towers. The concrete pedestals on which the towers sit would be reinforced with additional concrete placed higher on the tower legs to protect the metal portions of the towers from the corrosive action of saltwater from the highest tides. The total combined area of the new concrete foundation is estimated to be 540 square feet (about 0.013 acre), and the total combined volume of that concrete is 2,160 cubic feet (80 cubic yards).

3.1 Adding Concrete for PG&E Tower Foundation Improvements

Boardwalk work would be completed first for worker safety and to more efficiently transport materials and tools to the towers. Following the completion of boardwalk replacement and construction, work would be performed on the footings of the towers in Pond A2W. Multiple towers will be worked at the same time from each side of the boardwalks. All structures would require adding additional concrete to existing concrete foundations to a greater height of up to 4 feet above existing structure footing.

Equipment required for this project would involve: wheel barrels, hand tools, drills, saws, jackhammers with air compressor, barge and pickup trucks. The material would be moved to each specific work site by hand or wheelbarrow. The new concrete would either be mixed at each tower location, or hauled in with a wheelbarrow to each location to the levee and removed in wheelbarrows for disposal. It is possible some concrete deliveries could be made by helicopter.

To upgrade the concrete foundations of the four legs of each tower, the following general steps would be taken: PG&E would construct a cofferdam around each of the footings, dewater the space between the cofferdam and the existing foundations, build a form for pouring additional concrete, pour the concrete, and remove the cofferdam.

The cofferdams would be installed at low tide to allow access to the foundation footing. The cofferdams would generally be plywood and wooden strongbacks. These would be placed around each footing. Mud would be removed by hand, and the dam pushed down to expose the solid piling, usually 3 feet below the mud line. The mud would be returned to the base of the footing after the cement is poured.

The dewatering would be done by pumping the enclosed pond water out of the cofferdam and per in accordance with the 2007 SBSP Program FEIS/R and 2016 SBSP Phase 2 Mitigation Measure 3.4-5a. Pumps would be gas- and diesel-powered. Each cofferdam could be dewatered in fewer than 6 hours of pumping. The pumps would be delivered to the towers via the boardwalks or by barge.

During the time that the tower foundations are exposed, new/replacement concrete footings would be poured between the reinforcements. Each footing would be chipped down to roughen concrete to accept the new concrete cap. Stockpiles would be necessary at each end of the boardwalks. Crews will use the existing boardwalk to transfer removed concrete to staging site located on the maintained outboard levee, loaded onto trucks, and transported to PG&E's facility in Newark for disposal. Any necessary steel repairs would be performed before the new concrete cap is added to the existing footing.

New pins would be inserted to form a new rebar cage around the pile to act as the form, and the concrete would then be poured. All concrete will be mixed by hand at each tower site. The new concrete caps would be at elevations three to five feet higher than the existing footing height. The cofferdam would be removed once the concrete is dry.

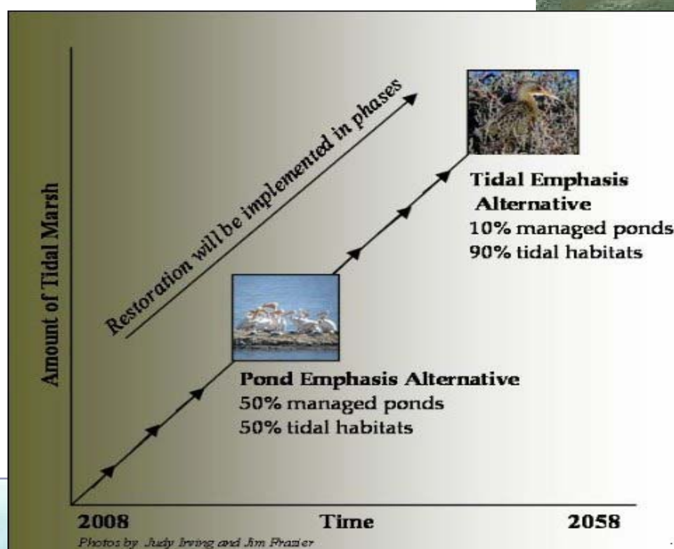
Footing repairs can be done within a work area extending approximately 2 feet from the footing. In very shallow water or at low tides, rubber mats could be used for short periods to gain temporary access to perform maintenance work and would be placed to help protect the vegetation around the boardwalk being built.

The duration of the tower foundation improvements would be 20 weeks, assuming PG&E crews would work 10-hour days, 7 days per week. These tasks would require 8 workers. Construction monitoring will be conducted as directed by PG&E's ECMP. If necessary for schedule compression, work on tower foundations near segments of boardwalk that have already been replaced or constructed could be implemented prior to the completion of all boardwalk work. However, this analysis assumes that these activities do not overlap.

Appendix C.
Adaptive Management Plan

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.

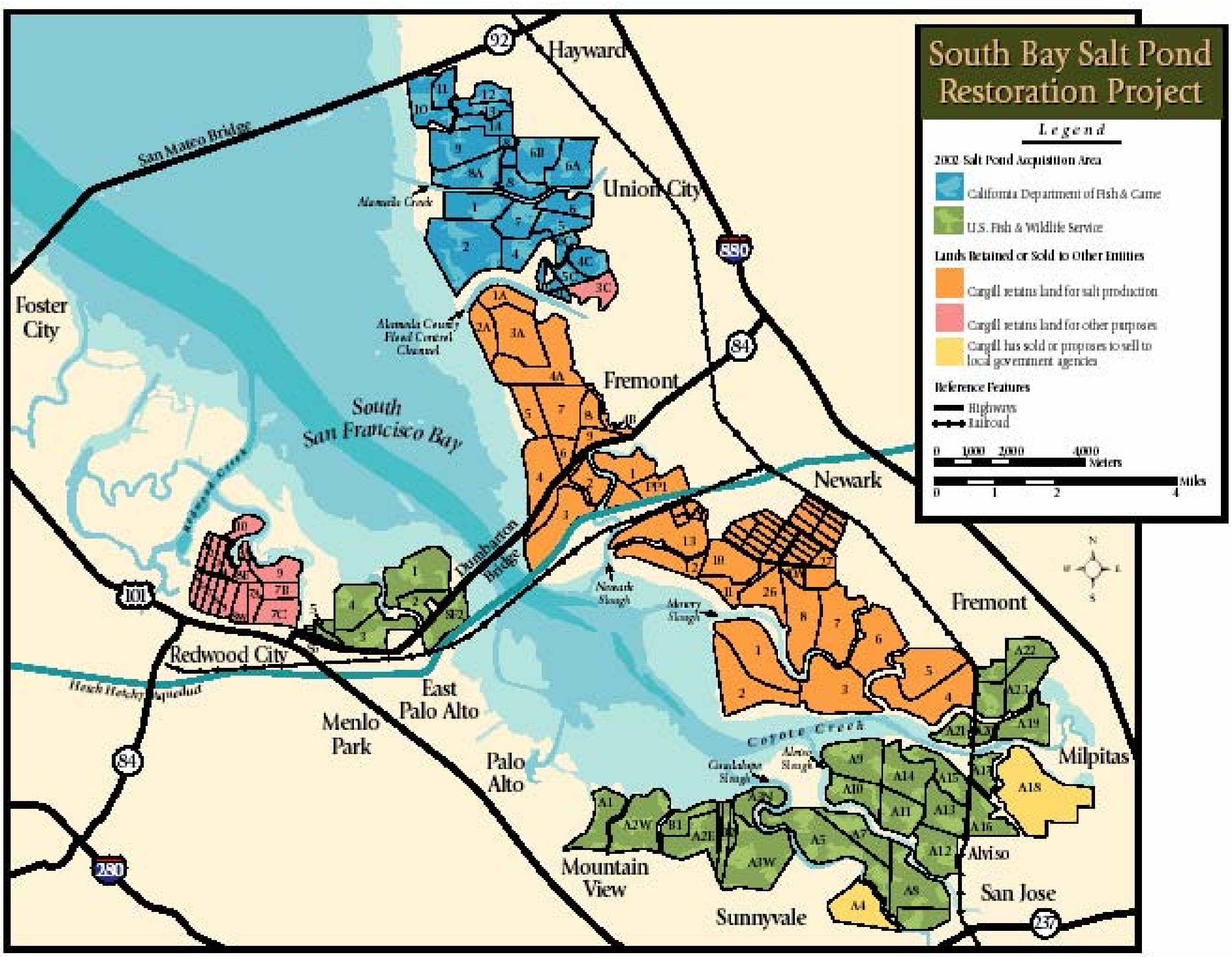
Objective 3. Provide public access opportunities compatible with wildlife and habitat goals.

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)

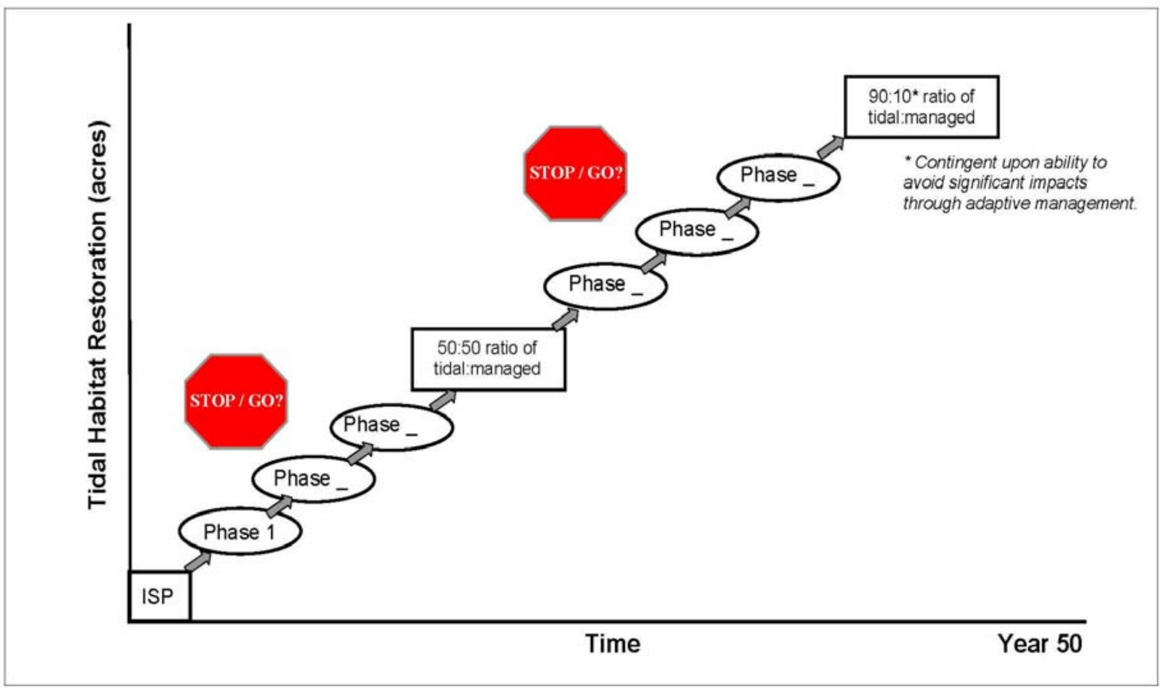
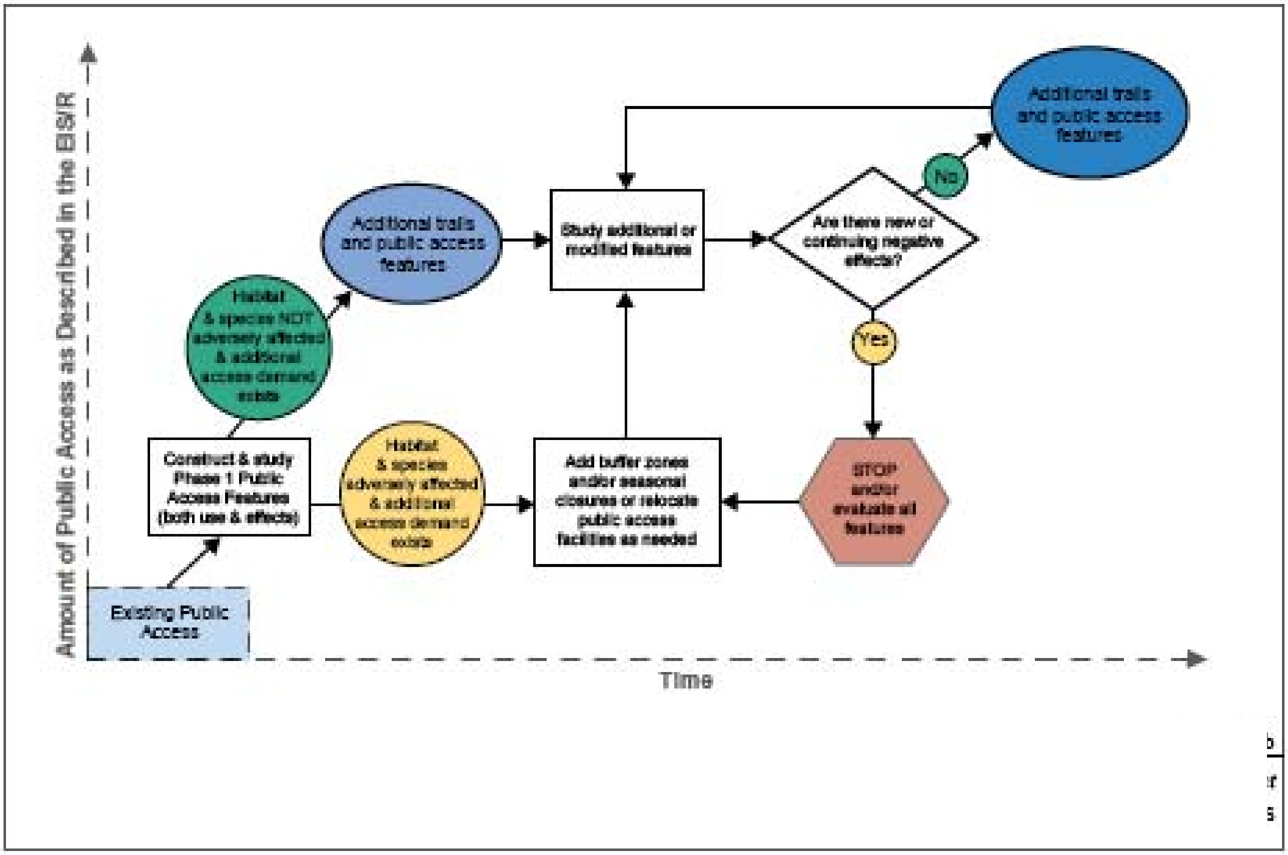


FIGURE 3. Adaptive Management Approach for Recreation and Public Access



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

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
Bird Use of Changing Habitats. ***(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
Effects on Non-Avian Species. 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

	<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>Public Access and Wildlife</u>. 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
	<u>Social Dynamics</u>. 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.

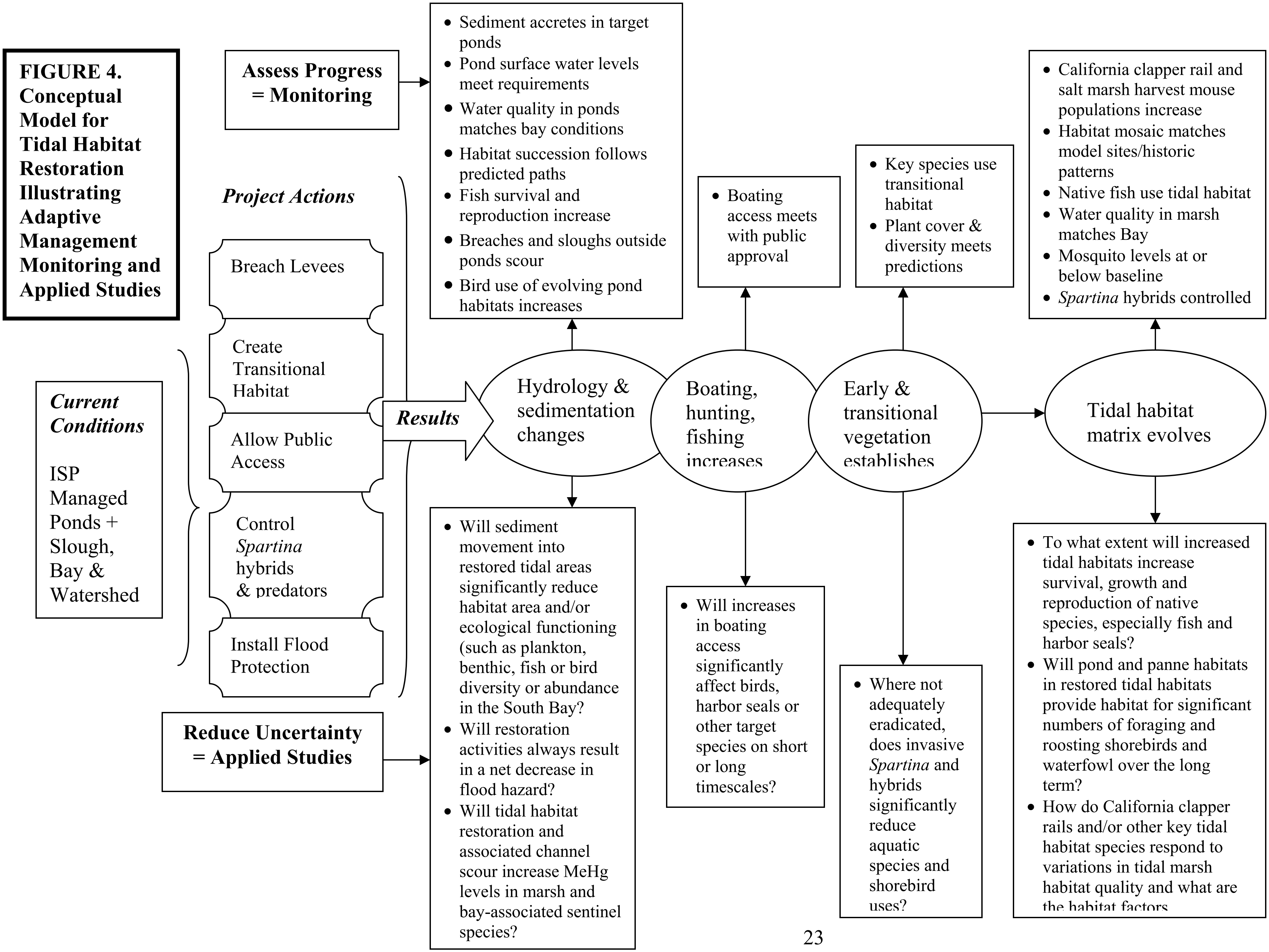


FIGURE 4. Conceptual Model for Tidal Habitat Restoration Illustrating Adaptive Management Monitoring and Applied Studies

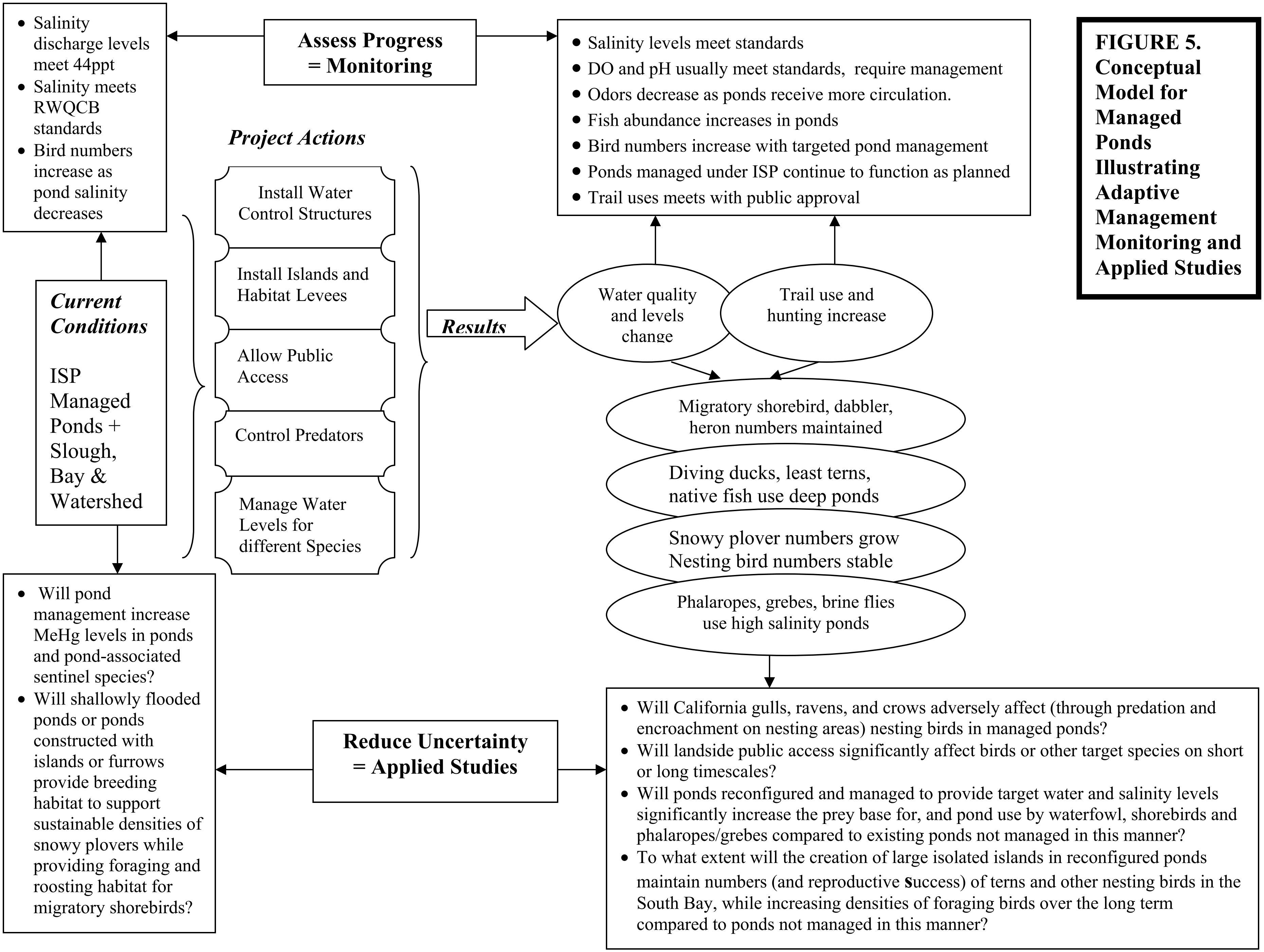
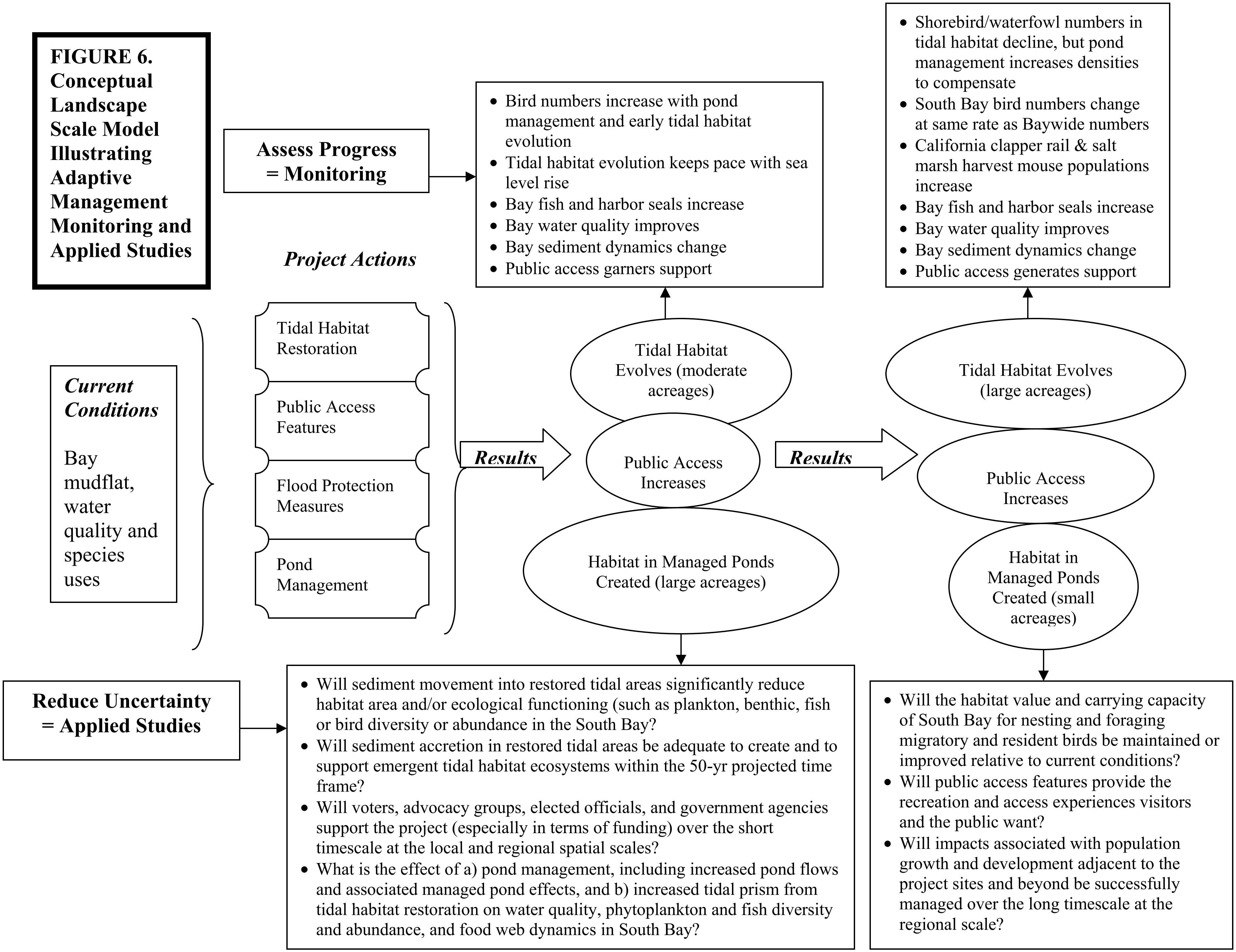


FIGURE 5. Conceptual Model for Managed Ponds Illustrating Adaptive Management Monitoring and Applied Studies

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:

- Beyond the Ecosystem Scale (Entire Bay Area and Beyond): 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

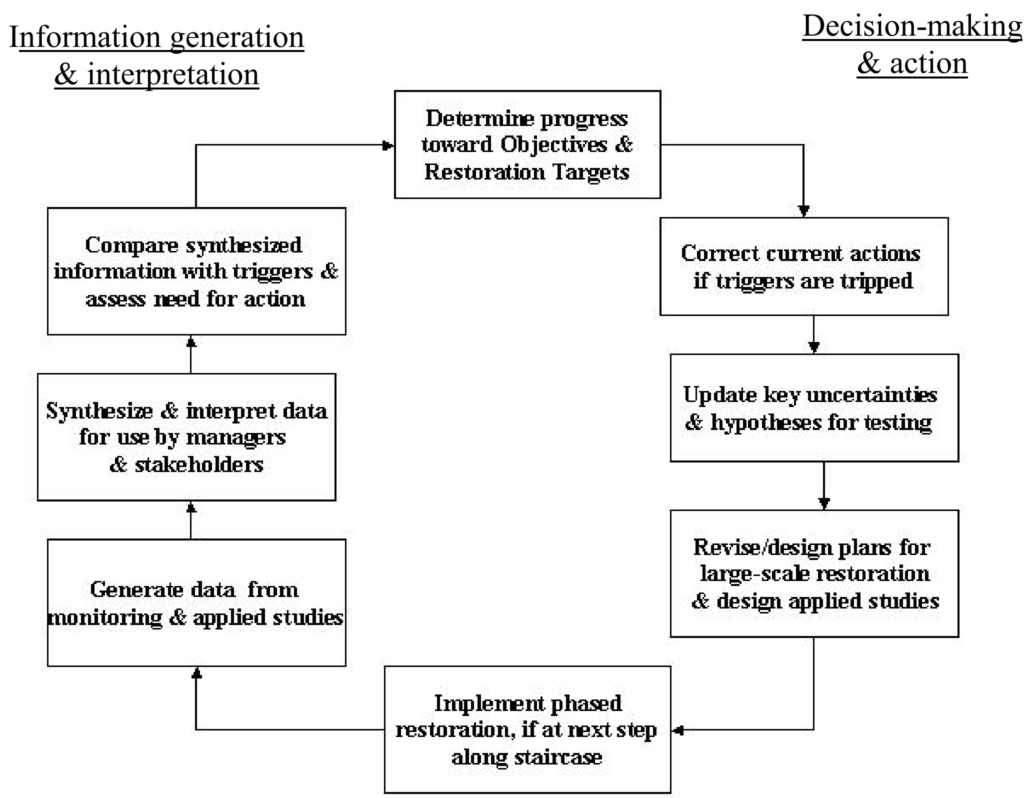
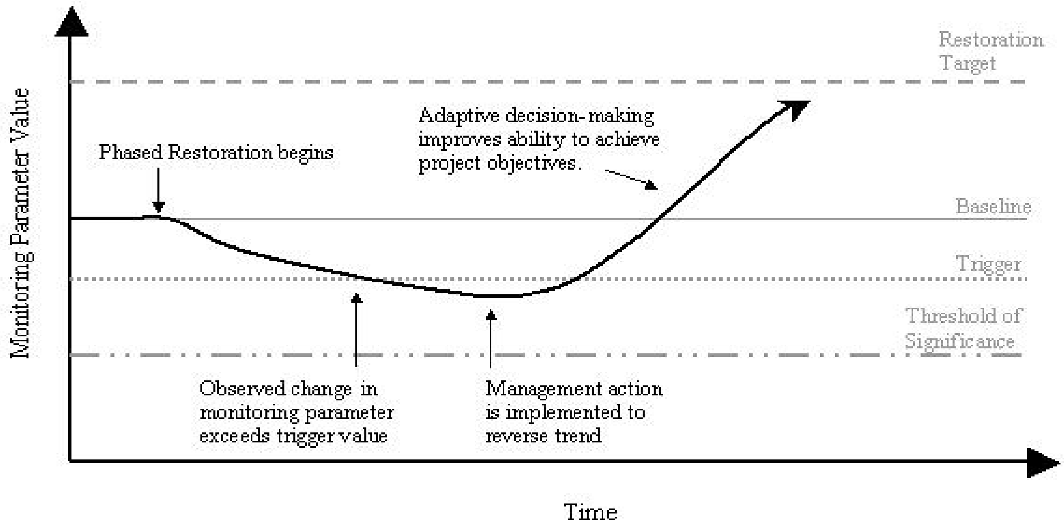


FIGURE 8. Linking Restoration Targets to Management Triggers



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.

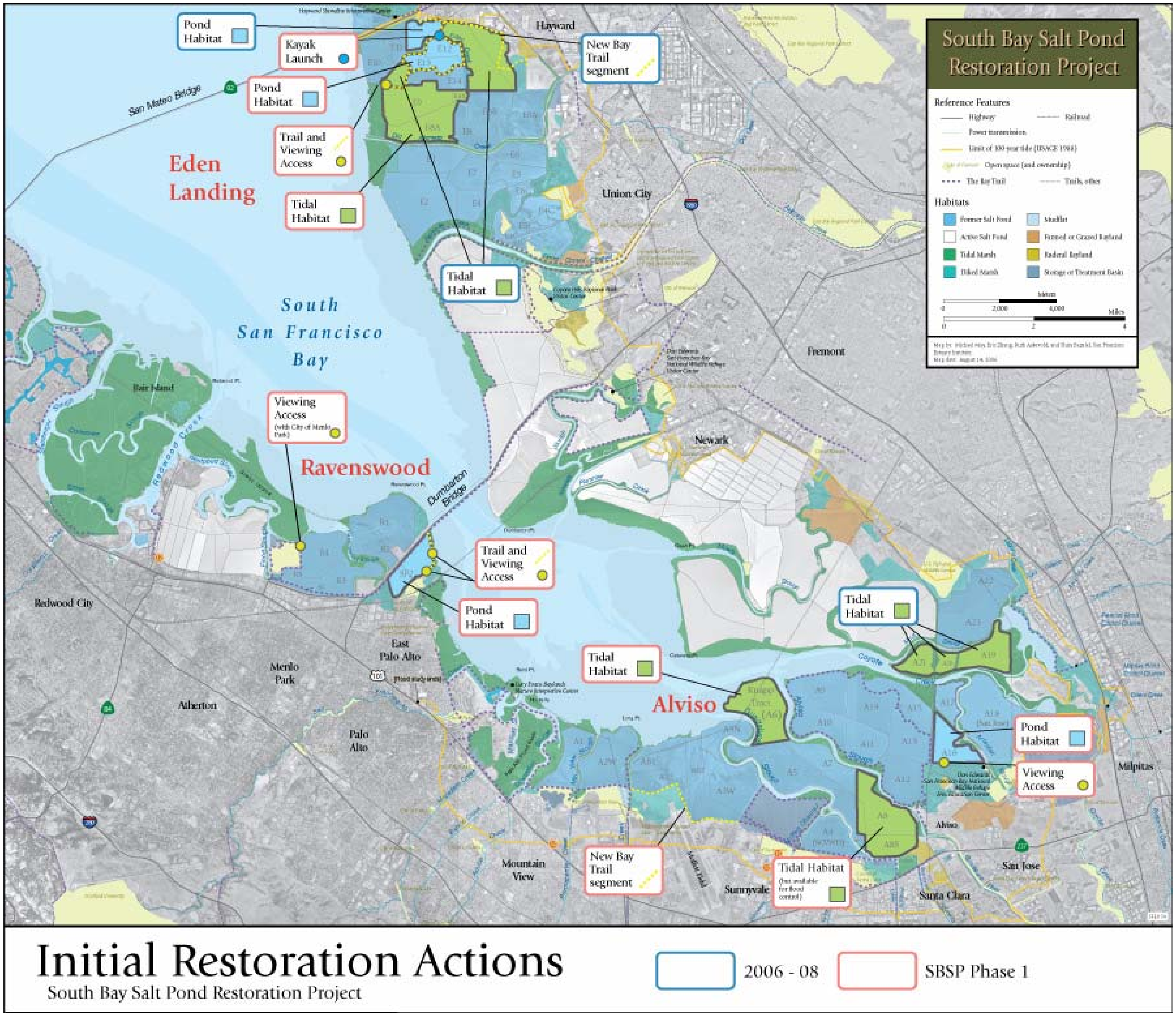
TABLE 5. Phase 1 Applied Studies and Restoration Techniques Questions

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.)	Applied Studies • 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? Restoration Techniques • 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.)	Applied Studies • 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? Restoration Techniques • 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	<u>Applied Studies</u> • 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	<u>Applied Studies</u> • 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:

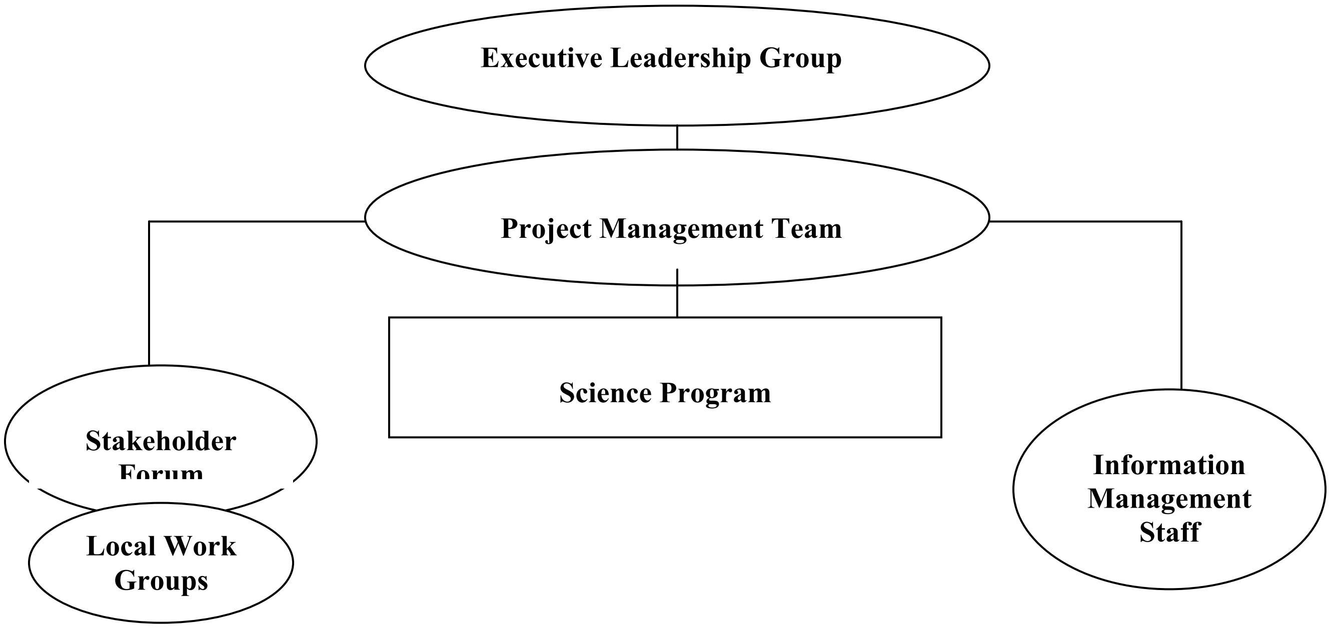
1. Generate science-based information for managers (from monitoring and studies);
2. Convert information into effective management decisions;
3. Involve the public to help provide management direction; and
4. Store and organize information for use by the decision-makers and the public.

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

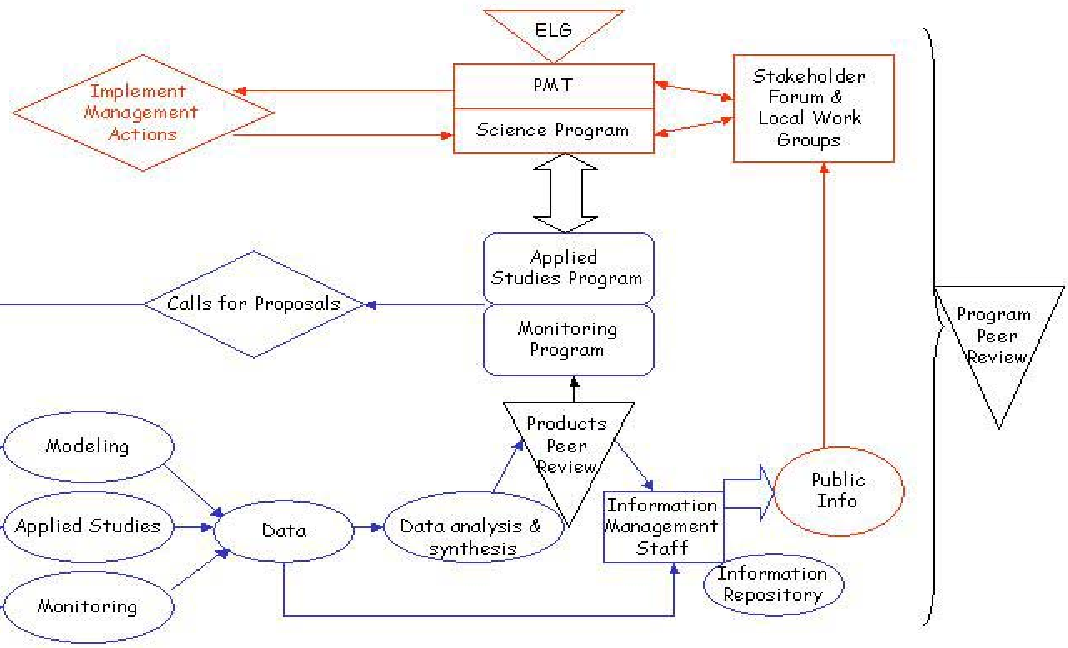
Stakeholders. The Project managers expect Local Work Groups to meet more frequently than the full Forum during the year to talk with the PMT about local Project activities.

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



REFERENCES CITED

Callaway, J. C., G. Sullivan, J. S. Desmond, G. D. Williams, and J. B. Zedler. 2001. Assessment and monitoring. Pages 271-335 *in* J. B. Zedler (ed.). Handbook for Restoring Tidal Wetlands. *CRC Press*. Boca Raton, Florida.

Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68-79.

Collins, J.N. and R.M. Grossinger. 2004. Synthesis of Scientific Knowledge Concerning Estuarine Landscapes and Related Habitats of the South Bay Ecosystem. Technical report of the South Bay Salt Pond Restoration Project. San Francisco Estuary Institute, Oakland, CA. [online] URL: http://www.southbayrestoration.org/Science.html

Comprehensive Everglades Restoration Plan (CERP). 2004. Development of the CERP Monitoring Plan and Adaptive Management Program. CERP Monitoring and Assessment Plan, Part 1. [online] URL: www.evergladesplan.org/pm/recover/ recover_docs/map/MAP_2.0_Develop.pdf

Davis, J. 2005. Draft Science Synthesis Summary for Issue 7: Predicting Pollutant Effects on the Biological Functioning of the South Bay. Technical report of the South Bay Salt Pond Restoration Project. San Francisco Estuary Institute, Oakland, CA. [online] URL: http://www.southbayrestoration.org/Science.html

Flanigan, F. H. 2004. Science Communication and Outreach in the Chesapeake Bay Watershed. Alliance for the Chesapeake Bay. Presentation at First National Conference on Ecosystem Restoration. December 6-10, 2004. Orlando, Florida.

Glen Canyon Dam Adaptive Management Program. Strategic Plan. 2001. New Final Draft Strategic Plan. [online] URL: www.usbr.gov/uc/envprog/amp/pdfs/sp_final.pdf

Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U. S. Environmental Protection Agency, San Francisco, Calif., and San Francisco Bay Regional Water Quality Control Board, Oakland, CA. 209 pp. and appendices.

Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life Histories and Environmental Requirements of Key Plants, Fish, and Wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P. R. Olofson, ed. San Francisco Bay Regional Water Quality Control Board, Oakland, CA. 407 pp.

Gunderson, L., C.S. Holling, and S. S. Light. 1995. Barriers and Bridges to Renewal of Ecosystems and Institutions. Columbia University Press, New York, New York, USA.

Holling, C.S. 1978. Adaptive Environmental Assessment and Management. John Wiley and Sons. London, United Kingdom.

Jacobson, C. 2003. Introduction to Adaptive Management. PhD dissertation. (Online) URL: http://student.lincoln.ac.nz/am-links/am-intro.html

Josselyn, M. 1983. The Ecology of San Francisco Tidal Marshes: A Community Profile. U.S. Fish and Wildlife Service FWS/OBS-83/23. 102 pp.

Life Science Inc. 2003a. South Bay Salt Ponds Initial Stewardship Plan, June 2003. Woodland, CA. 251 pp. [online] URL: http://www.southbayrestoration.org/Documents.html

Life Science Inc. 2003b. South Bay Salt Ponds Initial Stewardship Plan - Environmental impact report/environmental impact statement, December 2003. Woodland, CA. 437 pp. http://www.southbayrestoration.org/Documents.html

Light, S.S. and K. Blann. 2001. Adaptive Management and the Kissimmee River Restoration Project (unpublished manuscript). Implications of Kissimee River Restoration. Unpublished manuscript prepared for the Committee on Restoration of the Greater Everglades Ecosystem. [online] URL:www.adaptivemanagement.net/abstracts.htm

National Research Council. 1992. Restoration of Aquatic Ecosystems. National Academies Press, Washington, DC. 552 pp.

National Research Council. 2003. Adaptive Monitoring and Assessment for the Comprehensive Everglades Restoration Plan. National Academies Press, Washington, DC. 111 pp.

National Science Panel. 2005. South Bay Salt Ponds Charette: A National Science Panel Report. South Bay Salt Pond Restoration Project Meeting, February 27-28, 2005. 30 pp.

Neuman, K.K. 2005. Western Snowy Plover. Unpublished Report to the State Coastal Conservancy, Oakland, California.

Orr, M., S. Crooks, and P. B. Williams. 2003. Will Restored Tidal Marshes Be Sustainable? *San Francisco Estuary and Watershed Science* 1(1) Art. 5. [online] URL: www.doaj.org/openurl?genre=journal&issn=15462366&volume=1&issue=1&date=2003

Parson, E. A., and W. C. Clark. 1995. Sustainable development as social learning: theoretical perspectives and practical challenges for the design of a research program. Pages 428-460 *in* L. H. Gunderson, C. S. Holling, and S. S. Light, editors. *Barriers and bridges to the renewal of ecosystems and institutions.* Columbia University Press, New York, New York, USA.

Philip Williams & Associates, Ltd. (PWA), and P. M. Faber. 2004. *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay*. The Bay Institute and California State Coastal Conservancy, Oakland, CA. 83 pp. San Francisco Estuary Institute. 1998. The San Francisco Bay Area EcoAtlas. Oakland, CA. [online] URL: http://www.sfei.org/ecoatlas/index.html

Schoellhamer, D., J. Lacy, N. Ganju, G. Shellenbarger, and M. Lionberger. 2005. Draft Science Synthesis for Issue 2. Sediment Management: Creating Desired Habitat while Preserving Existing Habitat. Technical Report of the South Bay Salt Pond Restoration Project. State Coastal Conservancy, Oakland, California. [online] URL: http://www.southbayrestoration.org/Science.html

Siegel, S. W., and P. A. M. Bachand. 2002. Feasibility Analysis of South Bay Salt Pond Restoration, San Francisco Estuary, California. Wetlands and Water Resources, San Rafael, CA. 228 pp.

Society of Wetland Scientists. 2003. Position Paper on Performance Standards for Wetland Restoration and Creation. Wetland Concerns Committee, Society of Wetland Scientists. [online] URL: http://www.sws.org/wetlandconcerns/Performance.html. Retrieved on March 6, 2003.

South Bay Salt Pond Restoration Project EIS/R. 2007. Prepared by EDAW, Philip Williams and Associates, Ltd., H.T. Harvey and Associates, Brown and Caldwell, and Geomatrix. Submitted to U.S. Fish and Wildlife Service and California Department of Fish and Game.

Taylor, B., L. Kremsater and R. Ellis. 1997. Adaptive Management of Forests in British Columbia. BC Ministry of Forests, Forest Practices Branch, Victoria BC.

Trivedi, D. 2005. Science Synthesis for Key Science Issue 10: Minimizing The Negative Ecosystem Effects of Infrastructure Related Effects. Technical Report of the South Bay Salt Pond Restoration Project. State Coastal Conservancy, Oakland, California. [online] URL: http://www.southbayrestoration.org/Science.html

Trulio, L.A. 2005. *Science Synthesis for Issue 9*: Understanding the Effects of Public Access and Recreation on Wildlife and their Habitats in the Restoration Project Area. Technical Report of the South Bay Salt Pond Restoration Project. State Coastal Conservancy, Oakland, California. [online] URL: http://www.southbayrestoration.org/Science.html

Trulio, L. A., J. C. Callaway, E. S. Gross, J. R. Lacy, F. H. Nichols, and J. Y. Takekawa. 2004. *South Bay Salt Pond Restoration Project Conceptual Models*. Unpublished Report to the State Coastal Conservancy, Oakland, California. 96 pp.

Van Cleve, F. Brie, C. Simenstad, F. Goetz, and T. Mumford. 2003. Application of "Best Available Science" in Ecosystem Restoration: Lessons Learned From Large-Scale Restoration

Efforts in the U.S. Puget Sound Nearshore Ecosystem Restoration Project, Nearshore Science Team. [online] URL: sal.ocean.washington.edu/ nst/public/products/Lessons_Learned.htm

Walters, C. 1997. Challenges in Adaptive Management of Riparian and Coastal Ecosystems. *Conservation Ecology* 1(2):1. [online] URL: http://www.consecol.org/vol1/iss2/art1/

Walters, C. and C.S. Holling. 1990. Large-Scale Management Experiments and Learning by Doing. *Ecology* 71:2060-2068.

Warnock, N. 2005. Synthesis of Scientific Knowledge for Managing Salt Ponds to Protect Bird Populations. Technical Report of the South Bay Salt Pond Restoration Project. State Coastal Conservancy, Oakland, California. [online] URL: http://www.southbayrestoration.org/Science.html

Warnock, N., G. W. Page, T. D. Ruhlen, N. Nur, J. Y. Takekawa, and J. T. Hanson. 2002. Management and Conservation of San Francisco Bay Salt Ponds: Effects of Pond Salinity, Area, Tide, and Season on Pacific Flyway Waterbirds. *Waterbirds* 25: 79-92.

Woodward, F.I. 1994. How Many Species are Required for a Functional Ecosystem? Pg. 271-292. In Schulze, E.-D. and H.A. Mooney, eds. Biodiversity and Ecosystem Function. Springer-Verlag, New York, New York.

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.

Citations

Bollman, F. H., and P. K. Thelin. 1970. Bimonthly bird counts at selected observation points around San Francisco Bay, February 1964 to January 1966. Calif. Fish and Game 56:224-239.

Harvey, T. E., Miller, K. J., Hothem, R. L., Rauzon, M. J., Page, G. W., and Keck, R. A. 1992. Status and trends report on wildlife of the San Francisco Bay Estuary. Prepared by the U.S. Fish and Wildlife Service for the San Francisco Estuary Project. U.S. Environmental Protection Agency, San Francisco, California.

Page, G. W., L. E. Stenzel and W. D. Shuford. 1991. Distribution and abundance of the Snowy Plover on its western North American breeding grounds. Journal of Field Ornithology 62: 245-255.

Stenzel, L. E. and G. W. Page. 1988. Results of the first comprehensive shorebird census of San Francisco and San Pablo bays. Wader Study Group Bulletin 54: 43-48.
Stralberg, D., N. Warnock, N. Nur, H. Spautz and G.W. Page. 2003. Predicting the effects of habitat change on South San Francisco Bay bird communities: an analysis of bird-habitat relationships and evaluation of potential restoration scenarios (Contract # 02-009, Title: Habitat Conversion Model). Final report, California Coastal Conservancy, Oakland, CA
Strong, C. M., L. Spear, T. Ryan, and R. Dakin. 2004. Forster's Tern, Caspian Tern, and California Gull colonies in San Francisco Bay: habitat use, numbers and trends, 1982-2003. Waterbirds 27: 411-423.
Takekawa, J. Y. , G. W. Page, J. M. Alexander, and D. R. Becker. 2000. Waterfowl and shorebirds of the San Francisco Bay estuary. Pages 309-316 *in* Goals project 2000. Baylands ecosystem species and community profiles: life histories and environmental requirements of key plants, fish and wildlife (P. Olofson, Ed.). Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, California.
Warnock, N. 2005. Synthesis of Scientific Knowledge for Managing Salt Ponds to Protect Bird Populations. Technical Report of the South Bay Salt Pond Restoration Project. State Coastal Conservancy, Oakland, California. [online] URL: http://www.southbayrestoration.org/Science.html

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.

Citations
Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif.

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).

Citations

Beutel, M., and K. Abu-Saba. South Bay Salt Ponds Restoration Project: Mercury Technical Memorandum. Brown and Caldwell / Larry Walker and Associates. Report prepared for the South Bay Salt Ponds Restoration Project Management Team.

Coates, R., M. Swanson and P. Williams. 1989. Hydrologic analysis for coastal wetland restoration. Environ. Manage. 13(6):715-727.

Collins, L.M., J.N. Collins, and L.B. Leopold. 1987. Geomorphic processes of an estuarine tidal marsh: preliminary results and hypotheses. In: International Geomorphology 1986 Part I. V. Gardner (ed.). John Wiley and Sons, LTD.

Collins, J.N. and R. Grossinger. 2005. Syntheses of scientific knowledge for maintaining and improving functioning of the South Bay ecosystem and restoring tidal salt marsh and associated habitats over the next 50 years at pond and pond-complex scales. Report to the South Bay Salt Pond Restoration Project.

Dedrick, K.G. 1979. Effects of levees on tidal currents in marshland creeks. Abstracts of the G.K. Gilbert Symposium: San Francisco Bay its past, present, and future. Annual meeting of the Geological Society of America, 1979, San Jose, CA.

Dedrick. K.G. and L.T. Chu. 1993. Historical atlas of tidal creeks San Francisco Bay, California. Proceedings of the eighth symposium on coastal and ocean management (Coastal Zone 93). American Society of Engineers, New York, NY.

Dyer, K.R., 1995. Sediment transport processes in estuaries, in G.M.E. Perillo (ed). Geomorphology and Sedimentology of Estuaries. Developments in Sedimentology 53, Elsevier.

Goals Project. 1999. Baylands ecosystem habitat goals, A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, CA.

Leopold, L. B., J. N. Collins, and L. M. Collins. 1993. Hydrology of some tidal channels in estuarine marshlands near San Francisco, Catena, 20, 469–493.

NRC (National Research Council). 2000. Toxicological Effects of Methylmercury. National Academies Press, Washington DC.

Wiener, J.G., D.P. Krabbenhoft, G.H. Heinz, and A.M. Scheuhammer. 2003. Ecotoxicology of mercury. *In* Handbook of Ecotoxicology, 2nd edition. D.J. Hoffman, B.A. Rattner, G.A. Burton, and J. Cairns, eds. Boca Raton, CRC Press, pp. 409-463.

Williams, P.B. and M.K. Orr. 2002. Physical evolution of restored breached levee salt marshes in the San Francisco Bay Estuary. Restoration Ecology 10(3):527-542.

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.

Citations

Beutel, M., and K. Abu-Saba. South Bay Salt Ponds Restoration Project: Mercury Technical Memorandum. Brown and Caldwell / Larry Walker and Associates. Report prepared for the South Bay Salt Ponds Restoration Project Management Team. 47 pp.

Conaway, C.H., Watson, E.B., Flanders, J.R., and Flegal, A.R., 2004, Mercury deposition in a tidal marsh of south San Francisco Bay downstream of the historic New Almaden mining district, California: Marine Chemistry, v. 90, p. 175–184.

Marvin-DiPasquale, M., and J.L. Agee. 2003. Microbial mercury cycling in sediments of the San Francisco Bay-Delta. Estuaries 26:1517-1528.

Marvin-DiPasquale, M., J. Agee, C. McGowan, R.S. Oremland, M. Thomas, D. Krabbenhoft, and C. Gilmour. 2000. Methyl-mercury degradation pathways: a comparison among three mercury-impacted ecosystems. Environmental Science and Technology 34:4908-4916.

NRC (National Research Council). 2000. Toxicological Effects of Methylmercury. National Academies Press, Washington DC.

SFEI. 2005. The Pulse of the Estuary 2005. San Francisco Estuary Institute, Oakland, California.

Wiener, J.G., D.P. Krabbenhoft, G.H. Heinz, and A.M. Scheuhammer. 2003. Ecotoxicology of mercury. *In* Handbook of Ecotoxicology, 2nd edition. D.J. Hoffman, B.A. Rattner, G.A. Burton, and J. Cairns, eds. Boca Raton, CRC Press, pp. 409-463.

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?

Cheryl Strong, San Francisco Bay Bird Observatory
Josh Ackerman, U. S. Geological Survey Davis Field Station
Steve Rottenborn, H.T. Harvey and Associates

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.

California Gull foraging and breeding dynamics in the South Bay

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). This study is in progress through SFBBO and USGS.

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.

Literature Cited

Ackerman, J. T., J. Adams, J. Y. Takekawa, H. R. Carter, D. L. Whitworth, S. H. Newman, R. T. Golightly, and D. L. Orthmeyer. 2004. Effects of radio transmitters on the reproductive performance of Cassin's auklets. Wildlife Society Bulletin 32: 1229-1241.

elant, J. L., T. W. Seamens, S. W. Gabrey, and S. K. Ickes. 1993. Importance of landfills to nesting herring gulls. Condor 95:817-830.

Dill, H. H., and W. H. Thornsberry. 1950. A cannon projected net trap for capturing waterfowl. Journal of Wildlife Management 14:132-137.

Duhem, C., E. Vidal, P. Roche, and J. Legrand. 2005. How is the diet of yellow-legged gull chicks influenced by parents' accessibility to landfills? Waterbirds 28:46-52.

ESRI. 1996. ArcView GIS: Using ArcView GIS. Environmental Systems Research Institute, Inc., Redlands, CA, USA.

Gilmer, D. S., M. R. Miller, R. D. Bauer, and J. R. LeDonne. 1982. California's Central Valley wintering waterfowl: concerns and challenges. Transactions of the North American Wildlife and Natural Resources Conference 47:441-452.

Hebert, C. E., J. L. Shutt, K. A. Hobson, and D. V. C. Weseloh. 1999. Spatial and temporal differences in the diet of Great Lakes herring gulls (*Larus argentatus*): evidence from stable isotope analysis. Canadian Journal of Fish and Aquatic Science 56:323-338.

Josselyn, M. A. Hatch, C. Strong, and F. Nichols. 2005. Science Synthesis for Issue 8: Impact of Invasive Species and other Nuisance Species. Report to the South Bay Salt Pond Restoration Project, State Coastal Conservancy, Oakland, CA. URL: www.southbayrestoration.org/Science.html

MacWhirter, R. B., and K. L. Bildstein. 1996. Northern Harrier (Circus cyaneus). In The Birds of North America, No. 210 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Page, G. W., J. S. Warriner, J. C. Warriner, and P. W. C. Paton. 1995. Snowy Plover (*Charadrius alexandrinus*). *In* The Birds of North America, No. 154 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Strong, C. M., L. B. Spear, T. P. Ryan, and R. E. Dakin. 2004. Forster's Tern, Caspian Tern, and California Gull colonies in the San Francisco Bay: habitat use, numbers and trends, 1982-2003. Waterbirds 27:411-423.

Takekawa, J. Y., A. K. Miles, D. H. Schoellhamer, G. Martinelli, M. K. Saiki, and W. G. Duffy. 2001a. Science support for wetland restoration in the Napa-Sonoma salt ponds, San Francisco Bay estuary, 2000 progress report. Unpubl. Prog. Rep. USGS, Davis and Vallejo, CA. 66pp.

Takekawa, J. Y., C. T. Lu, and R. T. Pratt. 2001b. Avian communities in baylands and artificial salt evaporation ponds of the San Francisco Bay estuary. Hydrobiologia 466: 317-328.

Takekawa, J. Y., N. Warnock, G. Martinelli, A. K. Miles, and D. Tsao. 2002. Waterbird use of bayland wetlands in the San Francisco Bay estuary: movements of long-billed dowitchers during the winter. Waterbirds 25: 93-105.

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.

<u>1. 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.

Citations

Burger, J. 1981. The effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Burger, J. and M. Gochfeld. 1993. Tourism and short-term behavioral responses of nesting masked, red-footed and blue-footed boobies in the Galapagos. Environmental Conservation 20:255-259.

Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68-79.

Farallones Marine Sanctuary Association. 2000. SEALS Program Annual Report: 1999. San Francisco: National Oceanic and Atmospheric Administration.

Kaiser, M.S. and E.K. Fritzell. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management 48:561-567.

Keller, V.E. 1991. Effects of human disturbance on eider ducklings Somateria mollissima in an estuarine habitat in Scotland. Biological Conservation 58: 213-228.

Mikola, J., M. Miettinen, E. Lehikoinen and K. Lehtila. 1994. The effects of disturbance caused by boating on survival and behavior of velvet scoter *Melanitta fusca* ducklings. Biological Conservation 67: 119-124.

Rodgers, J.A., Jr. and H.T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin 25:139-145.

Rodgers, J. A., and H. T. Smith. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9:89-99.

Rodgers, J.A., Jr. and S.T. Schwikert. 2002. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. Conservation Biology 16:216-224.

Rodgers, J.A., Jr. and S.T. Schwikert. 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. Waterbirds 26:437-443.

Suryan, R.M., and J.T. Harvey. 1999. Variability in reactions of Pacific harbor seals, *Phoca vitulina richardsi*, to disturbance. Fishery Bulletin 97:332-9.

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.

Citations

Burger, J. and M. Gochfeld. 1991. Human activity influence and diurnal and nocturnal foraging of sanderlings (*Calidris alba*). Condor 93:259-265.

Burger, J. and M. Gochfeld. 1993. Tourism and short-term behavioral responses of nesting masked, red-footed and blue-footed boobies in the Galapagos. Environmental Conservation 20:255-259.

Carney, K.M., Sydeman, W.J., 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22, 68-79.

DeLong, A.K., 2002. Managing visitor use and disturbance in waterbirds—a literature review of impacts and mitigation measures. Prepared for Stillwater National Wildlife Refuge. Appendix L (114 pp.) *in* Stillwater National Wildlife Refuge Complex Final Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision (Vol. II). Dept. of the Interior, U.S. Fish and Wildlife Service, Region 1, Portland, OR.

Gill, J.A., Norris, K., Sutherland, W.J., 2001. The effects of disturbance on habitat use by black-tailed godwits, *Limosa limosa*. Journal of Applied Ecology 38, 846-856.

Ikuta, L.A., Blumstein, D. T., 2003. Do fences protect birds from human disturbance? Biological Conservation 112, 447-452.

Josselyn, M., Martindale, M., Duffield, J., 1989. Public access and wetlands: impacts of recreational use. Technical Report #9. Romberg Tiburon Center, Tiburon, California.

Klein, M.L., Humphrey, S.R., Percival, H.F., 1995. Effects of ecotourism on distribution of waterbirds in a wildlife refuge. Conservation Biology 9, 1454-1465.

Pease, M.L., Rose, R.K., Butler, M.M., 2005. Effects of human disturbances on the behavior of wintering ducks. Wildlife Society Bulletin 33, 103-112.

Rodgers, J.A., Jr., Schwikert, S.T., 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. Waterbirds 26, 437-443.

Thomas, K., Kvitek, R.G., Bretz, C., 2003. Effects of human activity on the foraging behavior of sanderlings, *Calidris alba*. Biological Conservation 109, 67-71.

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.

Citations

California Department of Parks and Recreation. 2002. California Outdoor Recreation Plan. 78 pp. The Resources Agency, Sacramento, CA. Retrieved from the internet on September 4, 2004. http://www.parks.ca.gov/default.asp?page_id=796

Trulio, L.A. 2005. Science Synthesis for Issue 9: Understanding the Effects of Public Access and Recreation on Wildlife and their Habitats in the Restoration Project Area. Report to the South Bay Salt Pond Restoration Project, State Coastal Conservancy, Oakland, CA. URL: **www.southbayrestoration.org/Science.html**

U.S. Department of the Interior, Fish and Wildlife Service and U.S Department of Commerce, U.S. Census Bureau. 2003. 2001 National Survey of Fishing, Hunting and Wildlife-associated Recreation: California (revised). 86 pp. Retrieved from the internet on September 4, 2004. http://www.census.gov/prod/www/abs/fishing.html .

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

---

[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

---

[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

---

[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

---

[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.

[20] Slocombe, D. Scott (1993). "Environmental Planning, Ecosystem Science, and Ecosystem Approaches for Integrating Environment and Development," Environmental Management 17(3): 289-303.

[21] Miller, James R. and Richard J. Hobbs (2002). "Conservation Where People Live and Work," Conservation Biology 16(2): 330-337; quote on p. 330.

[22] Meyer, William B. and B. L. Turner II (1992). "Human Population Growth and Global Land-Use/Cover Change," Annual Review of Ecology and Systematics 23: 39-61; quote on p. 39.

[23] Holdren, John P. (1991). "Population and the Energy Problem," Population and Environment 12(3): 231-255.

[24] Meyer, William B. and B. L. Turner II (1992). "Human Population Growth and Global Land-Use/Cover Change," Annual Review of Ecology and Systematics 23: 39-61; quote on p. 39.

[25] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269; quote on p. 261.

[26] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269; quote on p. 266.

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

[27] Drake, John M. and Reuben P. Keller (2004). "Environmental Justice Alert: Do Developing Nations Bear the Burden of Risk for Invasive Species?," BioScience 54(8): 718-719.

[28] Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, Jianchu Xu (2001). "The causes of land-use and land-cover change: moving beyond the myths," Global Environmental Change 11: 261–269.

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.

References

Cloern, J.E., 2006, "Surprising Trends of Phytoplankton Increase in South San Francisco Bay," presentation at the *South Bay Science Symposium*, June 6, 2006, San Jose, CA.

Fram, J.P., Martin, M.and Stacey, M. T. "Dispersive fluxes between the coastal ocean and a semi-enclosed estuarine basin," accepted for publication in *Journal of Physical Oceanography*, 2006

Fringer, O.B., Gerritsen, M. and Street, R.L. 2006. "An unstructured-grid, finite-volume, nonhydrostatic, parallel coastal-ocean simulator", *Ocean Modelling*, v.14 (3-4), pp. 139-173.

Marvin-DiPasquale, M.C., Agee, J.L., McGowan, C., Oremland, R.S., Thomas, M., Krabbenhoft, D. and Gilmour, C.C. 2000. "Methyl-mercury degradation pathways: A comparison among three mercury-impacted ecosystems," *Env. Sci. & Tech.*, v.34(23), pp.4908-4916.

Marvin-DiPasquale, M.C., Agee, J.L., Bouse, R.M. and Jaffe, B.E. 2003. "Microbial cycling of mercury in contaminated pelagic and wetland sediments of San Pablo Bay, California," *Environmental Geology*, v.43(3), pp.260-267.

Ralston, D.K. and Stacey, M.T. 2006. "Tidal and meteorological forcing of sediment transport in tributary mudflat channels (San Francisco Bay, CA)," accepted for publication in *Continental Shelf Research*.

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.

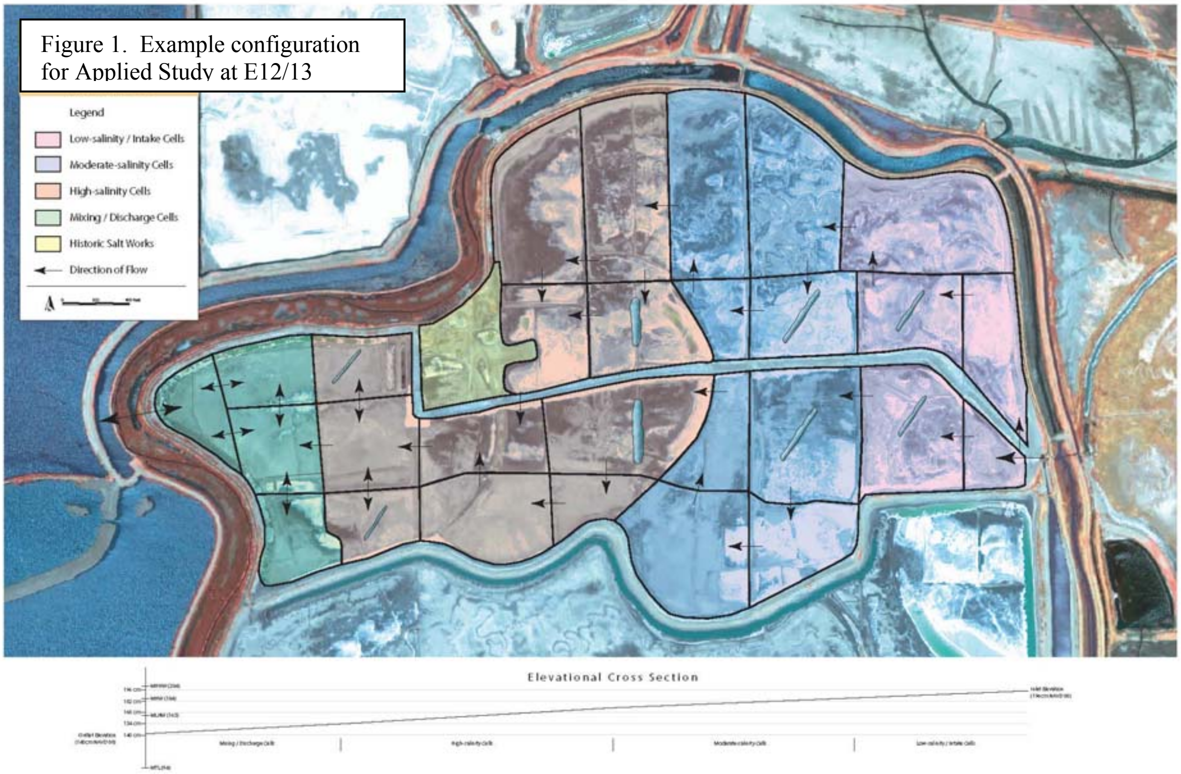


Figure 1. Example configuration for Applied Study at E12/13

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.

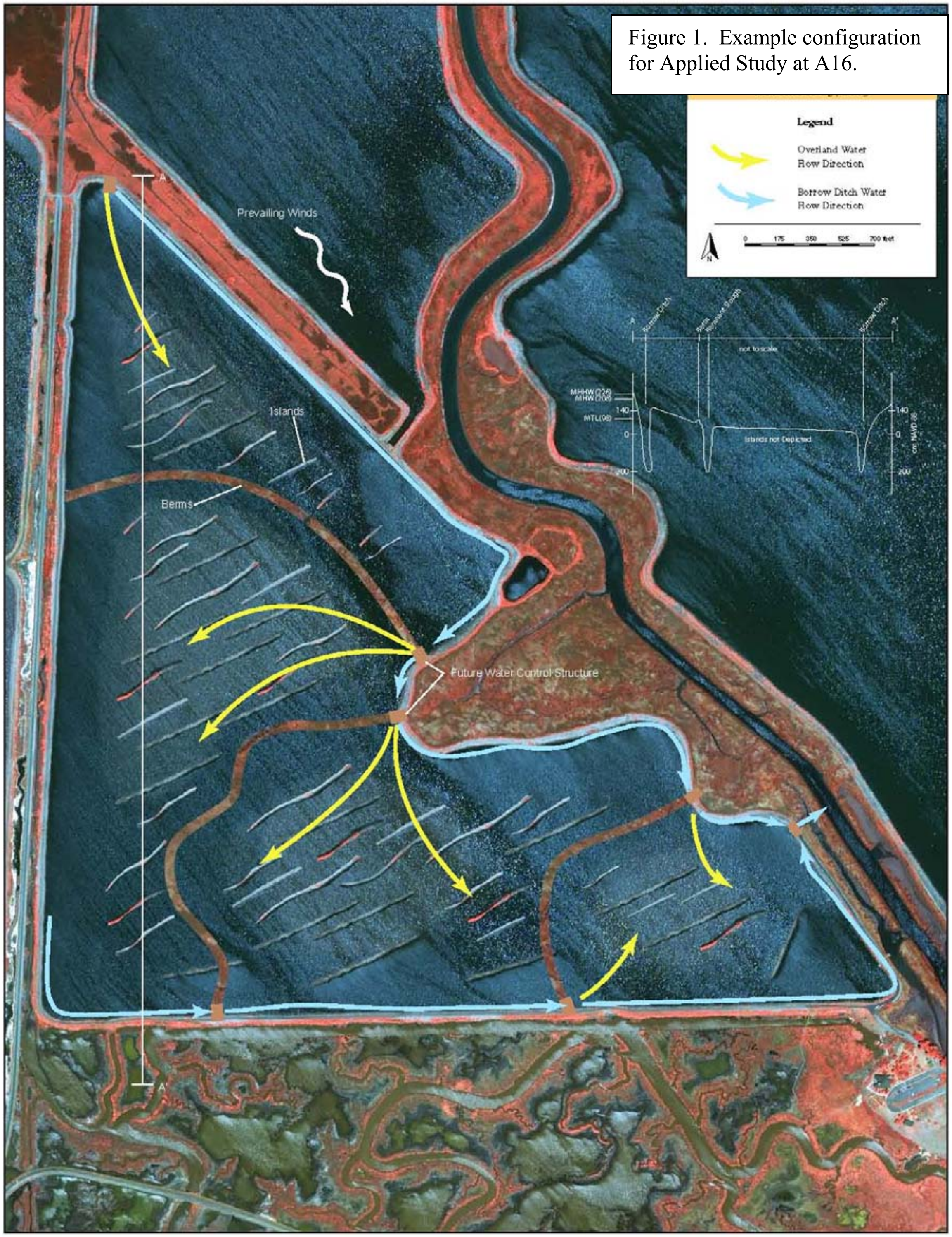


Figure 1. Example configuration for Applied Study at A16.

Appendix D.
U.S. Fish and Wildlife Service
Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL, SUITE 8-300
SACRAMENTO, CA 95814
PHONE: (916)930-5603 FAX: (916)930-5654
URL: kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0086 January 26, 2017
Event Code: 08FBDT00-2017-E-00152
Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at:
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm;
http://www.towerkill.com; and
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

Expect additional Species list documents from the following office(s):

Sacramento Fish and Wildlife Office
FEDERAL BUILDING
2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
(916) 414-6600

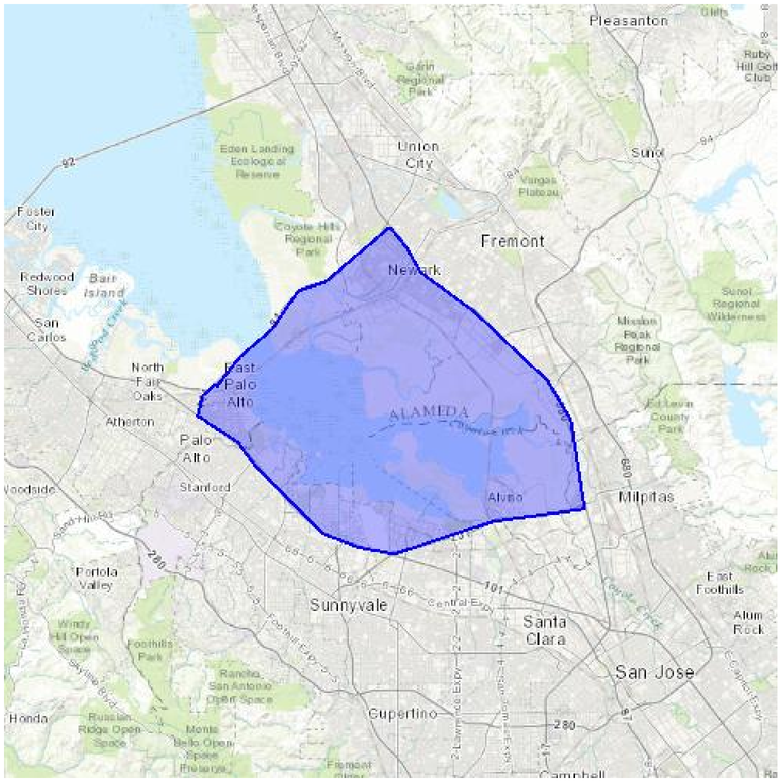
Consultation Code: 08FBDT00-2017-SLI-0086
Event Code: 08FBDT00-2017-E-00152

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso
Project Description: The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill, Inc. in 2003. Project Website is here: http://www.southbayrestoration.org/. Location of the project is South San Francisco Bay. Draft EIR/S can be found here http://www.southbayrestoration.org/planning/phase2/.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: Alameda, CA | San Mateo, CA | Santa Clara, CA

Endangered Species Act Species List

There are a total of 21 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	Status	Has Critical Habitat	Condition(s)
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Threatened	Final designated	
Yellow-Billed Cuckoo *(Coccyzus*	Threatened	Proposed	

americanus) Population: Western U.S. DPS			
Crustaceans			
Conservancy fairy shrimp *(Branchinecta conservatio)* Population: Wherever found	Endangered	Final designated	
Vernal Pool fairy shrimp *(Branchinecta lynchi)* Population: Wherever found	Threatened	Final designated	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened	Final designated	
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Endangered	Final designated	
Fountain thistle *(Cirsium fontinale var. fontinale)*	Endangered		

Population: Wherever found			
Robust spineflower *(Chorizanthe robusta var. robusta)* Population: Wherever found	Endangered	Final designated	
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		
San Joaquin Kit fox *(Vulpes macrotis mutica)* Population: wherever found	Endangered		
Reptiles			
Alameda whipsnake *(Masticophis lateralis euryxanthus)* Population: Wherever found	Threatened	Final designated	
San Francisco Garter snake *(Thamnophis sirtalis tetrataenia)* Population: Wherever found	Endangered		

Critical habitats that lie within your project area

The following critical habitats lie fully or partially within your project area.

Birds	Critical Habitat Type
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Final designated
Crustaceans	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Final designated
Fishes	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Final designated
Flowering Plants	
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Final designated

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
FEDERAL BUILDING, 2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
PHONE: (916)414-6600 FAX: (916)414-6713

Consultation Code: 08ESMF00-2017-SLI-0921 January 26, 2017
Event Code: 08ESMF00-2017-E-02065
Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

Sacramento Fish and Wildlife Office
FEDERAL BUILDING
2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
(916) 414-6600

Expect additional Species list documents from the following office(s):

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

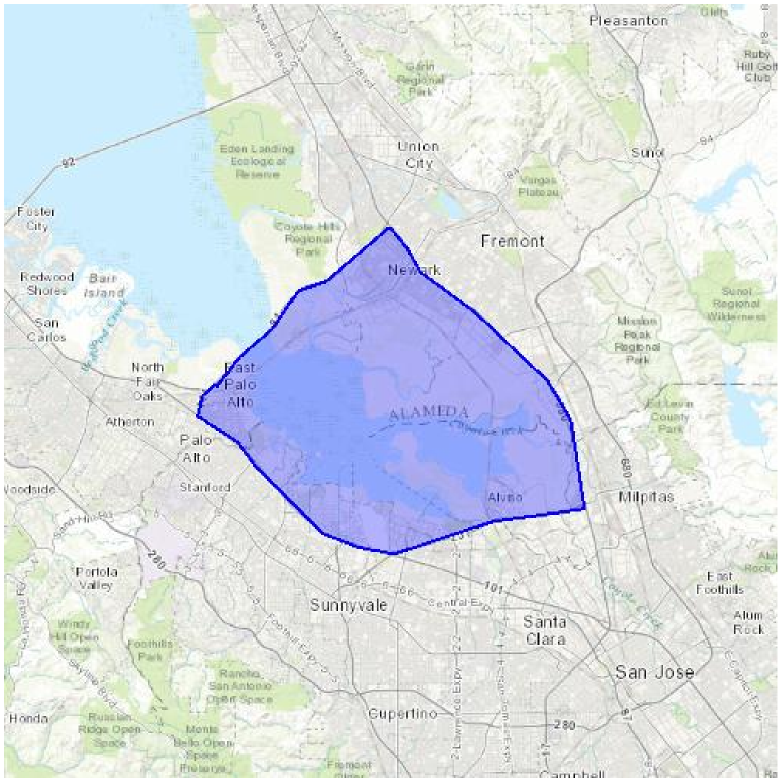
Consultation Code: 08ESMF00-2017-SLI-0921
Event Code: 08ESMF00-2017-E-02065

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Name: Phase 2 - South Bay Salt Ponds Restoration Project - Mountain View and Alviso
Project Description: The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill, Inc. in 2003. Project Website is here: http://www.southbayrestoration.org/. Location of the project is South San Francisco Bay. Draft EIR/S can be found here http://www.southbayrestoration.org/planning/phase2/.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: Alameda, CA | San Mateo, CA | Santa Clara, CA

Endangered Species Act Species List

There are a total of 25 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	**Status**	**Has Critical Habitat**	**Condition(s)**
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
Marbled murrelet *(Brachyramphus marmoratus)* Population: U.S.A. (CA, OR, WA)	Threatened	Final designated	
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-	Threatened	Final designated	

U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)			
Yellow-Billed Cuckoo *(Coccyzus americanus)* Population: Western U.S. DPS	Threatened	Proposed	
Crustaceans			
Conservancy fairy shrimp *(Branchinecta conservatio)* Population: Wherever found	Endangered	Final designated	
Vernal Pool fairy shrimp *(Branchinecta lynchi)* Population: Wherever found	Threatened	Final designated	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened	Final designated	
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Contra Costa goldfields *(Lasthenia conjugens)*	Endangered	Final designated	

Population: Wherever found			
Fountain thistle *(Cirsium fontinale var. fontinale)* Population: Wherever found	Endangered		
Marin dwarf-flax *(Hesperolinon congestum)* Population: Wherever found	Threatened		
Robust spineflower *(Chorizanthe robusta var. robusta)* Population: Wherever found	Endangered	Final designated	
San Mateo thornmint *(Acanthomintha obovata ssp. duttonii)* Population: Wherever found	Endangered		
Showy Indian clover *(Trifolium amoenum)* Population: Wherever found	Endangered		
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		
San Joaquin Kit fox *(Vulpes macrotis*	Endangered		

mutica) Population: wherever found			
Reptiles			
Alameda whipsnake *(Masticophis lateralis euryxanthus)* Population: Wherever found	Threatened	Final designated	
San Francisco Garter snake *(Thamnophis sirtalis tetrataenia)* Population: Wherever found	Endangered		

Critical habitats that lie within your project area

The following critical habitats lie fully or partially within your project area.

Birds	Critical Habitat Type
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Final designated
Crustaceans	
Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Final designated
Fishes	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Final designated
Flowering Plants	
Contra Costa goldfields *(Lasthenia conjugens)* Population: Wherever found	Final designated

Appendix E. California Natural Diversity Database - RareFind 5 Occurrence Record

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Milpitas (3712148) OR Mountain View (3712241) OR Newark (3712251) OR Niles (3712158) OR Palo Alto (3712242) OR Redwood Point (3712252))

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Acanthomintha duttonii San Mateo thorn-mint	G1 S1	Endangered Endangered	Rare Plant Rank - 1B.1 SB_UCBBG-UC Berkeley Botanical Garden	170 170	5 S:1	0	0	0	0	1	0	1	0	0	0	1
Accipiter cooperii Cooper's hawk	G5 S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	505 950	107 S:3	0	1	0	0	0	2	0	3	3	0	0
Agelaius tricolor tricolored blackbird	G2G3 S1S2	None Candidate Endangered	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_EN-Endangered NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	5 254	906 S:9	0	0	0	0	3	6	8	1	6	3	0
Allium peninsulare var. franciscanum Franciscan onion	G5T1 S1	None None	Rare Plant Rank - 1B.2	170 415	21 S:4	0	0	1	0	0	3	2	2	4	0	0
Ambystoma californiense California tiger salamander	G2G3 S2S3	Threatened Threatened	CDFW_WL-Watch List IUCN_VU-Vulnerable	10 1,280	1148 S:24	1	11	2	2	4	4	7	17	20	1	3
Aneides niger Santa Cruz black salamander	G3 S3	None None	CDFW_SSC-Species of Special Concern	340 340	77 S:1	0	0	0	0	0	1	1	0	1	0	0
Antrozous pallidus pallid bat	G5 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	30 420	406 S:4	0	0	0	0	0	4	4	0	4	0	0
Aquila chrysaetos golden eagle	G5 S3	None None	BLM_S-Sensitive CDF_S-Sensitive CDFW_FP-Fully Protected CDFW_WL-Watch List IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	2,200 2,200	312 S:1	0	1	0	0	0	0	1	0	1	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Ardea herodias great blue heron	G5 S4	None None	CDF_S-Sensitive IUCN_LC-Least Concern	1 215	138 S:4	2	1	1	0	0	0	1	3	4	0	0
Asio flammeus short-eared owl	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern		10 S:1	0	0	0	0	0	1	1	0	1	0	0
Astragalus tener var. tener alkali milk-vetch	G2T2 S2	None None	Rare Plant Rank - 1B.2	5 20	65 S:5	0	1	0	0	4	0	4	1	1	3	1
Athene cunicularia burrowing owl	G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	0 132	1923 S:55	3	13	8	15	10	6	11	44	45	8	2
Atriplex depressa brittlescale	G2 S2	None None	Rare Plant Rank - 1B.2	20 20	61 S:1	0	1	0	0	0	0	0	1	1	0	0
Atriplex minuscula lesser saltscale	G2 S2	None None	Rare Plant Rank - 1B.1	2 2	37 S:1	0	0	0	0	0	1	0	1	1	0	0
Bombus caliginosus obscure bumble bee	G4? S1S2	None None	IUCN_VU-Vulnerable	75 400	181 S:3	0	0	0	0	0	3	3	0	3	0	0
Bombus crotchii Crotch bumble bee	G3G4 S1S2	None None		100 100	233 S:2	0	0	0	0	0	2	2	0	2	0	0
Bombus occidentalis western bumble bee	G2G3 S1	None None	USFS_S-Sensitive XERCES_IM-Imperiled	10 400	282 S:8	0	0	0	0	0	8	8	0	8	0	0
Campanula exigua chaparral harebell	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	300 300	32 S:1	0	0	0	0	0	1	1	0	1	0	0
Centromadia parryi ssp. congdonii Congdon's tarplant	G3T2 S2	None None	Rare Plant Rank - 1B.1 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	2 290	93 S:15	0	4	6	2	2	1	2	13	13	1	1

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Charadrius alexandrinus nivosus western snowy plover	G3T3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	0 15	124 S:10	0	2	0	0	1	7	5	5	9	1	0
Chloropyron maritimum ssp. palustre Point Reyes salty bird's-beak	G4?T2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	1 5	68 S:5	0	0	0	0	5	0	5	0	0	4	1
Chorizanthe robusta var. robusta robust spineflower	G2T1 S1	Endangered None	Rare Plant Rank - 1B.1 BLM_S-Sensitive		20 S:1	0	0	0	0	1	0	1	0	0	1	0
Circus cyaneus northern harrier	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	5 10	48 S:6	0	1	0	0	0	5	5	1	6	0	0
Cirsium fontinale var. fontinale Crystal Springs fountain thistle	G2T1 S1	Endangered Endangered	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	150 440	5 S:2	0	0	2	0	0	0	0	2	2	0	0
Cirsium praeteriens lost thistle	GX SX	None None	Rare Plant Rank - 1A	50 50	1 S:1	0	0	0	0	1	0	1	0	0	1	0
Clarkia concinna ssp. automixa Santa Clara red ribbons	G5?T3 S3	None None	Rare Plant Rank - 4.3	300 300	20 S:1	0	0	0	0	0	1	1	0	1	0	0
Coccyzus americanus occidentalis western yellow-billed cuckoo	G5T2T3 S1	Threatened Endangered	BLM_S-Sensitive NABCI_RWL-Red Watch List USFS_S-Sensitive USFWS_BCC-Birds of Conservation Concern	20 20	155 S:1	0	0	0	0	1	0	1	0	0	0	1
Collinsia corymbosa round-headed Chinese-houses	G1 S1	None None	Rare Plant Rank - 1B.2		13 S:1	0	0	0	0	1	0	1	0	0	0	1
Collinsia multicolor San Francisco collinsia	G2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden	100 100	25 S:1	0	0	0	0	0	1	1	0	1	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Corynorhinus townsendii Townsend's big-eared bat	G3G4 S2	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	160 2,240	625 S:4	0	0	0	0	1	3	4	0	3	1	0
Danaus plexippus pop. 1 monarch - California overwintering population	G4T2T3 S2S3	None None	USFS_S-Sensitive	10 150	378 S:3	0	1	1	0	0	1	0	3	3	0	0
Dicamptodon ensatus California giant salamander	G3 S2S3	None None	CDFW_SSC-Species of Special Concern IUCN_NT-Near Threatened	380 380	228 S:1	0	0	0	0	0	1	1	0	1	0	0
Dipodomys venustus venustus Santa Cruz kangaroo rat	G4T1 S1	None None		5 600	14 S:3	0	0	0	0	0	3	3	0	3	0	0
Dirca occidentalis western leatherwood	G2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden	150 150	65 S:2	0	0	0	0	0	2	1	1	2	0	0
Egretta thula snowy egret	G5 S4	None None	IUCN_LC-Least Concern	10 10	17 S:1	0	0	0	0	0	1	0	1	1	0	0
Elanus leucurus white-tailed kite	G5 S3S4	None None	BLM_S-Sensitive CDFW_FP-Fully Protected IUCN_LC-Least Concern	5 10	162 S:8	0	1	0	0	0	7	7	1	8	0	0
Emys marmorata western pond turtle	G3G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable USFS_S-Sensitive	0 370	1209 S:8	0	4	0	1	0	3	2	6	8	0	0
Eryngium aristulatum var. hooveri Hoover's button-celery	G5T1 S1	None None	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	5 80	16 S:7	0	0	2	0	4	1	5	2	3	4	0
Eryngium jepsonii Jepson's coyote-thistle	G2 S2	None None	Rare Plant Rank - 1B.2	525 625	19 S:2	0	0	0	0	0	2	1	1	2	0	0
Euphydryas editha bayensis Bay checkerspot butterfly	G5T1 S1	Threatened None	XERCES_CI-Critically Imperiled	600 600	24 S:1	0	0	0	0	1	0	1	0	0	0	1

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Extriplex joaquinana San Joaquin spearscale	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	6 10	109 S:3	0	1	0	0	0	2	2	1	3	0	0
Fritillaria liliacea fragrant fritillary	G2 S2	None None	Rare Plant Rank - 1B.2 USFS_S-Sensitive		81 S:1	0	0	0	0	0	1	1	0	1	0	0
Geothlypis trichas sinuosa saltmarsh common yellowthroat	G5T3 S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	0 360	111 S:17	0	5	0	0	0	12	11	6	17	0	0
Hesperolinon congestum Marin western flax	G1 S1	Threatened Threatened	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	200 200	26 S:1	0	0	1	0	0	0	0	1	1	0	0
Lasiurus cinereus hoary bat	G5 S4	None None	IUCN_LC-Least Concern WBWG_M-Medium Priority		235 S:6	0	0	0	0	0	6	6	0	6	0	0
Lasthenia conjugens Contra Costa goldfields	G1 S1	Endangered None	Rare Plant Rank - 1B.1 SB_UCBBG-UC Berkeley Botanical Garden	10 10	33 S:3	0	2	0	0	1	0	1	2	2	0	1
Laterallus jamaicensis coturniculus California black rail	G3G4T1 S1	None Threatened	BLM_S-Sensitive CDFW_FP-Fully Protected IUCN_NT-Near Threatened NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	4 40	244 S:7	0	3	0	0	0	4	3	4	7	0	0
Lepidurus packardi vernal pool tadpole shrimp	G4 S3S4	Endangered None	IUCN_EN-Endangered	7 10	320 S:2	0	1	0	0	0	1	0	2	2	0	0
Malacothamnus arcuatus arcuate bush-mallow	G2Q S2	None None	Rare Plant Rank - 1B.2	5 360	30 S:4	0	0	0	1	0	3	2	2	4	0	0
Masticophis lateralis euryxanthus Alameda whipsnake	G4T2 S2	Threatened Threatened		1,160 1,745	158 S:2	1	1	0	0	0	0	0	2	2	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Melospiza melodia pusillula Alameda song sparrow	G5T2? S2S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	1 70	38 S:21	0	13	0	0	0	8	9	12	21	0	0
Monolopia gracilens woodland woollythreads	G3 S3	None None	Rare Plant Rank - 1B.2	400 600	57 S:2	0	0	0	0	0	2	2	0	2	0	0
Myotis yumanensis Yuma myotis	G5 S4	None None	BLM_S-Sensitive IUCN_LC-Least Concern WBWG_LM-Low-Medium Priority	870 870	262 S:1	0	1	0	0	0	0	0	1	1	0	0
Navarretia prostrata prostrate vernal pool navarretia	G2 S2	None None	Rare Plant Rank - 1B.1	10 10	60 S:2	0	2	0	0	0	0	0	2	2	0	0
Neotoma fuscipes annectens San Francisco dusky-footed woodrat	G5T2T3 S2S3	None None	CDFW_SSC-Species of Special Concern	215 262	16 S:3	0	1	2	0	0	0	0	3	3	0	0
Northern Coastal Salt Marsh Northern Coastal Salt Marsh	G3 S3.2	None None		10 15	53 S:7	0	1	0	0	0	6	7	0	7	0	0
Nycticorax nycticorax black-crowned night heron	G5 S4	None None	IUCN_LC-Least Concern	10 10	26 S:1	0	0	1	0	0	0	1	0	1	0	0
Oncorhynchus mykiss irideus steelhead - central California coast DPS	G5T2T3Q S2S3	Threatened None	AFS_TH-Threatened	200 200	39 S:1	0	0	0	0	0	1	0	1	1	0	0
Phalacrocorax auritus double-crested cormorant	G5 S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	1 30	38 S:2	1	0	0	0	0	1	1	1	2	0	0
Plagiobothrys chorisianus var. chorisianus Choris' popcornflower	G3T2Q S2	None None	Rare Plant Rank - 1B.2		40 S:1	0	0	0	0	0	1	1	0	1	0	0
Plagiobothrys glaber hairless popcornflower	GH SH	None None	Rare Plant Rank - 1A	15 15	9 S:1	0	0	0	0	0	1	1	0	0	1	0
Puccinellia simplex California alkali grass	G3 S2	None None	Rare Plant Rank - 1B.2	5 5	71 S:1	0	0	0	0	0	1	0	1	1	0	0
Rallus longirostris obsoletus California clapper rail	G5T1 S1	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	0 15	98 S:17	4	4	0	0	0	9	10	7	17	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Rana draytonii California red-legged frog	G2G3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable	45 1,190	1407 S:12	0	8	2	1	0	1	1	11	12	0	0
Reithrodontomys raviventris salt-marsh harvest mouse	G1G2 S1S2	Endangered Endangered	CDFW_FP-Fully Protected IUCN_EN-Endangered	0 5	144 S:44	3	9	3	1	1	27	40	4	43	0	1
Riparia riparia bank swallow	G5 S2	None Threatened	BLM_S-Sensitive IUCN_LC-Least Concern	10 10	297 S:1	0	0	0	0	0	1	1	0	1	0	0
Rynchops niger black skimmer	G5 S2	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern NABCI_YWL-Yellow Watch List USFWS_BCC-Birds of Conservation Concern	11 11	7 S:1	0	0	0	0	0	1	0	1	1	0	0
Senecio aphanactis chaparral ragwort	G3 S2	None None	Rare Plant Rank - 2B.2		47 S:1	0	0	0	0	0	1	1	0	1	0	0
Serpentine Bunchgrass Serpentine Bunchgrass	G2 S2.2	None None		5,800 5,800	22 S:1	0	0	0	0	0	1	1	0	1	0	0
Sorex vagrans halicoetes salt-marsh wandering shrew	G5T1 S1	None None	CDFW_SSC-Species of Special Concern	0 5	12 S:8	0	0	0	0	1	7	8	0	7	0	1
Spirinchus thaleichthys longfin smelt	G5 S1	Candidate Threatened	CDFW_SSC-Species of Special Concern	0 0	45 S:1	0	0	0	0	0	1	1	0	1	0	0
Sternula antillarum browni California least tern	G4T2T3Q S2	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	1 3	68 S:7	0	0	0	0	1	6	7	0	6	0	1
Streptanthus albidus ssp. peramoenus most beautiful jewelflower	G2T2 S2	None None	Rare Plant Rank - 1B.2 SB_RSABG-Rancho Santa Ana Botanic Garden USFS_S-Sensitive	400 2,400	96 S:2	0	0	0	0	0	2	2	0	2	0	0
Stuckenia filiformis ssp. alpina slender-leaved pondweed	G5T5 S3	None None	Rare Plant Rank - 2B.2	40 50	21 S:2	0	0	0	0	0	2	2	0	2	0	0
Suaeda californica California seablite	G1 S1	Endangered None	Rare Plant Rank - 1B.1	5 10	18 S:2	0	0	0	0	2	0	2	0	0	2	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Taxidea taxus American badger	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	70 200	523 S:2	0	0	0	0	0	2	2	0	2	0	0
Thamnophis sirtalis tetrataenia San Francisco gartersnake	G5T2Q S2	Endangered Endangered	CDFW_FP-Fully Protected	350 350	67 S:1	0	0	0	0	0	1	1	0	1	0	0
Trifolium amoenum two-fork clover	G1 S1	Endangered None	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden SB_USDA-US Dept of Agriculture		26 S:1	0	0	0	0	0	1	1	0	1	0	0
Trifolium hydrophilum saline clover	G2 S2	None None	Rare Plant Rank - 1B.2	5 10	49 S:4	0	0	0	0	0	4	2	2	4	0	0
Tryonia imitator mimic tryonia (=California brackishwater snail)	G2 S2	None None	IUCN_DD-Data Deficient	0 5	39 S:2	0	0	0	0	0	2	2	0	2	0	0
Valley Oak Woodland Valley Oak Woodland	G3 S2.1	None None		40 40	91 S:1	0	0	0	0	0	1	1	0	1	0	0

Appendix F.
Evaluation of Potential to Occur

Federally and State-Listed Plant Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS*	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Federal or State Threatened or Endangered Species			
San Mateo thorn-mint (*Acanthomintha duttonii*)	FE, SE, CRPR 1B	Chaparral, valley and foothill grassland, coastal scrub in relatively open areas. Only known to occur on very uncommon serpentinite vertisol clays. Elev. 50–200 meters(m).	**No potential to occur.** Only CNDDB occurrence within 5 miles is presumed extirpated. No appropriate habitat or suitable serpentinite substrate is present in the Phase 2 project area.
Robust spineflower (*Chorizanthe robusta* var. *robusta*)	FE, CRPR 1B	Cismontane woodland, coastal dunes, coastal scrub, growing on sandy terraces and bluffs or in loose sand. Elev. 3–120 m.	**No potential to occur.** Only CNDDB occurrence within 5 miles is a historical record from 1882. The Phase 2 project area does not include appropriate coastal habitat with sandy substrate.
Fountain thistle (*Cirsium fontinale* var. *fontinale*)	FE, SE, CRPR 1B	Valley and foothill grassland, chaparral, growing in serpentine seeps and grassland. Elev. 90–180 m.	**No potential to occur.** No serpentine seeps are present in the Phase 2 project area.
Marin dwarf-flax (*Hesperolinon congestum*)	FT, ST, CRPR 1B	Chaparral, valley and foothill grassland, growing in serpentine barrens and in serpentine grassland and chaparral. Elev. 30–365 m.	**No potential to occur.** No serpentine habitats are present in the Phase 2 project area.
Contra Costa goldfields (*Lasthenia conjugens)*	FE, CRPR 1B	Saline/alkaline vernal pools, mesic areas within grassland. Known from Alameda, Solano, Monterey, Contra Costa, and Napa Counties. Annual; blooms March through June. Elev. 4 – 180 m,	**No potential to occur.** Historically known from edges of salt ponds at the Bay shore near Mt. Eden and Newark. Occurs on the Warm Springs vernal pool unit of the Refuge (Fremont). No suitable habitat is present in the Phase 2 project area. Otherwise occurs in disjunct populations in Monterey and North Bay areas.

Federally and State-Listed Plant Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS*	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
California seablite (*Suaeda californica*)	FE, CRPR 1B	Sandy, high-energy shorelines within salt marsh. Relictual populations in South Bay considered extirpated; known from the San Francisco Bay and Morro Bay, San Luis Obispo county. Elev. 0 – 160 m.	**No potential to occur.** Suitable habitat occurs within Ravenswood pond complexes. However the species was last documented in the South Bay Salt Ponds Region in 1971 (Calflora 2016).

* Definitions:

FE – Federally Endangered

FT – Federally Threatened

SE – State Endangered (California)

ST – State Threatened (California)

Sources:

CNDDB 2013.

Nomenclature from Baldwin et al. 2012.

CRPR – California Rare Plant Rank CRPR 1A – Plants considered extinct.

CRPR 1B – Plants rare, threatened, or endangered in California and elsewhere.

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Threatened or Endangered Species			
Green sturgeon, Southern	FT, CSSC	Spends majority of life in near-shore oceanic	**Known to occur.** Spawns in Sacramento River, but

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
Distinct Population Segment (DPS) (*Acipenser medirostris*)		waters, bays, and estuaries; spawns in freshwater rivers.	not known to spawn in South Bay. Present in the South Bay; unlikely to be inside ponds.
Steelhead – California Central Coast DPS (*Oncorhynchus mykiss irideus*)	FT, CSSC	Cool streams with suitable spawning habitat and conditions allowing migration and marine habitats.	**Known to occur.** Known to be present in several South Bay creeks (including Coyote, Stevens, San Francisquito, and Alameda Creeks and the Guadalupe River) and associated slough channels within the project area. Suitable spawning habitat is not present in the project area, but this species moves through the area to spawn upstream.
Delta Smelt (*Hypomesus transpacificus*)	FT, SE	Occurs in the Sacramento-San Joaquin Delta. Seasonally in Suisun Bay, Carquinez Strait & San Pablo Bay. Seldom found at salinities > 10 ppt. Most often at salinities < 2ppt.	**No potential to occur.** The location of the Phase 2 project does not fall within the habitat for this species. Programmatic BA notes that this species exists in the region, but not in the project area.
Longfin smelt (*Spirinchus thaleichthys)*	FC, ST, CSSC	Spends the majority of life in San Francisco Bay, moving upstream to spawn in low-salinity waters in winter/spring.	**Known to occur**. Occurs year-round in San Francisco Bay and known to occur in the South Bay. Longfin smelt have been caught in Coyote Creek and Alviso Slough and could possibly be present in Pond A8 but have not yet been detected there. They are present throughout the Bay and presumed to spawn and rear in freshwater habitats.
California red-legged frog *(Rana draytonii*)	FT,CSSC	Lowlands & foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation.	**No potential to occur.** The location of the Phase 2 project does not fall within the habitat for this species. Programmatic BA notes that this species exists in the region, but not in the project area.
California tiger salamander (Central California population) (*Ambystoma*	FT, ST, WL	Vernal or temporary pools in annual grasslands, or open stages of woodlands.	**No potential to occur.** A population is present on Don Edwards Refuge lands in the Fremont/Warm Springs area, though not in the immediate SBSP pond complexes. The population is closest to the Island Ponds action area. However, a road as well as ponds A23 and A22, are movement barriers preventing any

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
californiense)			CTS individuals from entering the action area of the Islands Ponds.
Salt marsh harvest mouse (*Reithrodontomys r. raviventris*)	FE,SE, SFP	Salt marsh habitat dominated by pickleweed.	**Known to occur.** Resident in pickleweed marshes within the project area.
San Joaquin Kit fox *(Vulpes macrotis mutica)*	FE, ST	Annual grasslands or grassy open stages with scattered shrubby vegetation.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
Bald eagle (*Haliaeetus leucocephalus*)	Delisted, SE, SFP, BCC	Occurs mainly along seacoasts, rivers, and lakes; nests in tall trees or in cliffs. Feeds mostly on fish.	**Potential to occur.** Occasional visitor, primarily during winter, to the project area. May occasionally forage, but does not nest, in the project area.
California Ridgway's rail (*Rallus obsoletus obsoletus*)	FE, SE, SFP	Salt and brackish marsh habitat usually dominated by pickleweed and cordgrass.	**Known to occur.** Resident in many tidal marshes and sloughs in the project area. Large numbers are known to occur in tidal marsh habitats adjacent to Phase 2.
California least tern (*Sterna antillarum browni*)	FE, SE, SFP	Nests along the coast on bare or sparsely vegetated flat substrates.	**Known to occur.** The South Bay is an important post-breeding staging area for California least terns. Current Bay Area nesting sites include Alameda Point and Hayward Regional Shoreline. Has attempted to nest in small numbers at Eden Landing Pond E8A, but not in recent years. Forages and roosts in a number of South Bay ponds, especially Ponds A1 and A2W.
California brown pelican (*Pelecanus occidentalis californicus*)	SFP	Occurs in near-shore marine habitats and coastal bays. Nests on islands in Mexico and Southern California.	**Known to occur.** Regular in project area during nonbreeding season (summer and fall). Roosts on levees in the interiors of pond complexes; forages in ponds and Bay.
California black rail (*Laterallus jamaicensis coturniculus*)	ST, SFP	Breeds in fresh, brackish, and tidal salt marsh.	**Known to occur.** Non-breeding individuals winter in small numbers in tidal marsh within the project area. Have been observed in small numbers during breeding

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
			seasons around the Island Ponds and potentially breeding in small numbers.
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT, CSSC, BCC	Nests on sandy beaches and salt panne habitats, including dry ponds.	**Known to occur.** Resident in the project area. Greatest numbers at Eden Landing and Ravenswood pond complexes. Additional birds occur in the project area during winter.
Critical Habitat for Western Snowy Plover	Final Designated		**No potential to occur.** There is no Designated Critical Habitat within the Phase 2 Action Area.
Bank swallow (*Riparia riparia*)	ST	Colonial nester on vertical banks or cliffs with fine-textured soils near water.	**Potential to occur.** Observed in the project area as rare transient. No suitable breeding habitat in the project area.
Conservancy fairy shrimp *(Branchinecta conservatio)*	FE	Endemic to the grasslands of the northern two-thirds of the Central Valley; found in large, turbid pools.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
Vernal Pool tadpole shrimp *(Lepidurus packardi)*	FE	Inhabits vernal pools and swales in the Sacramento Valley containing clear to highly turbid water.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA. Suitable habitat for species is absent from the Action Area.
Bay Checkerspot butterfly *(Euphydryas editha bayensis)*	FT	Restricted to native grasslands on outcrops of serpentine soil in the vicinity of San Francisco Bay.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
San Bruno Elfin butterfly *(Callophrys mossii bayensis)*	FE	Coastal, mountainous areas with grassy ground cover, mainly in the vicinity of San Bruno Mountain, San Mateo County.	**No potential to occur.** The CNDDB shows no records of this species in Alameda and Santa Clara Counties. There is no habitat for this species within the Phase 2 project area.
Alameda whipsnake *(Masticophis lateralis euryxanthus)*	FT, ST	Typically found in chaparral and scrub habitats but will also use adjacent grassland, oak savanna and woodland habitats.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.

Federally and State-Listed Wildlife Species with Potential to Occur in the Phase 2 Action Area

NAME	STATUS	HABITAT/DESCRIPTION	POTENTIAL TO OCCUR
San Francisco garter snake *(Thamnophis sirtalis tetrataenia)*	FE, SE, SFP	Vicinity of freshwater marshes, ponds and slow-moving streams in San Mateo County & extreme northern Santa Cruz County.	**No potential to occur.** The location of the Phase 2 project does not fall within the species' range; also noted in the Programmatic BA.
State Fully Protected Species			
Golden eagle (*Aquila chrysaetos*)	SFP, WL, BCC	Breeds on cliffs or in large trees or electrical towers; forages in open areas.	**Potential to occur.** Occasional forager, primarily during the nonbreeding season. No nesting records within the project area.
Tricolored blackbird (*Agelaius tricolor*)	Provisional Listing, CDFW (nesting), CSSC, BCC	Breeds near freshwater in dense emergent vegetation.	**Potential to occur.** May breed in extensive freshwater marshes around the periphery of the project area, such as at Coyote Hills. Occurs elsewhere in the project area as a nonbreeding forager.
American peregrine falcon (*Falco peregrinus anatum*)	SFP, BCC	Forages in many habitats; nests on cliffs and similar human-made structures.	**Known to occur.** Regular forager (on other birds) in the project area, primarily during migration and winter. In the Alviso pond complex, individuals have nested on electrical towers regularly since at least 2006, and two pairs nested on towers in 2007.
White-tailed kite (*Elanus caeruleus*)	SFP (nesting)	Nests in tall shrubs and trees; forages in grasslands, marshes, and ruderal habitats.	**Known to occur.** Common resident; breeds at inland margins of the study site, where suitable nesting habitat occurs.
Definitions: FE – Federally Endangered FT – Federally Threatened FC – Candidate for Federal Listing BCC – USFWS Bird of Conservation Concern SE – State Endangered		ST – State Threatened SFP – Fully Protected (California) CSSC – California Species of Special Concern WL – CDFW Watch List Source: CNDDB 2014.	

Appendix G.
Underwater Noise Analysis for Phase 2 Construction Memo

South Bay Salt Pond Restoration Project

M E M O R A N D U M

TO:	Members of the South Bay Salt Pond Restoration Project Management Team
FROM:	AECOM
DATE:	08/1/2016
RE:	**Underwater Noise Analysis for Phase 2 Construction**

1 Purpose

This memorandum provides an analysis of the potential for underwater noise resulting from the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 actions to affect biological resources. This memorandum described potential underwater noise effects that will be needed for development of Endangered Species Act (ESA) consultation, and other regulatory agency permitting processes such as California Endangered Species Act (CESA), and a makes a recommendation on whether or not an Incidental Harassment Authorization (IHA) pursuant to the requirements of the Marine Mammal Protection Act (MMPA) should be requested for those actions.

2 Project Description

The SBSP Restoration Project is a multi-agency effort to restore tidal marsh habitat, reconfigure managed pond habitat, maintain or improve flood protection, and provide recreation opportunities and public access in 15,100 acres of former salt-evaporation ponds purchased from and donated by Cargill Incorporated (Cargill) in 2003. These former salt ponds are part of the U.S. Fish and Wildlife Service (USFWS) owned and managed Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), and cover approximately 9,600 acres in the South San Francisco Bay (South Bay).

The selection of and planning for the Phase 2 projects started in 2010 and completed its Final EIS/R in April 2016. The project is currently developing more detailed designs sufficient to inform applications for permits and other regulatory agreements for work at four groups of ponds ("pond clusters") in the Ravenswood and Alviso pond complexes. The four Refuge ponds clusters in Phase 2 are collectively nearly 2,400 acres in size. One regulatory agreement that may be needed is an IHA under the MMPA.

The SBSP Restoration Project's proposed actions for Phase 2 provide a variety of habitat enhancements at all four Phase 2 pond clusters. It also includes maintained or increased flood protection and additional public access and recreation features at two of the pond clusters. Figure 1 and Figure 2 show the regional location and the vicinity of the Phase 2 pond clusters. Figures 3 through 7 illustrate the proposed construction as it would be implemented at each of the Phase 2 pond clusters. Generally speaking, Phase 2 activities include:

- Breaching, lowering, and removal of levees to provide tidal flows to pond interiors and to improve habitat connectivity
- Raising and improving certain levees for flood control
- Excavation of pilot channels to improve drainage and connect ponds to external waterways
- Construction of viewing areas and trails
- Installation of water control structures to enhance managed pond habitats
- Construction of habitat transition zones and habitat islands
- Building bridges over two new levee breaches, which would be armored to prevent scour
- Improvements to Pacific Gas and Electric (PG&E) transmission tower footings and associated access boardwalks

Of the above activities, only the construction of bridges and the installation of one particularly long water control structure are expected to require pile driving or other activities that would generate substantial under water noise. Only hand tools would be used for the improvements to PG&E transmission towers and the associated boardwalks. Hand tools would not generate substantial noise and thus are not considered in this analysis.

Pile driving would occur at three locations. Two of these locations (rail car bridges) are located along Whisman Slough/Stevens Creek, approximately 2,300 and 4,000 feet from its mouth with the bay, respectively. The third pile driving location (water control structure) is at the terminus of Flood Slough near the southeast corner of Bedwell Bayfront Park. This point is located approximately 3,500 feet from where Flood Slough meets others and flows around Greco Island before meeting the open Bay. Piles may be driven here to support a 100 foot-long (or longer) water control structure under the entrance road to Bedwell Bayfront Park.

Two rail car bridges would be installed to extend over the armored breaches on the eastern levee of Pond A2 and would provide access to existing PG&E utilities. These bridges would be approximately 60 feet long and 10 feet wide. The bridges would span the two proposed breaches along the Pond A2W east levee to provide all-weather PG&E access route to the utility's facilities near the northwest corner of Pond A2W. A public access trail for bicycle and foot traffic would also be built on this levee and would use these bridges.

The railcar bridge superstructure would rest on top of cast-in-place concrete abutments. The integrated concrete wing walls would be built with stem to contain the embankment. Because the bridge is not subject to busy traffic, a concrete approach slab is not required. The abutments would be supported with multiple 14-inch x14-inch precast pre-stressed concrete piles with an estimated total of eight piles at each abutment. The pile length is assumed to be 45 feet long. Armoring and bridging of breaches would be done in dry conditions. Therefore, installation of temporary cofferdams would be required at the breach and bridge locations to facilitate the construction of concrete abutments and wingwalls. This analysis assumes the abutment piles would be driven with an impact pile driver, which is the installation method typically used for concrete piles. It is also assumed that creation of these cofferdams would use vibratory driving of 24-inch steel sheet piles. Pumped water would be discharged downstream of the construction area and possibly directed to Pond A2W or the lower end of Stevens Creek, shown on some maps as Whisman Slough.

The water control structure at Flood Slough would likely be supported by several 14-inch concrete piles. It is assumed that a temporary cofferdam, constructed of 24-inch steel sheet piles, would also be constructed at this location to temporarily dewater the site.

3 Site Conditions and Sensitive Resources Considered

Factors such as topography, bathymetry, and sediment type are important factors in considering how underwater noise propagates through the environment. This section also briefly describes the sensitive resources that are considered in this memorandum.

3.1 Site Topography, Bathymetry, and Sediment Profile

The portions of the project area that are above Mean Higher High Water (MHHW) are limited to levees and other areas of fill that parallel the sloughs and border the ponds of the project area. The levees and other areas of fill would greatly limit the movement of pile driving noise during construction, as the compacted fill of the levees is expected to reflect and absorb sound energy with very little transmission into the surrounding waters.

The project area is located in very shallow waters, ranging from approximately 0 feet Mean Lower Low Water (MLLW) in Flood Slough, -2 feet MLLW in Whisman Slough/Stevens Creek, and 4-5 feet MLLW within large areas of the ponds. The Ravenswood Ponds currently have no tidal connection to the Bay, and are dry unless rainwater collects in the ponds. The maximum tidal range there is approximately 9 feet, meaning that water depths would be, at most, 11 feet in the deepest parts of the project area.

Though the Phase 2 ponds vary in their own depth and hydrology, they all have bay mud as the dominant substrate type below their pond bottoms and in the areas surrounding them. The thickness of the bay mud depends on the location, with bay muds generally 10 to 20 feet thick in the Alviso complex and 20 to 60 feet deep in the Ravenswood complex (AECOM 2016). Underneath the bay mud are clays and alluvial deposits that may vary from sand to cobble. Due to the geology of the area, piles driven for the project are not expected to encounter bedrock.

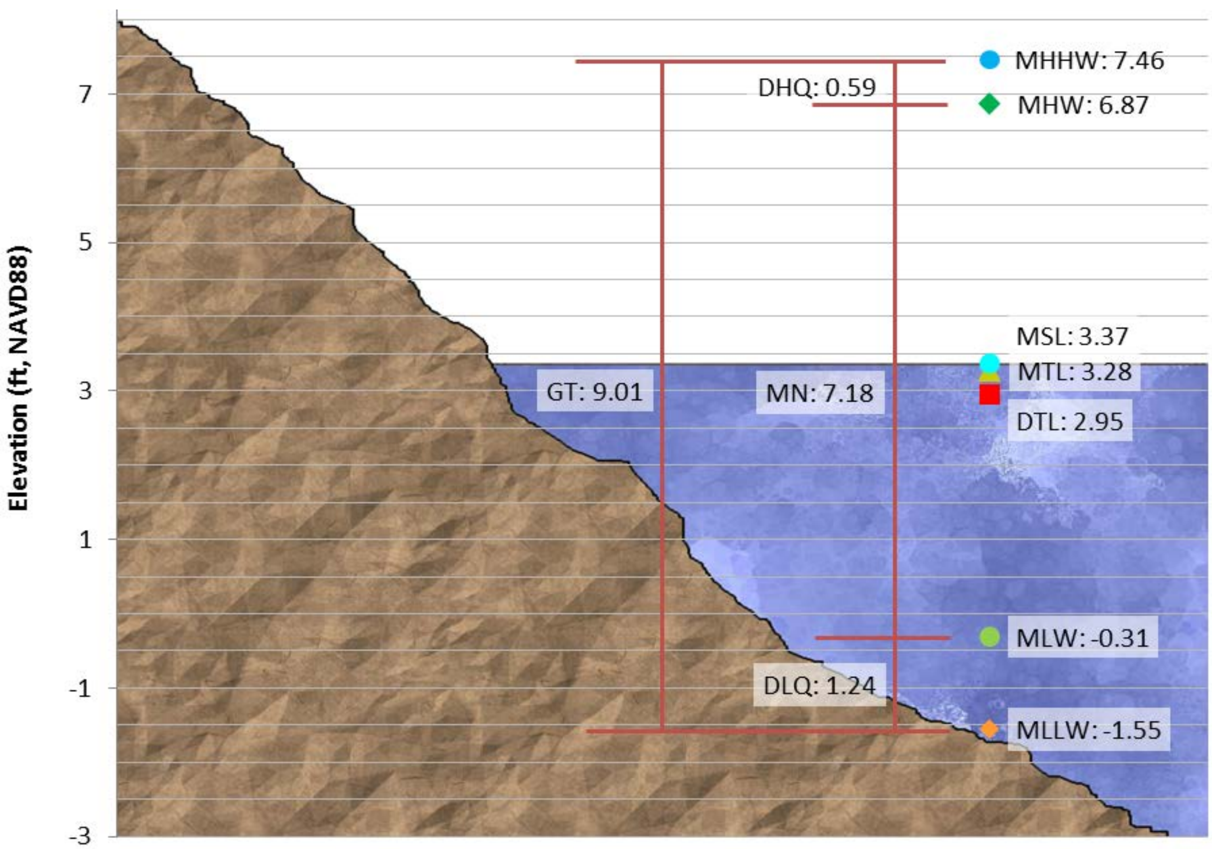
3.2 Hydrologic Data

Water surface elevations representative of the project area were obtained from the Coyote Creek tide gauge near the mouth of Coyote Creek (NOAA gauge 9414575). Tide elevation at this gauge generally varies between -1.64 feet (-0.5 meters) and 7.9 feet (2.4 meters). **Figure 8** shows the average tide elevations for the Coyote Creek station.

3.3 Sensitive Receptors of Underwater Noise in the Action Area

Underwater noise generated by pile driving can have adverse effects on both fish and marine mammals. Many species of marine mammals can be found in San Francisco Bay (Bay), but only one species, Pacific harbor seal, is typically present in the southern portion of the Bay. The largest harbor seal haul-out site in the South Bay occurs along lower Mowry Slough, which located approximately 3.5 miles northeast of the pile driving locations. Other areas frequently used as haul-out sites in the South Bay are near Calaveras Point along Coyote Slough, at Dumbarton Point, on Greco and Bair Islands, and along Corkscrew Slough (AECOM 2016). These lesser used sites are two miles or more from the proposed Phase 2 pile driving locations.

Two distinct population segments (DPS) of ESA listed fish may be present in the project area – Steelhead (Central California Coast DPS, or CCC) and Green Sturgeon (Southern DPS). Additionally, one CESA listed fish species may be present, the longfin smelt. These fish species may utilize tidal waters of the Bay (including the lower portions of Flood Slough, Stevens Creek and other waterways) for foraging areas. Stevens Creek supports an anadromous population of CCC steelhead and thus is a migratory pathway for that species. Stevens Creek, the Guadalupe River, and Coyote Creek are designated as critical habitat for the Central California Coast Distinct Population Segment for this species, and all portions of San Francisco Bay below MHHW are designated as critical habitat for Southern DPS green sturgeon.



Note:	All elevations in feet, NAVD88	Source: NOAA 2013; SBSP 2013	
Key:	MHHW (mean higher high water)	MHW (mean high water)	MSL (mean sea level)
	MTL (mean tide level)	DTL (mean diurnal tide level)	MLW (mean low water)
	MLLW (mean lower low water)	GT (great diurnal range)	DHQ (mean diurnal high water inequality)
	MN (mean range of tide)	DLQ (mean diurnal low water inequality)	

Figure 8. Coyote Creek gauge tide elevations

4 Underwater Noise Analysis

The methods, results, and effects of the underwater noise analysis are discussed in the sections below.

4.1 Fundamentals of Underwater Noise

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of a sound, and is measured in the number of cycles per second, or hertz (Hz). Intensity describes the pressure per unit of area (i.e., loudness) of a sound, and is measured in decibels (dB). A dB is a unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 microPascal (µPa) is commonly used to describe sounds in terms of decibels, and is expressed as "dB re 1 µPa." Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 µPa. As sound levels in dB are calculated on a logarithmic basis, an increase of 10 dB represents a tenfold increase in acoustic energy, while 20 dB is 100 times more intense, 30 dB is 1,000 times more intense, etc. For airborne sound pressure, the reference amplitude is usually 20 µPa, and is expressed as "dB re 20 µPa."

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects the frequency range of human hearing. This method is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. The method is called A-weighting, and the dB level that is measured using this method is called the A-weighted sound level (dBA). Sounds levels measured underwater are not weighted, and include the entire frequency range of interest.

When a pile-driving hammer strikes a pile, a pulse is created that propagates through the pile and radiates sound into the water, substrate, and air. The sound pressure pulse is a function of time and is referred to as the waveform. The instantaneous peak sound pressure level (SPL_{peak}) is the highest absolute value of pressure over the measured waveform, and it can be a negative or positive pressure peak. Sound is frequently described as a root mean square (RMS) level, which is a statistical average of the sound wave amplitude. The RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that constitutes the portion of the waveform containing 90 percent of the sound energy (Richardson et al., 1995).

Table 1 contains definitions of these terms. In this document, dB for underwater sound is referenced to 1 µPa, and dB for airborne noise is references to 20 µPa. The practical spreading model has been used to estimate underwater noise in this analysis.

In common use, noise refers to any unwanted sound. This meaning of noise will be used in the following discussion in reference to marine mammals and fish; that is—pile driving noise may harass marine mammals or affect fish.

Table 1. Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference

	pressure for air is 20 µPa, and 1 µPa for underwater.
SPL_{peak} Sound Pressure Level (dB)	Peak sound-pressure level, based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1 µPa), but can also be expressed in units of pressure, such as µPa or pounds per square inch (psi).
SEL, sound exposure level	SEL is the total noise energy produced from a single noise event and is the integration of all the acoustic energy contained within the event. SEL takes into account both the intensity and the duration of a noise event. SEL is stated in dB re 1 µPa2 · s for underwater sound.
RMS Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile-driving impulse.

Notes:
dB = decibel
µPa = microPascal
NMFS = National Marine Fisheries Service
psi = pounds per square inch
SPL_{peak} = sound pressure level
SEL = sound exposure level
RMS = root mean square

4.2 Applicable Criteria for Noise Effects

The National Marine Fisheries Service (NMFS), through coordination with other agencies, has established guidelines for the thresholds of underwater noise that may affect fish and underwater or airborne noise that may affect marine mammals. These criteria are summarized below.

4.2.1 Fish

On June 12, 2008, NMFS; USFWS; California, Oregon, and Washington Departments of Transportation; California Department of Fish and Wildlife; and the U.S. Federal Highway Administration agreed in principal to interim criteria to protect fish from pile driving activities. These criteria were established after extensive review of available analysis of the effect of underwater noise on fish. The agreed-upon threshold criteria for impulse-type noise to harm fish has been set at 206 dB SPL_{peak}, as well as 187 dB accumulated sound exposure level (SEL) for fish over 2 grams (0.07 ounces), and 183 dB accumulated SEL for fish less than 2 grams (FHWG, 2008). Any listed fish species that are present in the project area would be bigger than 2 grams, thus the 187 dB accumulated SEL threshold is used in this analysis.

The primary difference between the adopted criteria and previous recommendations is that the single strike SEL was replaced with a cumulative SEL over a day of pile driving. NMFS does not consider sound that produces an SEL per strike of less than 150 dB to accumulate and cause injury. The adopted criteria in the above paragraph are for pulse-type sounds (e.g., pile driving with an impact hammer) and do not address sound from vibratory driving of piles. As other guidance is lacking, the 206 dB SPL_{peak} and 187 dB accumulated SEL threshold has conservatively been applied to vibratory pile driving as well. NMFS also generally uses a 150 dB RMS threshold for potential behavioral effects to listed fish species, so this metric will also be utilized in this analysis.

4.2.2 Marine Mammals

Under the MMPA, NMFS has defined two levels of harassment for marine mammals (Cetaceans, Pinnipeds, Mustileds (sea otters), and Sirenians). Level A harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."

Current NMFS recommendations regarding exposure of marine mammals to underwater noise are as follows: Cetaceans and Pinnipeds exposed to impulse sounds of 180 and 190 dB RMS or greater, respectively, are considered to have been taken by Level A harassment (potential injury). Level B (behavioral harassment) is considered to have occurred when marine mammals are exposed to sounds 160dB RMS or greater for impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile extraction and driving). The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations.

The NMFS has also adopted thresholds for airborne noise that may cause harassment and injury to marine mammals. The appropriate airborne noise thresholds for behavioral disturbance for all Pinnipeds, except harbor seals, is 100 dB re 20 μPa RMS and for harbor seals is 90 dB re 20 μPa RMS. The underwater and airborne noise criteria for marine mammals are shown in Table 2. In-air noise generated during pile driving would likely exceed the 90 dB noise threshold (AECOM 2016). However, harbor seal haul-outs are two or more miles from the pile driving locations, and at that distance airborne noise would have attenuated to 50 dB or less, which is similar to typical ambient sound in a quiet natural environment (Dooling and Popper 2007). As a result, airborne noise will not be considered further.

Table 2. Regulatory Noise Criteria for Marine Mammals

Marine Mammal Type	Airborne Marine Construction Criteria (re 20 μPa)	Underwater Continuous Noise Criteria (e.g., vibratory pile extraction and driving) (re 1μPa)		Underwater Pulsed Noise Criteria (e.g., impact pile driving) (re 1 μPa)	
	Level B Threshold	Level A Threshold	Level B Threshold	Level A Threshold	Level B Threshold
Cetaceans (whales, porpoises)	N/A	180 dB RMS	120 dB RMS	180 dB RMS	160 dB RMS
Pinnipeds (sea lions)	100 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS
Pinnipeds (harbor seals)	90 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS

Notes:
dB = decibel
μPa = microPascal
RMS = root-mean-square pressure

4.3 Approximation of Project-related Noise

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory pile extraction and driving and impact pile driving. Pile driving sound levels from similar types and sizes of piles have been measured from other projects and can be used to estimate the noise levels that the proposed action would generate. This analysis utilizes the practical spreading loss model (Transmission loss = 15*log(R1/R0), the use of which NMFS and the USFWS have accepted to estimate the propagation of noise through water. The default transmission loss utilized by NMFS of 15log R represents a loss of 4.5 dB per doubling of distance unless data are available to support a different model. Transmission losses within the project area are expected to be greater due to the extremely shallow waters (average depths of a few feet during high tide and many areas would be dry during low tide) and extensive unconsolidated sediments that are a poor conductor of sound energy.

The primary sources of underwater noise produced during construction would be pile driving. This includes the installation of 14-inch square concrete piles and the installation and removal of temporary steel sheet piles for cofferdams at the bridge construction locations as described in **Section 2**.

4.3.1 14-Inch Square Concrete Piles

The 14-inch square concrete piles, which current project designs assume would measure approximately 45 feet long, would be installed using an impact hammer. It is estimated that each pile would require approximately 300 blows of a Delmag D46 or similar sized hammer for full installation and that up to four piles may be installed per day. The best fit acoustic data of pile driving comes from installation of 14-inch square concrete piles at the Noyo Harbor in Fort Bragg, CA (Caltrans 2015). The pile lengths, substrate type, and maximum water depths were all similar to the pile driving scenario for the proposed project. During installation of those piles, the maximum sound levels measured for unattenuated pile strikes were 183 dB peak, 166 dB RMS, and 154 dB for the single strike SEL. Using the practical spreading loss model described above, these values were used for approximating the distance over which underwater noise thresholds may be exceeded during installation of the 14-inch square concrete piles. These distances are provided in **Table 3** and **Table 4**.

4.3.2 Steel Sheet Piles

Temporary steel sheet piles would be installed with a vibratory driver in the event that dewatering is needed for construction of the railcar bridge footings. It is estimated that each pile would require, at most, 5 minutes of vibratory driving for installation and for removal and that up to 6 of these piles may be installed per day. The best fit acoustic data of pile driving comes from installation of a sheet pile cofferdam at Ten Mile River Bridge, Fort Bragg, CA (Caltrans 2015). The pile size, substrate type, and maximum water depths were all similar to the pile driving scenario for the proposed project. During installation of those piles, the maximum sound levels measured for vibratory pile driving were 174 dB peak, 142 dB RMS, and 142 dB for the one-second SEL. Using the practical spreading loss model described above, these values were used for approximating the distance over which underwater noise thresholds may be exceeded during installation of the 14-inch square concrete piles. These distances are provided in **Table 3** and **Table 4**.

Table 3. Distances of Exceeded Regulatory Thresholds for Pile Driving Noise – Fish

Pile Type	Source Levels at 10 meters (dB)				Distance of Threshold* (feet)		
	Peak Noise Level	SEL, Single Strike**	SEL, Accumulated	RMS	206 dB Peak	187 dB accumulated SEL	150 dB RMS
Impact Driving							
14-inch square concrete (4 per day)	183	154	185	166	NE	24 (assumed)	385
Vibratory Driving/Extraction							
24-inch sheet pile (6 per day)	174	142	175	142	NE	5	10

Notes:

dB decibels
NE threshold not exceeded
SEL sound exposure level

* The distance from the pile over which the effects threshold of 206 dB peak sound level and 187 dB accumulated SEL would be exceeded. These threshold values apply to fish over 2 grams in weight.

** For vibratory driving, the Single Strike SEL represents the SEL of one second of pile driving.

Table 4. Distances of Exceeded Regulatory Thresholds for Pile Driving Noise – Marine Mammals

Pile Type	Source Levels at 10 meters (dB)		Distance to Threshold (meters)		
	Peak Noise Level	RMS	190 dB RMS (Level A)**	180 dB RMS (Level A)**	160/142 dB RMS (Level B)*
Impact Driving					
14-inch square concrete (4 per day)	183	166	NE	NE	83
Vibratory Driving/Extraction					
24-inch sheet pile (6 per day)	174	142	NE	NE	966

Notes:

dB decibels
NE threshold not exceeded within 10m of the pile
RMS root mean square
* For underwater noise, the Level B harassment threshold is 160 dB for impulsive noise and 120 dB for continuous noise.
** For underwater noise, the Level A harassment threshold for cetaceans is 180 dB and 190 dB for pinnipeds.

4.4 Effects of Approximated Noise to Fish

The above modeling indicates that underwater noise produced during pile driving for the proposed project would not exceed the 206 dB peak or 187 dB accumulated SEL thresholds that NMFS has established for injury or temporary hearing threshold shifts. However, the underwater noise would exceed the 150 dB RMS threshold used by NMFS for behavioral effects on fish. Potential behavioral effects of underwater noise include the temporary cessation of feeding, startle responses, or movements to other areas. Depending on the timing of work, these behavioral effects could disrupt migratory movements of steelhead. Following the cessation of pile driving, fish are expected to resume the use of the affected area. The estimated distance over which 150 dB RMS may be exceeded is 385 feet for impact driving of the concrete piles and 10 feet for vibratory driving of the sheet piles (**Table 3**). During low tide, the pile driving areas would be separated from the wetted channel by a distance of at least 30 feet. At these times, very little of the sound energy is expected to enter waters where fish may be present. During high tide, however, the pile driving noise could more readily radiate out into the channel and affect fish, such as green sturgeon or steelhead that may be present within the distances provided in **Table 3**.

In order to avoid impacts on nesting birds, pile driving activities may need to occur during the migration period. Steelhead and green sturgeon may be present in the project area year-round. As a result, complete seasonal avoidance of these special-status fish species is not possible, though there are months when these species are less abundant in the Bay. Pile driving could be scheduled to occur during low tide, during which there would minimize direct transmittal of noise into water in the work area and the presence of special-status fish would be unlikely in the nearby shallow waters that remain.

4.5 Effects of Approximated Noise to Marine Mammals

Pile driving noise could exceed the 160 dB RMS and 120 dB RMS thresholds established by NMFs for harassment of marine mammals over the distances specified in **Table 4**. The distance over which these thresholds may be exceeded (966 feet or less) does not extend into the open waters of the bay. Additionally, levees and other similar landforms present barriers to any sound emanating towards the open waters of the Bay. While harbor seals occasionally enter Stevens Creek slough, the likelihood that they may be present in the small area where underwater noise exceeds the aforementioned Level B harassment thresholds is very small. If pile driving is conducted during low tide periods, this likelihood shrinks to virtually non-existent as the water likely becomes too shallow to permit movement of harbor seal.

5 Recommendations

With regards to the potential effects of pile driving noise on fish, it is recommended that the results of the analysis be integrated into the biological assessment that is being prepared for NMFS. This will allow for proper consideration of the potential effects of pile driving noise on listed fish species.

With regards to marine mammals, the results of this analysis indicate that an IHA would not be needed for potential effects to marine mammals due to the remote chance of exposure. This chance becomes even more remote if pile driving is scheduled to occur only during periods of low tide.

Finally, it is recommended that restricting driving to low tide periods be considered to further reduce the potential for listed fish or harbor seal to be exposed to underwater noise in excess of the regulatory thresholds described above.

6 References

AECOM. 2016. South Bay Salt Pond Restoration Project Phase 2: Final Environmental Impact Statement/Report. Prepared for the U.S. Fish and Wildlife Service and the California State Coastal Conservancy. April 2016.

California Department of Transportation (Caltrans). 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Authored by David Buehler, P.E., Rick Oestman, James Reyff, Keith Pommerenck, Bill Mitchell. Retrieved from http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.pdf.

Dooling, Robert J. and Popper, Arthur N. 2007. The Effects of Highway Noise on Birds. Prepared for California Department of Transportation, under Contract 43A0139 for Jones and Stokes Associates.

Fisheries Hydroacoustic Working Group (FHWG), 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. June 12.

NOAA 2013. National Oceanic and Atmospheric Administration. Tides and Currents Datums webpage. http://tidesandcurrents.noaa.gov/datums.html?id=9414575. Accessed December 30.

Richardson, W.J., G.R. Greene, Jr., C.I. Malme, and D.H. Thomson, 1995. Marine mammals and noise. San Diego, California: Academic Press. 576 pp.

About AECOM

AECOM (NYSE: ACM) is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries.

As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges.

From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US$19 billion during the 12 months ended June 30, 2015.

See how we deliver what others can only imagine at
aecom.com and @AECOM.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, California 94555

June 9, 2017

Kaylee Allen, Field Supervisor
Bay Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

Attention: Ms. Kim Squires and Ms. Katherine Sun

Dear Ms. Allen:

On February 21, 2017, a Biological Assessment and signed cover letter was transmitted to your office requesting formal consultation for Phase 2 of the South Bay Salt Pond (SBSP) Restoration Project pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.). That letter was signed by SBSP Executive Manager John Bourgeois on California State Coastal Conservancy (SCC) letterhead. To clarify, the U.S. Fish and Wildlife Service (USFWS) Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) is the Federal Action Agency for the SBSP Restoration Project and understands that under section 7of the ESA that requests for formal consultation needs to be initiated by us. The original letter from John Bourgeois was directed by me and sent on behalf of the Refuge by the SCC, which is the lead partner agency on the SBSP Restoration Project. With this letter, I am confirming that the February 21, 2017 request letter from SCC was directed by the Federal Action Agency, and I am reiterating herein our request for formal consultation pursuant to the section 7 of the ESA.

Streamlined Consultation Guidance

In our February 21, 2017 letter, the Refuge requested the SBSP Phase 2 Biological Opinion (BO) be considered for the expedited consultation process described in the USFWS's new *Streamlined Consultation Guidance for Restoration/Recovery Projects*. The Refuge understands that your office does not wish to pursue this pathway for issuing this BO. Therefore, the Refuge requests that you continue your review of the SBSP Restoration Project's Phase 2 Biological Assessment (BA) that was transmitted to your office on February 21, 2017. That BA was prepared in anticipation of a conventional formal section 7 review, pursuant to ESA section 7(a)(2), and not per the streamlined consultation guidance.

Summary of the Previously Transmitted Biological Assessment

The BA transmitted to your office on February 21, 2017, describes the Phase 2 design elements, conservation measures, environmental setting, Action Area, consultation history with multiple agencies, and presents the determination of effects to federally listed species. Longfin smelt, a candidate species for listing under the federal ESA, is also included in the BA per an agreement between the USFWS and the California Department of Fish and Wildlife (CDFW), even though the species is currently only listed under the California Endangered Species Act. A separate consultation with the National Marine Fisheries Service for potential effects to federally listed anadromous fishes and Essential Fish Habitat regulated under their jurisdiction is occurring simultaneously. The Refuge and the SCC have determined that, due to the short-term loss of tidal marsh habitat or breeding habitat, the SBSP Restoration Project *may affect, and is likely to adversely affect* salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*), California Ridgway's rail (*Rallus obsoletus obsoletus*), western snowy plover (*Charadrius nivosus nivosus*), and longfin smelt (*Spirinchus thaleichthys*). The proposed Project *may affect, but is not likely to adversely affect* the California least tern (*Sternula antillarum browni*).

Thank you for your consideration and for the important work you do in support of our shared goal of habitat restoration to benefit the recovery of threatened and endangered species and their habitats in the San Francisco Bay estuary. Please feel free to contact me at (510) 792-0222 extension 123 or SBSP Executive Project Manager John Bourgeois at John.Bourgeois@scc.ca.gov or (408) 314-8859 if you have further questions.

Sincerely,

Anne Morkill
Refuge Complex Manager

cc: Chris Barr/Jared Underwood, USFWS
John Krause/Conrad Jones, CDFW
John Bourgeois/Brenda Buxton, SCC
Seth Gentzler/Dillon Lennebacker, AECOM