Final
Restoration and Mitigation Monitoring Plan for the Island Ponds Restoration Project

US Fish and Wildlife Service
Don Edwards National Wildlife Refuge
and
Santa Clara Valley Water District

List of Tables

List of Figures (Figures follow text except Figure 2)

List of Appendices

1 INTRODUCTION

The Santa Clara Valley Water District (District) and US Fish and Wildlife Service (USFWS) Don Edwards National Wildlife Refuge (Refuge) plan to restore tidal action to the 475-acre Island Ponds complex during March and April 2006. The Island Ponds (Alviso Ponds A19, A20, and A21) are located at the southern end of the San Francisco Bay Estuary, near the mouth of Coyote Creek (Figure 1). The Refuge acquired the salt making rights to these lands as part of the 16,500 acre state/federal salt pond purchase from Cargill in 2003. Tidal marsh restoration at the Island Pond fulfills two goals: (1) ecological restoration under the South Bay Salt Ponds Interim Stewardship Plan (ISP), and (2) meeting mitigation requirements for the ISP and for the District's Stream Maintenance Program (SMP) and Lower Guadalupe River Project (LGRP). An added benefit will be that lessons learned through this restoration project can be applied to the South Bay Salt Pond Restoration Project (SBSP).

This Restoration and Mitigation Monitoring Plan (RMMP) presents the approaches necessary to satisfy mitigation and monitoring requirements described in the various permits and environmental documents for the ISP, SMP and LGRP. These environmental documents and permits were prepared by the following resource and regulatory agencies: the Refuge, the District (2001, 2002a,b, 2005a,b), the San Francisco Bay Conservation and Development Commission (BCDC 2004a,b,c), San Francisco Bay Regional Water Quality Control Board (RWQCB 1993, 2002a,b, 2004a,b,c,d,e,f), US Army Corps of Engineers (USACE 2002a,b,c,d, 2003, 2004), California Department of Fish and Game (CDFG 2004), US Fish and Wildlife Service Endangered Species Office (USFWS 2004a,b,c,d), and National Marine Fisheries Service (NMFS 2002, 2003, 2004).

This RMMP specifies frameworks for the two main project activities: (1) construction and (2) long-term monitoring. Construction activities include restoration-site construction (which will proceed according to District specifications), pre-construction site preparation as required by permits and environmental documents, and short-term monitoring before, during, and after construction as required by permits and environmental documents. Construction is scheduled for 2006 within a window from March 1 to April 30, as specified by permit conditions. Maintenance and monitoring procedures for the construction phase of this project are constrained by various permit conditions; this RMMP relies on District site-specific construction plans and specifications as well as relevant District best management practices (BMPs) to meet many of these permit requirements.

This RMMP projects that the mitigation requirements specified in the permits may be attained approximately fifteen (15) years post-construction. Long-term monitoring activities addressed in this RMMP will take place from the time of construction to fifteen years after construction with further monitoring required if performance criteria are not met in fifteen years. Throughout the 15-year period, the District and Refuge will hold a series of interagency discussions at key progress milestones to evaluate project status and monitoring effectiveness. These adaptive management checkpoints will provide the opportunity for adjustments in the monitoring program and/or implementation of corrective measures on the ground.

Long-term monitoring activities fall into two categories: (1) on-site restoration target outcomes, and (2) on- and off-site possible adverse outcomes. The following on-site restoration target outcomes will be monitored: hydrology, sedimentation, channel evolution, levee-breach and outboard marsh channel width, vegetation, and wildlife use of the Island Ponds. Long-term monitoring of these items will track changes of site conditions after the levees are breached in order to determine: (1) how the Island Ponds evolve towards the desired state of restoration, and (2) when project performance criteria have been attained. Potential long-term adverse outcomes that will be monitored are: non-native plant species colonization, impacts on cultural resources, integrity of remaining on-site and nearby levees, integrity of the nearby railroad bridge and rail line, scour of fringing marsh along Coyote Creek, and water quality in Coyote Creek. This monitoring will allow detection of possible on- and off-site adverse outcomes so that problems can be corrected before serious impacts develop.

This RMMP is organized into the following chapters:

Chapter 1:	**Introduction**
Chapter 2:	**Background** covering context, mitigation requirements, responsible parties, long-term site management, goals, and expected outcomes
Chapter 3:	**Site Description** covering past and current use, elevations, brine chemistry, gypsum, railroad, utilities, adjacent lands, species of concern, and outboard marsh
Chapter 4:	**Design and Construction** covering design elements, construction approach, and avoidance and minimization measures
Chapter 5:	**Monitoring** covering performance criteria, on-site target outcome monitoring, and on- and off-site possible adverse outcomes monitoring
Chapter 6:	**Ongoing Maintenance** covering invasive species and mosquito control
Chapter 7:	**Reporting and Adaptive Management** covering due dates, annual monitoring, adaptive management checkpoints, and final monitoring
Chapter 8:	**Contingencies** covering on-site and off-site possible corrective measures
Chapter 9:	**Completion** covering actions for permit closure on mitigation requirements
References:	Documents cited in this RMMP

2 BACKGROUND

This chapter describes relevant project background: the South Bay Salt Ponds ISP, the Refuge and District mitigation requirements, responsible parties, the project goals and objectives, and anticipated restoration outcomes.

2.1 The South Bay Salt Pond Interim Stewardship Plan

The Island Ponds were part of the Cargill South Bay salt evaporation complex purchased in 2003 with a combination of local, state, and federal funds. Specifically, this project falls under the ISP that was created to maintain the ponds while a long-term plan is created for the entire area. The objectives of the ISP for the Island Ponds include, but are not limited to (ISP 2003):

- Introduce tidal hydrology to the ponds;
- Assure ponds are maintained in a restorable condition to facilitate future long-term restoration;
- Minimize initial stewardship management costs; and
- Meet all regulatory requirements; especially discharge requirements to maintain water quality standards in the South Bay.

In 2004, the Final EIR/EIS for the ISP was certified by the USFWS and CDFG (ISP 2004). This document evaluated the environmental effects of implementing the ISP and identified broad mitigation measures that could be used to minimize adverse effects. The EIR found that potentially significant effects from ISP implementation could occur in several categories. Those that potentially apply to Island Ponds include:

- ***Hydrology*** **–** Breaching of the Island Ponds could potentially lead to erosion of mud flats and impacts to the Union Pacific railroad bridge pier.
- ***Water quality*** **–** Short term (24 hours to 8 weeks) impacts from elevated salinity in discharges to several of the creeks and sloughs in the area.
- ***Sediments*** **–** Changes in pond management under all the alternatives could lead to increased mobility and bioavailability of inorganic contaminants and increased exposure of wildlife to contaminants.
- ***Biological Resources*** **–** Benthic organisms in adjacent sloughs and creeks may be affected by elevated salinity in initial discharges. Disturbances related to construction may increase potential for spread of invasive perennial pepperweed (*Lepidium latifolium*), smooth cordgrass (*Spartina alterniflora*), or cordgrass hybrids. Changes in pond management may result in positive or negative effects on wildlife that use the salt ponds. Fish, particularly juvenile salmonids, may be affected by elevated salinity during initial discharge, and may be vulnerable to entrainment in borrow ditches or water control structures.
- ***Cultural Resources*** **–** Flooding of the ponds may affect undocumented cultural or archaeological sites.

Other effects pertaining to air quality, recreation, public access, visual resources, public health, land use, and socioeconomic values were identified as potentially occurring for some projects but do not apply to the Island Ponds Restoration Project.

2.2 Parties Responsible for Implementation and Long-Term Management

Both the District and the Refuge will participate in Island Pond restoration and compliance monitoring and the Refuge is responsible for all Pond management. Both parties are responsible for preparing the annual monitoring reports and submitting them to the regulatory agencies. The monitoring responsibilities specified under this RMMP will end when the mitigation goals have been achieved, or when the regulatory agencies determine that sufficient progress has been made towards the mitigation requirements.

This RMMP has been prepared for the District and the Refuge with the assistance of the team of Tetra Tech, Inc., FarWest Restoration Engineering, and Wetlands and Water Resources, Inc. (the Consultant Team).

2.3 Goals and Objectives and the Refuge and District Mitigation Requirements

Island Pond restoration is an activity of the South Bay Salt Ponds ISP and it fulfills mitigation requirements for the Refuge and CDFG under the ISP and for District under the SMP and LGRP. Beyond the mitigation requirements, the District and Refuge are under no obligation to ensure that the balance of the Ponds re-vegetate to any degree, nor are they responsible for monitoring beyond the mitigation monitoring requirements stated in Monitoring, Section 5. The District originally intended to fulfill its mitigation requirements at Pond A4 in Sunnyvale. The District was invited by CDFG and USFWS to participate in the breaching of the Island Ponds. Upon investigating this proposal further, the District agreed with CDFG and USFWS that transferring the District's tidal wetland mitigation requirements to the Island Ponds would allow Pond A4 to be better integrated with the South Bay Salt Pond Restoration Project. In addition, the Island Ponds project could be accomplished earlier with fewer technical challenges than the Pond A4 project.

Goals and objectives for the project are qualitative or quantitative statements derived from permit requirements and recommendations made in the ISP EIR/EIS. The project goals are to: (1) achieve restoration and mitigation project outcomes and (2) avoid off-site adverse impacts of construction and restoration activities. Monitoring associated with the project has three objectives that relate to these goals: (1) document progress towards achieving restoration and mitigation project outcomes, (2) detect on-site adverse impacts that could impede progress toward achieving the restoration and mitigation outcomes, and (3) detect potentially adverse off-site, post-restoration impacts.

2.3.1 Restoration and Mitigation Outcome Goals

The restoration and mitigation goals of this project are described in the environmental documents and permits prepared for this project. These documents establish the following goals (illustrated in Figure 2):

1) **Ecological restoration:** Restore the three Island Ponds to tidal marsh. This goal is a beneficial ecological restoration effort of the ISP designed to provide the ecological benefits and services of functioning tidal marshes, including increasing the amount of habitats for the numerous plant, fish, and wildlife species that utilize tidal marsh for portions or all of their life cycles. Specifically, BCDC identified the potential, long-term restoration of California clapper rail *(Rallus longirostris obsoletus)* habitat as an important benefit that might be provided by restoration of the Island Ponds (BCDC 2004a).

2) **Compensatory mitigation:**

   A) Restore 9 acres within Pond A21 to tidal marsh, as compensatory mitigation for the Refuge's ISP impacts.

   B) Restore 30 acres within the Island Ponds to tidal wetlands, as compensatory mitigation for District SMP impacts to tidal wetlands and clapper rail foraging habitat.

   C) Restore 35.54 acres within the Island Ponds to tidal marsh, as compensatory mitigation for the District's LGRP impacts.

The compensatory mitigation goals are non-overlapping; thus, a minimum of 74.54 ac of vegetated tidal marsh habitat must be restored to satisfy the mitigation requirements of the District and Refuge. The compensatory mitigation is intended to overlap with acreage restored under Goal #1 above (Ecological Restoration) as depicted in Figure 2.

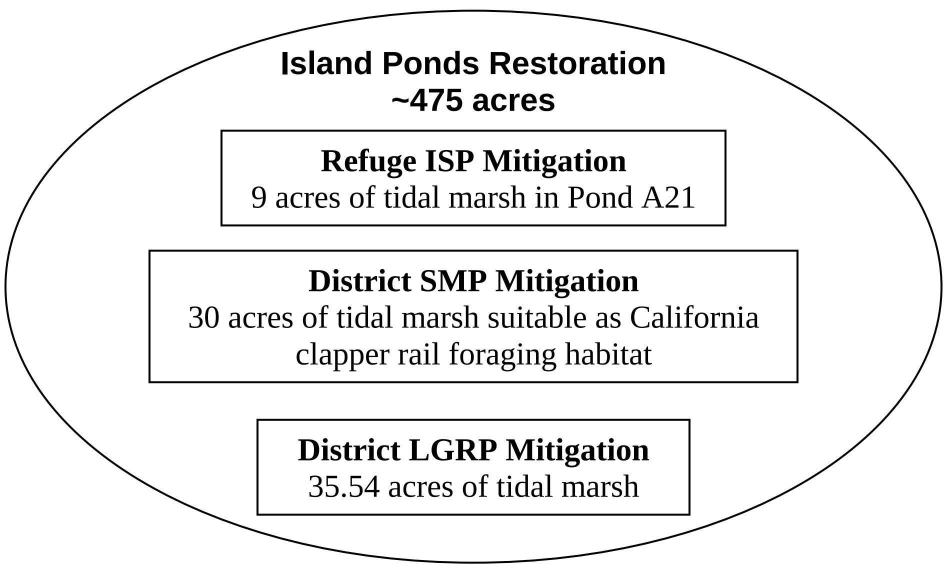

Figure 2. Compensatory Mitigation Goals within Overall Island Pond Restoration. Oval represents total Island Pond area; rectangles represent mitigation requirements to be achieved within the restored Island Ponds.

2.3.2 Detect Possible Post-Restoration Impediments to Achieving Restoration and Mitigation Outcomes

The ISP (2003) determined that conditions within and adjacent to the Island Ponds are favorable to positive outcomes and that the likelihood of any of the following adverse outcomes was low. A finite number of possible adverse outcomes following restoration could interfere with mitigation compliance. Practical contingency measures for each of these concerns will be developed jointly between the Refuge, District, and regulatory agencies as needed (see Section Contingency Measures, Section 8.1, for an initial set of measures). The following developments, though unlikely, may compromise the ecological outcomes of the Island Ponds restoration effort:

1) **Non-native vegetation establishment,** in particular, smooth cordgrass and its hybrids;
2) **Inadequate sedimentation combined with a lack of gypsum dissolution,** such that the final substrate depth is too shallow to support native tidal marsh vegetation;
3) **Inadequate vegetative cover establishment**, due to Development #2 or to other causes;
4) **Excessive sedimentation within the levee breaches or outboard marsh channels**, at levels interfering with unimpeded tidal exchange between each pond and Coyote Creek;
5) **Inadequate maintenance of existing intertidal channels combined with lack of new channel formation** leading to loss of channel habitats; or
6) **Inadequate tidal circulation throughout each pond** that could promote Development #2, #3, and/or #5 (above).

2.3.3 Detect Possible Off-Site, Post-Restoration Adverse Impacts

The ISP EIR/S (ISP 2004) and discussions during recent planning identified five specific adverse impacts that may occur near the Island Ponds following their restoration to tidal action. The monitoring program will allow detection of the nature and extent of these adverse impacts if they occur. Detection of these potential adverse impacts would trigger evaluation of the need for, and approach to, corrective measures. The impacts of concern are:

1) **Excessive scour around footings of the Union Pacific railroad bridge** across Coyote Creek that may compromise bridge integrity (caused by project-related ebb-tide flow velocity increases in Coyote Creek, downstream of breaches);
2) **Excessive scour of marshes along Coyote Creek** downstream of the levee breaches that may detrimentally affect biological resources (caused by project-related ebb-tide flow velocity increases in Coyote Creek, downstream of breaches);
3) **Excessive scour of levees opposite the Island Pond breaches** that may compromise integrity of those levees (caused by flow velocity increases during ebb tide drainage of the Island Ponds);
4) **Erosion along the rail line** between Pond A20 and A21 that may comprise integrity of the rail line (caused by increased inundation in the tidal marsh on either side of the rail line due to overtopping or failure of remaining levees); and
5) **Accelerated deterioration of structures in the Town of Drawbridge** caused by increased inundation in the tidal marsh on either side of the rail line due to overtopping or failure of remaining levees.
6) **Water quality impacts** caused by the release of pond water with raised salinity to Coyote Creek.

2.4 Anticipated Outcomes

Outcome projections are based on a variety of sources, use of computer models in prior studies, and institutional knowledge gained through experience on similar projects. Expected outcomes were described in a report prepared by HT Harvey Associates (HT Harvey 2005).

2.4.1 Marsh Development Projections from HT Harvey (2005)

The HT Harvey Associates report (HT Harvey 2005) projected:

1. "Early successional tidal marsh habitat is expected to rapidly establish throughout the majority of the Island Ponds within 10 years after levee breaching. Approximately 374 acres of tidal marsh habitat (50-100% vegetation cover) is projected to establish by Year-10."
2. "The site would increase in elevation over time via natural sedimentation processes and reach equilibrium marshplain elevations near MHHW approximately 25 years after breaching."
3. "Tidal brackish-salt marsh transition habitat would establish throughout the majority of the study area (313 acres; 65% of the total area). This habitat would be dominated by alkali bulrush and pickleweed on the marshplain with Pacific cordgrass lining the slough channels. Tidal salt marsh habitat is expected to establish in the northwestern portion of Pond A21 (60 acres; 13% of the total area)."
4. "The projected surface area and quality of tidal salt marsh habitat in Pond A21 is more than adequate to meet the District's tidal marsh mitigation requirements for the SMP."
5. "The surface area and quality of tidal brackish-salt marsh transition habitat is more than adequate to meet the District's tidal marsh mitigation requirements for the LGRP."
6. "Under the ISP conceptual restoration design where ditch-blocks would not be installed, the existing borrow ditches would become the primary tidal channels. Lower order channels would still develop within the restored tidal marsh and would drain to the borrow ditches."
7. "The existing gypsum layer is most likely not a constraint to the restoration of tidal marsh functions in the long-term as the gypsum should gradually dissolve and erode where drainage channels form and will be buried with 2-3 feet of sediment on the restored marsh plain. The gypsum layer will likely slow the rate of tidal marsh vegetation establishment, especially during the first 5 years following breaching before the layer is substantially buried by sediment."

2.4.2 Updates to HT Harvey (2005) Marsh Development Projections Based on New Data

One vital piece of information became available after completion of the HT Harvey (2005) report: the baseline elevations of the ponds are lower than the values used to generate those predictions. The USGS 2004 pond bathymetric survey results contained an error for each pond related to how they read the Cargill staff gauges relative to the surveyed geodetic elevations of each gauge (for further detail *see* Pond Elevations and Local Tides, Section 3.5). Correcting for this error lowered reported pond elevations 1.08ft for Ponds A19 and A21 and 0.58ft for Pond A20 relative to the elevations used by HT Harvey. Further, all USGS survey data are referenced to a 1999 Cargill survey that has not been documented or validated.

The District conducted a limited topographic survey in December 2005 to validate the bathymetric data and bring closure to pond elevation data issues. The District survey concluded that the pond bottoms are approximate 0.7 feet lower that the data used in the HT Harvey projections, but higher than the corrected USGS survey.

The key effect of the downward revision of pond surface elevations is that more time will be necessary for sedimentation to establish a new substrate suitable for colonization by native tidal marsh vegetation that is (a) of adequate depth for the root zones of these plant species and (b) at the intertidal elevations occupied by these plant species. Given the 0.2ft/year sedimentation rate prediction used by HT Harvey (2005), approximately an additional three (3) years will be required to achieve the target intertidal heights, extending the anticipated time frame for the Island Ponds Restoration Project to reach the mitigation requirements from 10 years to 13 years (*see* Adaptive Management Framework for Mitigation Compliance, Section 7.3).

Based on the nature of these estimations and the development of earlier estimates in the draft RMMP, a 15 year expectation is retained in the final RMMP with the inclusion of adaptive management strategies.

The median pond surface elevations are now believed to range between 2.1 to 2.4 ft below local MHW (*see* Pond Elevations and Local Tides, Section 3.5). HT Harvey (2005) presented the vertical ranges of occurrence of the anticipated dominant native tidal marsh plant species: alkali bulrush (*Schoenoplectus maritimus* [formerly known as *Scirpus maritimus*]) has a 2.5-foot vertical range from about 2 feet below local MHW to ½ foot above local MHW; cordgrass has a 1.9-foot vertical range from about 2½ feet to ½ foot below local MHW, and pickleweed (*Salicornia virginica*) has a 1.7-foot range from slightly less than 1 foot below to about 1 foot above local MHW.

Given the estimated elevations, pickleweed establishment is not expected to occur until at least one foot of net sediment accretion has occurred and the gypsum layer is not likely to interfere with its rooting zone. However, colonization by cordgrass and alkali bulrush is expected to occur as soon as enough sedimentation has occurred to provide some substrate; these early colonists will probably experience some rooting interference from the gypsum layer but as sedimentation continues and a thicker substrate forms, this interference should diminish to the point where there is no effect on plant growth. Tidal marsh is expected to establish on the balance of the acreage as sediment accrues in the upper reaches of the marsh, but this is not expected to occur over the life of this plan.

2.4.3 Additional Anticipated Outcomes

Wildlife Benefits. Several wildlife species may benefit from this restoration. Some of those species include:

- **California clapper rail**. This species exists in fully tidal salt marsh, and is generally found in the proximity of vegetated or semi-vegetated tidal sloughs and fully-vegetated salt marsh plains. A completely developed system of tidal sloughs is necessary to support this species, with extensive native cordgrass coverage in lower elevational zones and pickleweed in upper marsh areas. A fringe of vegetative cover in high-marsh areas is needed to provide cover for this species during periods of inundation.

- **Black rail** (*Laterallus jamaicensis*). This species is found in heavily vegetated (greater than 90% cover) mid- and high-marsh habitat with a vegetation height greater than 30cm. The best habitat for this species consists of tidal marshes with a full tidal range, particularly where freshwater inflow has allowed bulrushes to develop. This species is more likely to be found in broad marshes such as those projected to develop at Island Ponds than more narrow marshes.
- **Salt marsh harvest mouse** (*Reithrodontomys raviventris*; SMHM) and **salt marsh wandering shrew** (*Sorex vagrans halicoetes*). The development of large stands of pickleweed will provide adequate foraging habitat for both of these species; to support other aspects of these species' life-cycles requires a vegetated upland transition zone where these mammals can escape tidal inundation. Remnant levees can provide this refugia to some extent.
- **Northern harriers** (*Circus cyaneus*). Pickleweed stands may also provide adequate nesting habitat for northern harriers, a state species of concern. Some large stands of pickleweed may develop over the life of this plan, but associated high-marsh transition zone habitat formation may take longer to develop.

The only species for which habitat development are required are the California clapper rail. Other marsh dependent bird species that may benefit from tidal marsh restoration in Island Ponds include the salt marsh common yellowthroat *(Geothlypis trychis sinuosa),* and Alameda song sparrow *(Melospiza melodia pusillula).*

Fisheries Benefits. Tidal marshes represent important rearing and foraging habitats for juvenile fishes. Juvenile salmonids entering the Estuary from nearby Coyote Creek may find refuge from predators and foraging opportunities in cordgrass stands throughout the tidal cycle, and in mid-marsh vegetation during high tides. Other species including bat rays, stickleback, topsmelt, and gobies may also benefit from foraging and cover opportunities offered in low-marsh habitat.

Other Ecosystem Benefits. The Island Ponds Restoration Project represents an opportunity to realize many of the ecosystem benefits that are commonly associated with healthy tidal marsh habitat. Water quality may benefit as a result of the unique filtering capabilities of tidal marshes (Mitsch and Gosselink 2000). Flood reduction benefits to such low-lying communities as Alviso may be realized as greater area is available to absorb storm surges and high tides.

2.4.4 Outboard Marsh

Two possible changes could occur in the outboard fringing marshes in Coyote Creek following Island Pond Restoration. First, the increased tidal prism in Coyote Creek is expected to scour the waterway. This scour could extend laterally, leading to erosion of the bayward edge of the existing outboard fringing tidal marsh. Second, the increased tidal prism in Coyote Creek could increase near-surface water salinity. This increased salinity could lead to a shift over long time periods in tidal marsh species composition in the outboard marsh toward more salt-tolerant species. The current species mix includes the range of saline to salt-brackish marsh plants (HT Harvey 2003). Future changes would be most likely to shift relative percent cover of these existing species.

3 SITE DESCRIPTION

This chapter describes the Island Ponds and their surrounding environmental context. The present and historical uses of the ponds, physical context for the ponds, physical and chemical characteristics of the ponds, and the biological resources of the surrounding outboard marsh are all described below.

The Island Ponds are a part of the 25-pond, 8,300 acre evaporation pond system collectively referred to as the Alviso Complex (Figure 1; ISP 2004). The Alviso Complex, located at southern terminus of San Francisco Bay, was the largest of the three South Bay salt pond complexes. The Island Ponds are in the eastern portion of the Alviso Complex, on the bayshore edge of the City of Fremont. The Ponds are in Alameda County, immediately north of the Alameda-Santa Clara County boundary located in Coyote Creek.

3.1 Present and Historical Uses

Present Use

Since early 2003, the Island Ponds have been in full title ownership by the Refuge. Following the Purchase Agreement requirements, the Refuge assumed operation and management responsibility of the ponds from Cargill in October 2005. Though much of the land in the Alviso Complex subsided in past decades due to groundwater pumping in adjacent communities, the existing pond bottom elevations in the three Island Ponds remain relatively high in elevation (ISP 2004; *see* Pond Elevations and Local Tides, Section 3.5).

Use for Salt Production

Commercial solar salt production in the San Francisco Estuary began in the mid 1850s and initially focused on enhancing production of natural salt pans in Alameda County. Subsequently, small operations in diked tidal marshes proliferated in the South Bay (ISP 2004). Operations in diked tidal marsh systems capture bay water during high tide events; over time solar evaporation of this Bay water results in salt crystallization. By the 1900s, 37 salt pond facilities were operating in diked tidal marshes in the South Bay (ISP 2004). During the 1920s and 1930s, many of the smaller production facilities consolidated into two companies, the Oliver and Leslie companies (ISP 2004). Over the next decades production increased significantly. During Leslie's first year of production in 1936 it produced approximately 300,000 tons on 12,500 acres; production increased to over 1 million tons on 50,000 acres of salt ponds by the 1960s (Siegel and Bachand 2002, ISP 2004). In 1979, the Leslie Salt Company sold 11,430 acres of salt ponds to the Refuge, including the Island Ponds, subject to Leslie's continuing right to make salt. This same year, Cargill acquired the Leslie Salt Company. In 2003, California and federal agencies purchased an additional 16,500 acres of industrial salt ponds from Cargill, which included the salt making rights for the Island Ponds.

Salt production began at the Alviso Complex in 1929 (Ver Planck 1958). Within the larger Alviso Complex, the Island Ponds served as middle stage evaporator ponds. The ponds are characterized as having intermediate salinities relative to the other stages of the salt production process (Siegel and Bachand 2002).

Town of Drawbridge

The historic town of Drawbridge is located on Station Island between ponds A20 and A21 (Figure 3). During the mid-1870s, as agricultural production increase in the South Bay, a railroad bridge-tender established residence on Station Island for the purpose of raising bridges for the increasing number of boats using Coyote and Warm Springs sloughs, and a small town of cabins grew (USFWS 2003b). Drawbridge began declining in the 1920’s and was fully abandoned by the 1970’s.

The structures of the town of Drawbridge have not been maintained since the town was abandoned. The remaining structures of Drawbridge have not been evaluated for eligibility to the National Register of Historic Places and there are no plans to preserve these structures (ISP 2004).

Historic Tidal Marsh

The Island Ponds were tidal marshlands prior to European colonization of the region. These marshlands consisted of extensive channel networks, vegetated marsh plain and intertidal mudflats (Figure 4).

3.2 Adjacent Lands and Tidal Waterbodies

Significant features in the vicinity of the Island Ponds include Coyote Creek and Mud Slough, adjacent tidal marsh, other former evaporation ponds in the Alviso Complex (slated for restoration preparation under the ISP), solar evaporation ponds with ongoing salt production operations in the Newark complex, the Newby Island landfill, the San Jose/Santa Clara Water Pollution Control Plant, and the Warm Springs Restoration Site (Figure 3).

Coyote Creek and Mud Slough border the perimeter of the Island Ponds, with portions of tidal marsh extending immediately east of Pond A19. Coyote Creek borders the western and southern portions of the site. Coyote Creek drains approximately 205,145 acres of Santa Clara County (SCVWD 2002). Coyote Creek is the largest watershed in Santa Clara County, draining 29 tributaries across mixed landscapes (SCVWD 2002). Mud Slough, which borders the northern perimeter of the Island Ponds, drains the 47,636 acres of Alameda County’s Arroyo la Laguna watershed into Lower Coyote Creek (SCVWD 2005). The Arroyo la Laguna watershed drains the west-facing slopes of the Diablo Range, north of the Alameda-Santa Clara county boundary. The upper portions of the watershed are largely under agricultural cultivation and the lower portion is largely urbanized with waterways modified for flood control (SCBWMI 2001).

Former evaporation ponds in the immediate vicinity include Pond A15, A17, and A18 to the south and A22, A23, and M4 to the north. As with the Island Ponds, these ponds served as brine concentration ponds. Most of the ponds in the Alviso Complex are part of the ISP. The exceptions are Pond A4 and A18. The District purchased Pond A4 in 2000 with the intention of restoring wetlands to meet mitigation objectives for the LGRP and SMP. The District now seeks to transfer these mitigation objectives to the Island Ponds Restoration Project; the future use of Pond A4 remains to be determined.

The San Jose/Santa Clara Water Pollution Control Plant (WPCP), located approximately 2 miles south of the Island Ponds, discharges over 100 million gallons of treated wastewater daily into

Artesian Slough (City of San Jose 2005). From the southern terminus of Artesian Slough in the vicinity of the WPCP, the Slough travels northward discharging into Coyote Creek immediately south of Ponds A19 and A20. Pond A18 was purchased by the City of San Jose from Cargill in 2005 as additional bufferland and is part of the ongoing WPCP Master Planning effort.

Active evaporation ponds in the immediate vicinity include the Mowry Ponds located to the northwest of the Island Ponds. Though owned by the USFWS since 1979, the Mowry Ponds are not part of the ISP and Cargill continues to operate them for salt production.

The Newby Island Sanitary Landfill, an active 342-acre waste disposal facility, is located immediately southeast of Pond A19. BFI operates the landfill for the disposal of household and business solid waste from Santa Clara County.

The 220-acre Warm Springs Restoration site, also known as Coyote Creek Lagoon, is immediately east of Pond A19. The restoration project served as a soil borrow pit and wetland mitigation site for the adjacent business park development. Warm Springs is located at the northeast end of the bayward reach of Coyote Creek and the east end of Mud Slough at the head of a shallow, tapering channel. Prior to modern alteration including diking for agriculture in the 1950s, the site was probably pickleweed dominated tidal marsh (PWA and Faber 2004). The restoration site was breached in two locations in 1986. The vegetation colonizing the site includes pickleweed, cordgrass, bulrush, and cattail (PWA and Faber 2004). In the immediate vicinity there are extensive stands of alkali bulrush indicative of a mature brackish marsh (PWA and Faber 2004). Vegetation and site monitoring are ongoing as this site is one of a handful of long-term tidal marsh restoration mitigation monitoring efforts in San Francisco Estuary.

3.3 Rail Line

The UP Railroad operates an active rail line between Ponds A20 and A21. The railroad crosses bridges on Coyote Creek and Mud Slough. Based on limited LiDAR data from the USGS for the South Bay Salt Pond Restoration Project, the average elevation along the railroad line ranges from approximately 9.8-13.1ft NAVD88. Flood and erosion protection of the UP rail line is an important project requirement and will require monitoring during the post-breaching phase of this project.

3.4 Utility Line

Pacific Gas and Electric (PG&E) has an above ground power line consisting of 12 poles along the pond levees along Coyote Creek. This line brought power to the historic town of Drawbridge and supplies power to the pumps utilized for Cargill operations. The power lines are along the Coyote Creek levee of Ponds A19 and A20 from the UP railroad to the Pond A19 pump station are scheduled to be removed prior to construction and therefore should not present a constraint to the project design. The power line to the Pump A21 pump house will be removed after the pond is breached. This will allow transfer of excess brine to Pond M4 up to the point of breaching. There are no other public utilities at the site.

3.5 Pond Elevations and Local Tides

Tidal marshes occur at the interface of lands within the intertidal zone. The relationship of marsh elevation to tidal range exerts a fundamental control on marsh form and function. At the Island Ponds, existing data provide a solid starting point for determining pond elevations and tide heights. However, all of these data contain some uncertainties due to lack of sufficient independent connection to geodetic datums.

Two different vertical datums to which topographic and bathymetric survey data are referenced:

- **National Geodetic Vertical Datum of 1929, or NGVD29**, was in use across the United States for several decades and was superseded in 1988; the National Geodetic Survey and National Ocean Service no longer support data referenced to NGVD29
- **North American Vertical Datum of 1988, or NAVD88,** replaced NGVD29 and is the currently supported federal vertical datum.

3.5.1 Elevations

There have been several estimates of pond elevations, each of which is shown here and some of which have been used in prior analyses:

1) Cargill's 1999 survey (conducted by the Fremont Engineers), was incorporated into South Bay Salt Pond Restoration Feasibility Analysis (Siegel and Bachand 2002) and into the South Bay Salt Pond Restoration Project Interim Stewardship Plan (ISP 2003); this survey consisted of a handful of spot elevations within the ponds and was referenced to NGVD29.
2) USGS 2004 bathymetric survey consisted of approximately 34,000 depth soundings in the Island Ponds. These data contain two versions, both of which rely upon the 1999 Cargill survey data to reference their elevations to NGVD29 and both of which utilize VertCon (NGS 2005) to convert their data to NAVD88:
    a. Original data found to have a systematic vertical error due to misunderstanding of staff gauge survey points, distributed August 2004 and utilized as the basis to project Island Pond restoration outcomes (HT Harvey 2005)
    b. Corrected data resolving the staff gauge reference survey point
3) The District surveyed spot elevations on the pond surfaces and the reference benchmark for the January to April 2004 Coyote Creek tide stage data in NAVD88

Figure 5 shows the USGS bathymetric sampling transects in the Island Ponds, representing several thousand individual soundings in each pond with data points including pond surface, remnant natural channels, and perimeter borrow ditches. USGS utilized Cargill staff gauges within the ponds to determine pond levels during field work. Cargill's 1999 survey (*see* item #1 above) provided the elevations of the physical top of each staff gauge in each pond, relative to NGVD29. No metadata were provided on that survey. USGS used VertCon software (National Geodetic Survey on-line vertical datum conversion tool at http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl; USGS 2005) to convert its bathymetric data to NAVD88. Figure 6 shows the histogram of these data and illustrates the two distinct topographic features in the ponds –

the pond surface (upper data mode) and the channels and borrow ditches (lower data mode). Figure 7 shows the coarse-scale Digital Elevation Model surfaces developed by USGS from these data.

Table 1. Island Pond Areas and Pond Surface Elevations

POND	**AREA** (acres)	**POND SURFACE ELEVATIONS (feet NAVD88)**			
		Cargill	USGS 2004 Bathymetric Survey		District Spot Elevation Check
			Median with Staff Gauge Error, Unvalidated Reference	Median with Corrected Staff Gauge, Unvalidated Reference	
		1999	Aug 2004	May 2005	Dec 2005
A19	265	4.5	5.7	4.6	5.0
A20	63	4.5	5.2	4.6	4.8
A21	147	5.0	6.0	4.9	5.3
See Notes:		1,2	2,3,4,5	2,5,6	7
Data Used By:		ISP (2003) Table 4.1.7 p.4-5	HT Harvey (2005) Appendix B	Draft RMMP	Final RMMP

Notes:

1) Cargill 1999 data based on work of Fremont Engineers; data provided to South Bay Salt Pond Restoration Project and incorporated into the Interim Stewardship Plan.
2) Original data referenced to NGVD29; VertCon software from the National Geodetic Survey (http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl) used to establish a fixed conversion to NAVD88 for the Island Pond area of **2.7ft**.
3) Original data reported by USGS in August 2004 used incorrect position on pond staff gauges (highest marked number) to obtain reference elevation in NGVD29 based on Fremont Engineers survey for Cargill in 1999.
4) Philip Williams and Associates used 25-meter digital elevation model data from USGS in projecting Island Pond sedimentation (HT Harvey 2005).
5) Table reports data *median* values for the pond surfaces only, excluding data for the channels and borrow ditches. We established these *median* elevations from the data presented in Figure 6 that shows the distribution (number of data points at each surveyed elevation, or histogram) of the more than 34,000 bathymetric data points collected by USGS in February 2004 and corrected by USGS in May 2005 for the staff gauge reference elevation (see Note 6 below).
6) USGS revised its bathymetric data results in May 2005 to correct the staff gauge position reference to be physical top of staff gauge (point surveyed by Fremont Engineers in 1999). Adjusted values were -1.08ft for Ponds A19 and A21 and -0.58ft for Pond A20.
7) In December 2005, District independently surveyed approximately 60 random spot elevations on the pond surfaces as a validation step of the USGS 2004 bathymetric survey.

3.5.2 Tidal Datums

Environmental Data Solutions (EDS), subcontractor to Moffatt-Nichols Engineers working for the South Bay Salt Pond Restoration Project (SBSPRP), collected tide stage data in Coyote Creek at the railroad bridge from January to April 2004. EDS surveyed its sampling station to a nearby benchmark along the rail line (NGS BM Z1370, PID HS4389) for which a Processional Licensed Surveyor provided an updated geodetic elevation relative to NGVD29. EDS reported its data relative to NGVD29. Here, VertCon has been used to convert NGVD29 to NAVD88.

Figure 8 presents the January to April 2004 tide stage data used to calculate the preliminary tidal datum. Utilizing National Ocean Service (NOS) tidal datum reckoning protocols (Gill and Schultz 2001), the Consultant Team calculated the preliminary tidal datum heights using the NOS Alameda station as the reference station. The NOS Port of Redwood City station is half the distance as the Alameda station but the former does not have an established geodetic height and thus cannot be used for tidal datum reckoning. This data gap has been identified by the SBSPRP (PWA 2005). Table 2 presents the results of this preliminary tidal datum reckoning.

Table 2. Preliminary Tidal Datums, Coyote Creek at Railroad Bridge

Datum [1]	Elevation (ft NAVD88) [2,3]
MHHW	7.6
MHW	7.0
MTL	3.0
MLW	-0.4
MLLW	-1.5
Uncertainty [4]	0.11

Notes:

1. Datums calculated from South Bay Salt Pond Restoration Project 12-minute tide stage data collected January to April 2004 in Coyote Creek at the UPRR Railroad Bridge. Calculations used Alameda (NOS 941-4750) as reference station.
2. VertCon used to convert all data from NGVD29 to NAVD88.
3. These data will be updated for the Final RMMP with December 2005 District survey of reference benchmark to NAVD88, if these data are available in time.
4. Uncertainty in tidal datum estimates based on 3-month period of record, per National Ocean Service protocol (Gill and Schultz 2001)

The uncertainties in these data include the following elements:

- Reliance of tidal datum reckoning on Alameda vs. Redwood City reference data. The magnitude of this uncertainty is not known but would be expected to fall within the half-foot range. This uncertainty will remain unresolved for this RMMP as there are no plans in place to bring the Port of Redwood City NOS station into the NAVD88 geodetic datum. Three physical processes strongly affect tides in the South Bay generally, and near the Island Ponds in particular:
  - A) Tidal amplification (about 3 ft greater than at the Golden Gate);
  - B) Large watershed discharges that enter Coyote Creek; and
  - C) The nearby WPCP, which is permitted to discharge up to 120 million gallons per day of treated wastewater.
- Use of VertCon to convert data from NGVD29 to NAVD88. Because all prior data used nearly identical conversion factors, the conversion introduces a systematic error that is not likely to affect relative elevations. However, it does introduce uncertainty with absolute elevations that become important when relating Island Ponds to other data sets and locations.

3.5.3 Integrating Pond Elevations and Tidal Datum Heights

The relationship between pond elevations and tide heights is fundamental to the outcome of the Island Pond Restoration Project. Figure 6 integrates the results of these analyses and provides a view of the current understanding of the relationship between pond elevations and tide heights. Figure 6 shows the number of data points across the range of elevations encountered at the Island Ponds. These histograms illustrate the two different geomorphic elements present – the upper "mode" represents the pond surface and the lower "mode" represents the channels and borrow ditches. This figure and data in Tables 1 and 2 reveal that the median pond surface elevations are between 2.1 to 2.4 feet below local mean high water (MHW) at the railroad bridge, which indicates that a sufficient thickness of newly deposited sediment following restoration of tidal action should provide a suitable substrate for vegetation colonization and establishment. The relationship described reflects the limitations and uncertainties described in Sections 3.5.1 and 3.5.2.

3.6 Gypsum

The surfaces of the three Island Ponds as well as the extant natural channels and borrow ditches are covered by a surface layer of gypsum (calcium sulfate). Gypsum precipitates during production of brine at salinities greater than 147 parts per thousand (ppt; Ver Planck 1958). Gypsum is a hard yet breakable material. The thickness of the gypsum layers in the Island Ponds has not been determined systematically; HT Harvey (2005) reported thicknesses of about 6 inches based on a small number of field measurements. Qualitative observations during a site visit on October 10, 2005 confirmed this very general value and found chunks of gypsum atop the pond levees indicating its presence within the borrow ditches where levee maintenance material is excavated (*see* Figure 9).

Gypsum dissolution is anticipated once tidal action is restored to the Island Ponds, but the rate of this dissolution is not known. Gypsum dissolution occurs at salinities below 147 ppt and the rate of dissolution depends on water exchange rates, water salinity, surface flow velocities, and period of inundation (Siegel and Bachand 2002). At the Island Ponds, surface flow velocity and period of inundation are likely to be the controlling factors. Consequently, dissolution would be expected to occur more rapidly in areas closer to the breaches and in natural channels and borrow ditches. Whether gypsum will continue to dissolve once it is buried by under sediments is not known. Siegel and Bachand (2002) estimated dissolution periods for ponds at elevations of the Island Ponds to be 0- 40 years. As the gypsum is likely to be buried by two feet or more of sediment (*see* Table 1), it is not expected to impede marsh development. For the purposes of vegetation projections and timing of mitigation goals, no gypsum dissolution is assumed.

3.7 Brine Chemistry

The ISP reported average brine salinities for each of the Island Ponds (Table 3). Cargill used the Island Ponds as intermediate evaporation ponds in the salt production process. These ponds received water from Stage 1 evaporation ponds and distributed water to Crystallizer Ponds (HT Harvey 2005). The existence of gypsum on the surface of these ponds indicates that salinities in these ponds reached and exceeded 147ppt on a consistent basis (Siegel and Bachand 2002). Stage 2 Evaporation Ponds had brine salinities that typically ranged from 147-315ppt. Salinities outside of that range occurred seasonally due to short-term variations in weather and/or pond operations. The precise characteristics of brine remaining in the borrow ditches of the Island Ponds are currently unknown. The salinity, pH, dissolved oxygen, and temperature of the remaining brine will be measured prior to breach. In compliance with the RWQCB permit, brine in the Island Ponds has been pumped out to the greatest extent practicable given the existing pumps. Brine is currently restricted to the borrow ditch in Pond A21 and to less than ½ foot in Ponds A19 and A20. Precipitation is expected to raise these water levels and lower the salinity until the breach construction starts in March 2006. This excess lower salinity water will be pumped out again to the greatest extent practicable before the restoration construction begins.

Table 3. Island Pond Salinities

Pond	Average Salinity[1] Summer (ppt)	Winter (ppt)	Salinity[1] Range (ppt)
A19	152	132	79-290
A20	158	139	87-289
A21	173	151	87-304

Source: South Bay Salt Pond, Initial Stewardship Plan 2003

1. Salinities based upon values 6 year record (1997-2003).

3.8 Outboard Marsh Vegetation

Vegetation on the outboard side of the Island Ponds, along Mud Slough and Coyote Creek, grades from tidal salt marsh to a brackish marsh transitional plant association. A small amount of tidal salt marsh is found at the tip of Pond A21 and a large area of tidal brackish marsh lies east of Pond A19. This vegetative transition follows increasingly greater concentrations of saltwater downstream.

Tidal salt marsh habitat, dominated by Pacific cordgrass along the channel edge and pickleweed on the marshplain, is limited to an approximately 1600 foot long reach of Mud Slough adjacent to the northwestern tip of Pond A21. Because of the steep gradient found at the edge of the levees, only a narrow fringe of high-marsh transition vegetation is found at the edge of these levees. Both pure and mixed patches of alkali bulrush and pickleweed dominate the tidal brackish salt marsh transition along the entire north and south sides of the Island Ponds (HT Harvey 2005). Pacific cordgrass is limited to lower elevations along the channel edges around Pond A21. Perennial pepperweed is found in patches between Pond A19 and Coyote Lagoon. Other transition-zone species include alkali heath (*Frankenia salina*), spearscale (*Atriplex triangularis*), and saltgrass (*Distichlis spicata*).

3.9 Threatened, Endangered, and Special Management Concern Species

Special status fish and wildlife species include those designated as protected by, or eligible for protection under, federal and state law, including, but not limited to, the Endangered Species Act. The Island Ponds are currently barren and lack vegetative cover; no threatened, endangered or special status species are known to inhabit the Island Ponds (C. Morris, Refuge Manager, *personal communication*, 2005). The associated levees and outboard marsh may provide habitat suitable for special status species identified by the ISP as occurring within the South Bay Salt Pond project area. Agency permit conditions specify precautions to avoid or minimize impacts to special status species identified by the ISP as potentially occurring in the project vicinity.

No site-specific wildlife surveys were conducted at the Island Ponds for the preparation of this document and presence or absence of special status species on the site or associated levees and mudflats remains to be confirmed. Refuge staff believe the following California species-of-special-concern may occur in the vicinity of the Island Ponds: Northern Harrier, Salt Marsh Common Yellowthroat (*Geothlypis trichas sinuosa*), and the Alameda Song Sparrow (C. Morris, Refuge Manager, *personal communication*, November 2005). Because of the high salinities that were present on the Island Ponds when they were part of salt-making operations, use of this area by California Least Tern, currently or in the recent past, is highly unlikely (C. Morris, Refuge Manager, *personal communication*, December 2005).

California clapper rail and black rail are expected to benefit from this project but neither has been found in the Island Pond Vicinity on a regular basis (C. Morris, Refuge Manager, *personal communication*, November 2005). Additional special status species identified as potentially occurring in the project, include:

- **Bay shrimp** (*Crangon franciscorum*) – This species is commonly found in South Bay tidal sloughs and tributaries. The potential impacts of the initial release of high-salinity water from former salt ponds on Bay shrimp and its commercial fishery were evaluated in the ISP. The study concluded the salt pond release would likely result in a shift in habitat preference to upstream tributaries; juvenile habitat would decrease during initial release but adult habitat would remain unchanged. The report identified March – April as the optimal period for initial release as this period corresponds to the Bay shrimp's seasonal spawning migration to the ocean (ISP 2004).
- **Harbor seals** (*Phoca vitulina richardsi*) **–** This species utilizes the open waters of the San Francisco Estuary and isolated beaches, islands, or ledges as haul-outs. Similar undisturbed locations are used as pupping sites (ISP 2004). Of the 12 known haul out locations in the South Bay, four are within the greater ISP project vicinity, with one of these located along Coyote Creek, at the south end of Pond A20 (ISP 2004). Island Ponds permit conditions require pre-construction surveys for harbor seals within 30 days of construction.
- **Steelhead trout** (*Oncorhynchus mykiss*) and **Chinook salmon** (*O. tshawytscha*) **–** Both species migrate to spawning and rearing sites in the upper reaches of the South Bay tributaries, including Coyote Creek (ISP 2004). Steelhead migrate up Coyote Creek, past the Island Ponds, from late December through early April, with the greatest activity occurring between January and March (ISP 2004). Fall-run Chinook salmon migrate up tributaries, including Coyote Creek, from late-September through November. Juvenile salmon and steelhead migrate downstream to the ocean from mid-March to early May, earlier migration may occur during high flows caused by storm events. Based upon studies of the potential effects of pond water initial release on migrating salmonids, the ISP concluded that pond discharges "will not adversely affect the ability of the adult salmonids to find their spawning grounds" (ISP 2004, Technical Appendices, p. 220).

4 DESIGN AND CONSTRUCTION

The Island Ponds Restoration Project design calls for breaching the existing ponds levees and allowing for natural sedimentation of the pond surface. Sedimentation is intended to lead to pond re-vegetation and formation of small channels atop the existing pond surface. This design is a minimal-engineering approach that relies on natural processes to meet project goals and objectives. Several previous investigations have determined that natural sedimentation within the ponds will provide a suitable substrate for vegetation growth and channel formation sufficient to meet District and Refuge mitigation and habitat restoration goals. These studies and reports include:

1. **Alviso Island Pond Breach Initial Stewardship Plan Study, Ed Gross, Schaff and Wheeler (September 2003) –** Schaff and Wheeler focused their modeling study of the entire SBSPRP to include a more detailed analysis of the breach sizes and locations for the Island Ponds. The purpose of their modeling was to evaluate the impacts of the restoration on salinity in Coyote Creek. Their analysis evaluated a number of scenarios but determined that the relatively conservative scenario of somewhat undersized levee breaches in a July release period would result in minimum salinity impacts. Because of the spacing of the model nodes, breach widths were evaluated at 25 meters;
2. **South Bay Salt Ponds Initial Stewardship Plan (June 2003) and Final EIR/EIS (March 2004) –** Although the ISP and associated EIR/EIS covered the entire south bay salt ponds, these documents contained detailed descriptions of the Island Ponds restoration and analysis of the impacts and development of mitigation measures for the proposed project;
3. **Island Ponds Tidal Marsh Establishment Projections Reports, H. T. Harvey and PWA (January 14, 2005) –** This report contains the details of the sedimentation along with the associated vegetation and habitat development projections. This report identifies that suitable mitigation habitat can be developed within the Island Ponds. Following publication of this report, additional data showed that the bottom elevations of the Island Ponds were approximately 0.7 to 1.0 foot lower then expected (USGS 2005; *see* Pond Elevations, Section 3.5). The impact of this change in pond bottom elevation means that restoration targets will take slightly longer to achieve (*see* Anticipated Outcomes, Section 2.4).
4. **Santa Clara Valley Water District Engineer's Report (January 2006) –** The District has prepared a Preliminary Design Memorandum (January 2006) to provide specific details on breach sizing, anticipated tidal exchange and construction methods.

4.1 Design Elements

This section presents the basis for various design elements of the restoration project. Design elements are engineered aspects of the project that are required for construction of this restoration project to achieve project goals and objectives. These elements include the cross-section and profile of the levee breaches and the connection channels through the outboard marsh as well as removal of utilities and other structures critical from the project area.

4.1.1 Breaches

The design calls for two breach openings through existing levees at Ponds A19 and A21 and one breach opening at Pond A20 (Figure 10; Appendix A). For each breach opening, the top width will be approximately 35 to 45 feet, the bottom opening width will vary between approximately 6 to 30 feet, and the opening bottom elevation will be approximately 2.7 feet NAVD88 (0 foot NGVD29) with a maximum side slope of 1 (V) :2 (H) (Figure 11; Appendix B). The current design follows the general recommendations from ISP (ISP 2003) with a slight modification: the locations of the five breach openings were adjusted to meet the historical channel locations. The geometry of the levee breaches will be maintained in excavations through the outboard marsh into Coyote Creek.

Within each pond, there are deep borrow ditches that were created by excavation of material to construct and maintain the levees. After site-specific evaluations, the Consultant Team determined that use of ditch blocks in these borrow ditches might inhibit flow to the backside of each pond; thus, this design element was removed from the final construction plan. The excavated soil will be brought into the ponds and mechanically spread to use as pond surface fill in Ponds A19 and A21. This fill will not exceed a depth of 1 foot (BCDC 2004). Given the District estimate of 4,900 cubic yards of excavated material to be placed on the pond bottoms, placement at 1-foot thickness would cover approximately 3.0 acres and would have the added benefit of speeding marsh development in these locations. Materials greater than 40 feet from the levee at Pond A20 will be side-cast into the adjacent marsh. Excavated material will be placed along and approximately 10 feet from the hinge point on each side of the newly excavated channel. The materials will be placed in a berm-like configuration with a maximum bottom width of 20 feet and a side slope of approximately 1 (H) : 1 (V). One berm will be approximately 2 feet high and the other will be approximately 3 feet high. Approximate 1,100 cubic yards will be side-cast into these berms at Pond A20.

4.1.2 Outboard Marsh Channel

The channel across the outboard marsh will keep the same dimensions as the levee breach with a connection invert elevation into Coyote Creek of approximately 0 ft NGVD. Excavated material from the levee breach and outboard channel construction will placed inside of the ponds for A19 and A21, and will be side-cast for Pond A20 (*see* Breaches, Section 4.1.1).

4.1.3 Siphon Closure

The existing siphon to Pond A19 will be plugged on the Pond A18 side to prevent impacts associated with its removal. The siphon at Pond A21 will be plugged on the Pond M4 side once the Island Ponds are breached.

4.1.4 Utility Removal

The existing PG&E power line and poles (12 poles total) will be removed by PG&E prior to levee breach construction activities. PG&E will also remove the utility providing power to the pump at Pond A21. The A19 and A21 pumps and platforms will be removed as part of the restoration project.

4.2 Construction Approach

This section presents the anticipated approach to the construction of the Island Pond Restoration Project. The construction approach includes the means and methods for mobilization of equipment and performance of the work to achieve project construction requirements in a manner that meets permit requirements. Protection of existing wetlands and biological resources are key components of the construction approach.

4.2.1 Logistics

The Refuge will retain a contractor to perform the work. All funding for the work will be provided by the District through the Refuge. There are no access roads or bridges that can be used to reach the proposed breach locations. Amphibious excavators will be used for this project. The UP railroad bridge forms a barrier to the passage of construction equipment from Pond A21 to Ponds A19 and A20. Therefore, two separate transportation routes may be utilized to construct the Island Ponds Restoration Project.

For work at Pond A21, the excavator will be launched at Redwood City and floated to the work area across the South Bay and Coyote Creek. The Refuge will request UPRR to open the swing bridge on Mud Slough to access Ponds A19 and A20. If that is not possible the excavator will be assembled at a staging area along Cushing Parkway in Fremont and walked across Refuge Ponds A22, A23, and Mud Slough. Other supplies will be brought to ponds from the City of San Jose launch along Artesian Slough or Alviso Marina Park.

4.2.2 Construction Sequence

A Refuge biologist will conduct pre-construction surveys for sensitive species in the footprint of construction activities along the levees to be breached and adjoining outboard marsh channel (*see* Summary of Design and Construction Impact Avoidance and Minimization Measures, Section 4.3). Vegetation that the Refuge biologist determines may be suitable for SMHM in the work footprint will be removed by weed eaters. Fences will be installed around any cleared work area to prevent SMHM from entering the work area and to minimize turbidity impacts from excavation activities.

Excavation for each breach will begin near Coyote Creek and proceed toward the levee. A filter fence will be installed at the mouth of the channel to act as a barrier to keep turbid water from entering Coyote Creek during excavation of the channel. The elevation for the marsh area is around 7.4 to 8.7 feet NAVD 88, MHHW is about 7.6 feet NAVD 88, and MHW is about 7.0 feet NAVD 88 (Table 2). For the March 1 to April 30, 2006 construction window (see Appendix C), it is anticipated that the work area will not be inundated with water on two-thirds of the high tides.

The excavator has a reach of about 40 feet. Where the breach locations have a substantial band of outboard marsh on Pond A21, interim piles of excavated soil will be placed in the channel path approximately 40 to 60 feet behind the excavator toward the Ponds. A small excavator will load the material and load it into an amphibious dump truck that will carry it to the interior of the pond. Excavated soil will be placed in the borrow ditch to create a temporary access to the pond bottom, but will be removed at the end of the construction to keep the borrow ditches clear. There is little outboard marsh at Pond A19 and all material will be deposited on the pond bottom.

At Pond A20, material within the reach of the excavator (approximately 40 feet) will be placed on the pond bottom. Beyond 40 feet of the levee, excavated material will be placed along and approximately 10 feet from the hinge point on each side of the newly excavated channel. The materials will be placed in a berm-like configuration and with a maximum bottom width of 20 feet and a side slope of approximately 1 (H) : 1 (V). One berm will be approximately 2 feet high and one berm will be approximately 3 feet high.

The RWQCB wants the brine remaining in the borrow ditches of the Island Pond to mix with water from Coyote Creek before it is released into Coyote Creek. The excavator will complete the levee breach on the incoming tide once the water level in Coyote Creek equals or exceeds the water level in the borrow ditches. In this way, the contractor will ensure that brine from the Island Ponds mixes with Coyote Creek water before being released into Coyote Creek.

If by the end of the second breach construction on Pond A21 (assuming A21 is done first), the first breach appears to be constricting flows and shows little or no evidence that it is widening on its own, then the excavator will go back to the first breach to widen it further. This procedure will be assessed and repeated at each pond location.

4.2.3 Erosion Management

Long-term natural erosion and sedimentation is an integral part of the project design and sedimentation is required to meet project goals and objectives. The construction contractor will be required to implement short-term sediment control and erosion BMP's (SCVWD 2005; Appendix D). A detailed description of the approach to sediment management, brine release, and construction timing is described above (*see* Construction Sequence, Section 4.2.1).

4.2.4 Outboard Marsh Protection

Protection of the outboard marsh will be accomplished by minimizing the extent of excavation in the outboard marsh required to reach the levee for construction of the tidal breach (*see* Outboard Marsh Channel, Section 4.1.2). Also, excavated materials will be deposited in the Island Ponds in Ponds A19 and A21. Excavated material will be side-cast at Pond A20 within the area of the channel that is anticipated to erode away as the channel widens.

4.2.5 Construction Schedule

The anticipated construction schedule is as follows:

- **Early-February 2006 –** Conduct pre-construction surveys for special status species and pond brine quality;
- **March/April 2006 –** Breach pond levees to initiate restoration;
- **April 2006 –** Begin post-construction monitoring per this RMMP.

4.3 Summary of Design and Construction Impact Avoidance and Minimization Compliance Measures

The second goal of the Island Ponds restoration project is to avoid and minimize adverse impacts of restoration activities. The permits and environmental documents for the ISP, SMP, and LGRP identify a suite of requirements related to this goal. Design and construction compliance measures are summarized below.

Submittal of Pre-Construction Plans

The District submitted a Preliminary Design Memorandum in January 2006, along with construction plans and specifications referenced in this RMMP as part of the required pre-construction submittals. Calculations for determining the size of any levee breaches, the anticipated amount of cut and fill activities, and the expected full tidal exchange will be included in the Preliminary Design Memorandum.

The Refuge will complete a resource consultation with the California State Historic Places Officer prior to March 1, 2006 in regards to the Town of Drawbridge abandoned structures.

Excavated Soil Management and Minimization of Sedimentation into Coyote Creek

Construction of the levee breach will create excavated soils. This fill will be placed in the Island Ponds on the pond surfaces at a depth not to exceed 1 ft at Ponds A19 and A21 (*see* Breaches, Section 4.1.1). Excavated material will be side-cast to the adjacent marsh that is expected to erode away as the channel widens along Pond A20 at areas beyond the reach of the excavator to place material on the pond bottom.

Natural erosion of the levee breach and channel through the outboard marsh and sedimentation of the Island Pond surface are integral parts of the project design. However, if the breach does not widen on its own, the breaches may be further mechanically widened while the construction contract is still active.

The construction process will disturb the construction area making it susceptible to erosion. This erosion will be minimized to the extent practicable. The construction contractor will be required to implement sediment control and erosion BMP's that the Refuge will enforce (SCVWD 2005; Appendix D).

Minimization of Flooding Impacts

The project is designed to flood the Island Ponds as part of the restoration design. Previous modeling (ISP 2004) has determined that the proposed breach locations should not result in the flooding of adjacent properties.

Minimization of Water Chemistry Impacts

The precise characteristics of brine remaining on the Island Ponds are unknown. The project design uses a March/April breach date to reduce the salinity impacts to aquatic species. The RWQCB Waste Discharge Requirement permit prohibits initial release from these ponds when brine salinity is greater than 135ppt (RWQCB 2004a). The RWQCB assumed that salinities less than 135ppt correspond with metal ion concentrations within acceptable limits (RWQCB 2004a); thus, testing for concentrations of metals will not be required as part of this project.

The Refuge will measure brine salinity, dissolved oxygen, pH, and temperature within 30 days prior to breaching the Island Ponds and report these water chemistry results to the RWQCB prior to breach. In addition to the 135ppt salinity limit, RWQCB (2004a) specified that all pond waters discharging to the Bay or Sloughs would: (1) have pH between 8.5 and 6.5; (2) have dissolved oxygen concentrations greater than or equal to 5 mg/L; and (3) be no more than 20^{o}F warmer than receiving waters. The Island Ponds will be breached on an incoming tide to insure that remaining pond brine is well-mixed with (and diluted by) Bay water prior to release into Coyote Creek.

In specifying brine chemistry limitations for initial pond release, the RWQCB anticipated that the Island Ponds would be drained such that waters in Ponds A19 and A20 were less than 0.5 ft and only water in the borrow ditches remained at Pond A21 (RWQCB 2004a). The Refuge will insure that excess pond water (such as may accumulate from rain input) will be pumped to Pond M4 so that these volume requirements are met prior to breaching the Island Ponds.

The potential for contaminated sediment mobilization from the Island Ponds into Coyote Creek was identified as a concern in the ISP. Island Pond sediments were tested for inorganic contaminants. Mean concentrations for all inorganics tested were at or below ambient conditions elsewhere in the San Francisco Estuary. Thus, the ISP EIR/EIS (ISP 2004) concluded that breaching the Island Pond levees would not impact water/sediment quality in the Coyote Creek or the South Bay.

Minimization of Biological Impacts

The restoration was evaluated as part of the ISP EIR/EIS and determined to have less then significant impacts to in-stream biology. The construction window of March/April was selected to avoid impacts to **bay shrimp** when this species migrates to the ocean to spawn (ISP 2004, RWQCB 2004e); no other concentrated shellfish populations are known to occur in the immediate vicinity of the Island Ponds (C. Morris, Refuge Manager, *personal communication*).

The selected breach locations were designed to meet hydraulic requirements and also minimize the impacts of permanent loss or degradation of outboard salt marsh habitat on SMHM.

Migrating adult **steelhead** may be present in the vicinity of the Island Ponds at the time of initial release (Hansen 2003); however, no steelhead spawning habitat occurs in the Island Pond vicinity, so construction is not likely to directly impact steelhead spawning (NMFS 2004). Outmigrating juvenile steelhead may also be present in the vicinity at the time of Island Pond breaching; NMFS (2004) determined that there would be no significant impact to local steelhead populations as a result of restoration activities under the ISP.

Permits require pre-construction surveying for the following bird species: **California clapper rail, California least tern, burrowing owl, northern harrier, common yellowthroat, song sparrow, western snowy plover, Caspian tern, Forster's tern, California gull, black skimmer, herons, egrets, and other special status waterbirds.** Permit conditions mandate that the Refuge conduct these surveys no more than 30 days prior to construction. The Refuge must conduct surveys for the California least tern no more than 2 weeks prior to construction. If pre-construction surveys detect Western snowy plover nesting areas, construction activities will be limited to the period September 20-February 1 in nesting areas, which could affect the March 1 to April 30 construction period. If pre-construction surveys detect clapper rail activity on the project site, the Refuge will consult with the USFWS Endangered Species Office. If monitoring detects any of these species, the appropriate agencies will be notified and the necessary design, construction, or logistical changes will be made to minimize impacts to this species. Because these species are not thought to inhabit or utilize the Island Ponds or the adjacent outboard marsh on a regular basis, no delay in the construction schedule as a result of these species is anticipated.

Permits require pre-construction surveying for the **SMHM** no more than 14 days prior to construction and surveying for the **salt marsh wandering shrew** and **harbor seals** no more than 30 days prior to construction. The Refuge will conduct these pre-construction mammal surveys and if any of these species are detected, the appropriate agencies will be notified and the necessary design, construction, or logistical changes will be made to minimize impacts to these species. Any construction related damage to SMHM preferred habitat will be documented and assessed to the total allowed for entire ISP (less than 1.99 acre). No more than 5 days prior to the commencement of Island Ponds construction, the Refuge will arrange to clear by a weed-eater any vegetation within the construction area that may harbor SMHM. Sediment fencing will be deployed to define and isolate potential mouse habitat and act as a barrier to SMHM movement into the construction zone wherever Refuge biologists believe that such a barrier is necessary. The USFWS Endangered Species Office must be notified within 24 hours of the finding of any injured or dead SMHM or California clapper rail, or any unanticipated damage to SMHM or California clapper rail habitat due to project construction (USFWS 2004a). Based upon current understanding of existing conditions at the project site, no delays in the construction schedule as a result of these species are anticipated.

Other biological resource-protection actions will be performed prior to commencement of earth-moving activities. One breach locations at Pond A21 has been refined to avoid existing patches of non-native cordgrass in order to minimize the risk of further invasion due to construction activities. Also, construction equipment use areas (the construction footprint) will be limited to protect existing vegetated habitats. Finally, the contractor will wash any part of its construction equipment that came into contact with the non-native cordgrass so as not to disperse plant material during equipment relocation (ISP 2004).

Unavoidable Construction Delays

There are several developments that could delay implementation of the restoration plan. Pre-construction monitoring will be accomplished over a 2-4 week period in order to assess conditions immediately prior to breaching. Most delays would arise from adverse findings from this pre-construction biological monitoring. Adverse findings from pre-construction biological monitoring are considered unlikely but possible based on current knowledge of site conditions.

Unacceptable Biological Conditions – If the pre-construction surveys detect the presence of special status bird or mammal species (described previously) on the project site, the relevant management agencies will be notified and the protocols outlined in the project permits will be implemented. Minor revisions to the location of the levee breaches or outboard channels that may be necessary to avoid sensitive species are not expected to result in a significant construction delay; therefore, detection of these species should not cause the March/April 2006 work period to be missed.

Unacceptable Water Chemistry Conditions **–** If the brine quality in the Island Ponds exceeds permit requirements (salinity greater than 135 ppt, pH above 8.5 or below 6.5, dissolved oxygen concentrations less than 5 mg/L, or brine temperature more than 20^{o}F warmer than Coyote Creek), then the RWQCB will be consulted prior to proceeding with construction.

Construction Contractor/Construction Equipment-Related Delays – It is possible that there will be construction delays due to problems with the construction contractor's work, including equipment delays. The Refuge will use all means to insure that the construction contractor meets permit requirements, especially the April 30, 2006 end-of-construction deadline.

5 MONITORING

This chapter describes the monitoring program that will accompany the Island Ponds Restoration Project. Two principal goals have been identified for this project: (1) restoration and mitigation at the Island Ponds and (2) avoidance of off-site adverse impacts of construction and restoration activities. Specific performance criteria (Section 5.1) extend from these goals. All the Onsite (Section 5.2) and Offsite (Section 5.3) monitoring is geared to these performance criteria.

5.1 Restoration and Mitigation Performance Criteria

Restoration and mitigation goals stem from four sources: (1) the ISP and its associated EIR/EIS; (2) permits for the overall ISP process; (3) the District's LGRP permits and associated environmental documents; and (4) the District's SMP permits and associated environmental documents. Performance criteria associated with the restoration and mitigation goals from each of these sources are described below. Performance criteria are stated individually for the restoration goal and the three mitigation requirements.

5.1.1 Island Pond Restoration

The performance criteria for restoration of the Island Ponds are:

1) Restore unimpeded tidal action to approximately 475 acres;
2) Vegetative cover increases continuously throughout the period monitored for mitigation compliance;
3) Plant species composition consists of native tidal marsh species appropriate to the salinity regime.

5.1.2 ISP Mitigation

The RWQCB Water Quality Certification §401 for the overall ISP calls for compensatory mitigation of 9 acres of tidal marsh to be restored in Island Pond A21. The performance criteria for this mitigation requirement are:

1) Restore 9 acres of vegetated tidal marsh located within a larger marsh area in Pond A21;
2) Vegetation covers no less than 75% of the 9 acres;
3) Plant species composition consists of native tidal marsh species appropriate to the salinity regime;
4) Targets achieved within 15 years following levee breach.

5.1.3 LGRP Mitigation

Conditions detailed in environmental documents from RWQCB, USACE, CDFG, and the LGRP EIR mandate restoration of 35.54 acres of tidal marsh for LGRP activities. This restoration will occur within the three Island Ponds. The performance criteria for this mitigation requirement are:

1) Restore 35.54 acres of vegetated tidal marsh located within a larger marsh area on the three Island Ponds;
2) Vegetation covers no less than 75% of the 35.54 acres;

3) Plant species composition consists of native tidal marsh species appropriate to the salinity regime;
4) Targets achieved within 15 years following levee breach.

5.1.4 SMP Mitigation

The USACE permit and USFWS Biological Opinion for the SMP calls for compensatory restoration of 30.00 acres of tidal marsh suitable as California clapper rail foraging habitat. In addition, permits from CDFG and RWQCB and the SMP EIR call for restoration of tidal marsh to mitigate SMP impacts. This restoration will occur within the three Island Ponds. The performance criteria for these mitigation requirements are:

1) Restore 30 acres of vegetated tidal marsh located within a larger marsh area on the three Island Ponds;
2) Vegetation will cover no less than 75% of the 30 acres;
3) Plant species composition will consist of native tidal marsh species appropriate to the salinity regime.
4) Presence of California clapper rail at the Island Ponds as detected by a positive response to rail call counts using USFWS Endangered Species Office approved survey protocols. This performance criterion for the clapper rail mitigation requirement was established by the District through negotiations with the USFWS Endangered Species Office in December 2005.
5) Targets achieved within 15 years following levee breach.

5.2 Restoration and Mitigation Outcome Monitoring

Monitoring will both document the expected beneficial effects of this project and detect potential impediments to successful marsh restoration. Monitoring for each of the performance criteria above will continue until performance criteria are satisfied, at which point mitigation monitoring can cease. If these criteria are not met within 15 years, but monitoring shows continued, significant, positive progress, monitoring will continue (at reduced frequency, if appropriate) until performance criteria are met (*see* Adaptive Management, Section 7.3). If significant positive progress has not occurred by year 15 or if problems are found at any time within the 15-year monitoring period, then the causes will be investigated to determine appropriate corrective measures, if any (*see* Contingencies, On-site, Section 8.1).

Table 4 presents the monitoring schedule for a 15-year period.

Table 4. Monitoring Schedule – Projected Monitoring Duration, Frequency and Timing

Section	Description	Year(s) for Each Monitoring Activity [1]	Frequency During Years Monitored	Seasonal Timing
On-Site Restoration Monitoring				
5.2.1	Inundation regime	Years 1, 2, 3, 5, 10 and 15 (or until two monitoring cycles indicate that full tidal exchange has been achieved)	Annual (*6 week duration*)	Spring Tides (Jun - Jul or Dec - Jan)
5.2.2	Substrate development	a) Years 1 and 2	Semiannual	Apr, Oct
		b) Years 3 to 5	Annual	Oct
		c) Year 6 to 30 acres of vegetation	Biennial	Oct
5.2.3	Channel network evolution[3]	Years 1, 2, 3, 5, 10, 15	Annual	With aerial
5.2.4	Vegetation mapping – using aerial photos[3]	Until mitigation achieved	Biennial	Jul - Aug[2]
	Ground-based quantitative vegetation sampling	Once 30 acres of vegetated area is established until 75 acres of 75% vegetation cover is achieved	Biennial	Jul - Aug[2]
5.2.5	Levee breach and outboard marsh channel geometry[3]	Years 1, 2, 3, 5, 10, 15	Annual	With aerial
5.2.6	Invasive Spartina monitoring and control	Year 1 to 75% native vegetation cover	Annual	Sept-Nov
5.2.7	Wildlife use (CLRA)	Begin when 30 ac. native vegetation to detection	Annual	Jan - Apr 15
	Wildlife use (SMHM)	Begin at 5 acres contiguous suitable habitat, end at SMHM detected	Once every 5 years	Jun - Aug
	Wildlife use (shorebirds & waterfowl)	Years 1 - 5	Quarterly	Win, Spr, Sum, Fall
5.2.8	Aerial photo	a) Year 1 to 5, 10, 15	Annual	Jul - Aug
		b) Year 7, 9, 11 … to end	Biennial	Jul - Aug
Off-Site Possible Adverse Impact Monitoring				
5.3.1	Rail bridge pier scour	a) Years 1 - 5	Quarterly	Win, Spr, Sum, Fall
		b) Years 1 - 5	Once per 10-yr storm event	
		c) Begin at implementation of corrective measures, end 5 years after	Quarterly	Win, Spr, Sum, Fall
5.3.2	Fringing Marsh Scour in Coyote Creek[3]	a) Years 1 – 5, Final year	Annual	With aerial
5.3.3	Scour of levees opposite breaches[3]	a) Years 1 - 3	Annual	With aerial
		b) If outboard marsh retreats to levees opposite breach, then 3 additional years from occurrence	Annual	Jul - Sep
5.3.4	Rail line erosion	a) Years 1 - 5	Annual	Apr - Jun
		b) Years 1 - 5	Once per 10-yr storm event	
5.3.5	Deterioration of Town of Drawbridge structures	a) Years 1 - 5	Annual	Apr - Jun
5.3.6	Water Quality	a) Adjacent to breaches – Year 1	Weekly	March / April
		b) Upstream and downstream of ponds – Year 1	Monthly	May - Oct

Notes
1. Projected time estimates to achieve Performance Criteria, actual duration is dependent upon Performance Criteria (see Restoration and Mitigation Performance Criteria, Section 5.1). If mitigation performance criteria not all met by Year 15, then the project proponents and resource agency staff will meet to determine how best to proceed consistent with adaptive management strategies.
2. If CLRA are detected, on-site vegetation and sedimentation monitoring is then only allowed from Sept. 1st - Jan 31st
3. Monitoring to use annual aerial photo

5.2.1 Inundation Regime

Inundation regime monitoring inside and outside the Island Ponds will be performed to evaluate the project goal of unimpeded tidal exchange, a fundamental precursor to achieving mitigation and restoration goals.

The water level will be recorded at four locations in the ponds during years 1, 2, 3, 5, 10 and 15 of the Island Ponds Restoration Project, or until two monitoring cycles indicate that full tidal exchange has been achieved. Water level sensors will be deployed for periods of approximately six weeks each year at four locations: one in Coyote Creek to measure the "supplied" tide heights (which are reported to vary by a small amount along this reach of Coyote Creek (Schaff and Wheeler 2003) and for which the monitoring will assume a single station is adequately representative) and one on the northern side of each pond far from the levee breaches. These sensors will be deployed to coincide with summer or winter peak spring-tide conditions (generally June to July or December to January each year). Tide stage data will be sampled at 12-minute intervals coincident with National Ocean Service continuous monitoring in San Francisco Bay.

If tides are unimpeded, then the tide stage and tide range will be nearly identical inside vs. outside the ponds. If tides are constricted, then the tide height inside the ponds will be lower than outside and the tide range will be smaller; reduced height of high tides inside the ponds will provide a simple indicator of this problem. To ensure geodetic compatibility between all data sets, tide gauges will be tied to a common local benchmark via a topographic survey and sensors will be field calibrated at least three separate times during each deployment (i.e., at deployment, midway through deployment, and at end of deployment).

5.2.2 Substrate Development (Sedimentation)

To meet the project goals of restoring tidal marsh, sedimentation must occur within the Island Ponds. Naturally deposited sedimentation will form the substrate that is essential to plant establishment and growth and will provide the environment required by benthic organisms.

Substrate development will be monitored with sediment pins and field methods modified to account for the gypsum layer. A total of 30 pins will be installed across all three ponds (15, 5, and 10 pins, respectively, for Pond A19, A20, and A21). Pin locations will be distributed across the ponds to measure anticipated deposition gradients away from each levee breach. Sediment pins will consist of UV-resistant 2" schedule 40 PVC or similar. Holes will be drilled through the gypsum layer and the PVC pipe will be driven into the underlying mud to resistance. Past experience indicates pins may go between 5-30 feet deep. The top of each pin will be at least 1 foot above the highest predicted tide level so that it is always visible; tops will be capped with a flat PVC cap glued in place. Each pin will be numbered in a manner that cannot be removed to ensure no future errors occur in determining sample ID.

To measure the rate of sedimentation accurately and account for the possibility of gypsum dissolution, which would lower the ground surface and thus lead to underestimating sedimentation, three measurements must be made at each sediment pin. The baseline measurement will consist of measuring the distance from the top of the pin to the ground surface (survey stadia rods are a simple means to perform this measurement). At each post-restoration sampling event, this distance will be re-measured. Then, three measurements of deposited sediment thickness will be made at random, undisturbed locations within 10m of each sediment pin. No less than annually during the first three years, the physical top of each sediment pin will be surveyed to reference benchmarks to determine if the pins themselves have shifted vertically. Combining all three measurements will yield a valid measure of net sedimentation and thus substrate development.

Sedimentation data will be processed and analyzed to yield bivariate plots of change over time and simple isopleth maps of sedimentation. The typical measurement uncertainty with sediment pins is 2-3cm and derives from inherent limitations in accurately establishing the representative local ground surface, especially if sampling must be done through water (i.e., sampling at higher tides).

Substrate sampling will occur twice a year, once in April and once in October, for the first two years of the restoration project. Sampling will occur once a year, in October, from year 3 to year 5. After five years, monitoring will occur once every two years until 30 acres of vegetation with 75 percent cover has established; then sediment monitoring will cease.

If the South Bay Salt Pond Restoration Project implements a more detailed sedimentation study at the Island Ponds that will provide at least an equivalent level of data on the schedule and within the turn-around time necessary to meet Island Ponds reporting needs, then the methodology described above may be replaced in part or whole by that more intensive sampling.

5.2.3 Channel Network Evolution

Tidal channel networks must evolve on the Island Ponds in order to facilitate deposition of sediment, establishment of native marsh vegetation, restoration of California clapper rail habitat, and to support the diverse fish and wildlife communities expected to use the restored marshes. Channel networks are thus an indicator of progress towards attainment of restoration and mitigation goals for the Island Ponds Restoration Project. Much of the historic tidal marsh channels remain intact at the Island Ponds (*see* Figure 3), though some are dissected by the borrow ditches and other human interventions. It is anticipated that these existing channels will persist and that small channels will form on top of the pond surface within newly deposited sediments.

Monitoring will consist of extracting channel planform morphology from the aerial photographs collected periodically and rectified to ensure spatial comparability from photo to photo (*see* Aerial Photography, Section 5.2.8). Evolution of channel networks will be measured over time. Parameters to be measured include total surface area of channels and areas of expansion and loss. Monitoring results will be incorporated into a table showing, for each pond, the total pond acreage, total channel coverage, and percent of pond as channel. Maps will show the channel network in each year, the change from prior year that an aerial image was taken, and the change from the baseline (2002 aerial photo shown in Figure 3).

These data will provide planform morphologic data on the channel network. No cross sections are planned. If inundation monitoring indicates inadequate tidal inundation, then cross sections may be added to evaluate channel geometry to assist in determining whether undersized interior channels are contributing to tidal dampening.

Analysis of aerial photographs will take place Years 1, 2, 3, 5, 10, and 15. The early years will yield critical data on the channel network relative to forming full tidal circulation and habitats for clapper rail and many other species. The later years will demonstrate the quantity of these habitats and assist with evaluating inundation regime problems, should they occur. Since this monitoring is based solely on the aerial photographs and there are likely to be more photographs available than are anticipated to be analyzed for channel network development, if unanticipated site evolution problems do occur the other photographs may also need to be analyzed to determine if diminishing channels are contributing to problems.

5.2.4 Native Vegetation Development

To evaluate progress in achieving the success criteria for tidal marsh restoration, vegetation establishment will be monitored using aerial photographs and field sampling.

Biennial Aerial Photograph Mapping - Vegetation monitoring will solely consist of biennial examinations of ortho-rectified aerial photographs until a minimum of 30-acres of vegetation has established in the project area. Aerial photos will be taken during the mid-day hours, at low tide, in the months of July or August in order to capture peak vegetation production under optimal diurnal and tidal conditions (*see* Aerial Photography, Section 5.2.8). Mapping will begin with the first full growing season after tidal flows are re-established. Aerial photos of each pond will be examined by a qualified botanist to delineate locations of plant colonization using GIS software. Subsequently, vegetation boundaries, species composition (dominant/sub-dominant), and estimates of total percent cover will be field-truthed from adjacent levees by a qualified botanist to verify the office mapping and species signatures. Tidal channels large enough to delineate at the 1:200 aerial photograph scale will be designated as open water habitat and not included in the vegetation acreage totals (e.g., borrow ditches, etc.). To allow for future comparison of the island ponds mapping with other marsh mapping in the general vicinity, the methodology used for this monitoring program is consistent with that utilized by the City of San Jose for their annual marsh study (HT Harvey, 2005). Biennial monitoring for this task will continue until the 75 acre, 75% vegetated success criteria are achieved.

Biennial Quantitative Sampling - Once a minimum of 30 acres of vegetation establishes in the study area, biennial quantitative sampling will be initiated coincident with the aerial photo mapping. A stratified sampling design will be used to determine the total percent vegetative cover in order to better evaluate the success of the mitigation, and to verify the cover estimates made from the aerial mapping method. Sampling will only occur in native-dominated vegetation patches of 2 acres in size and larger having a minimum of 50% total vegetative cover per patch (referred to as "qualifying patches").

The number, acreage, and estimate of total cover of all qualifying patches will be determined from the aerial photo mapping and field-truthing exercise (*see* above). A stratified sub-sample of qualifying patches will be selected for monitoring. Twenty-five percent of all qualifying patches having 50-75% cover will be sampled and 25% of all patches with estimated 75-100% cover will be sampled. For the safety of the botanical field staff due to logistical constraints, representative patches which are easiest to access will be sampled (e.g., those adjacent to the borrow ditches).

Qualifying patches will be sampled using a 1 meter square quadrat. The minimum sample size needed for each qualifying patch will be determined at the time of sampling so that total site variability is captured without over-sampling. Within each quadrat, total vegetative cover will be measured and cover of each species present will be documented to the nearest 10% cover category.

Monitoring should occur at low tide to enable the best viewing of the marsh vegetation. In the event that the vegetation structure compromises the ability to accurately estimate percent cover using quadrats, consideration will be given to using the line intercept method.

Monitoring will continue on a biennial schedule until the success criterion is met (i.e., 75 acres at 75% vegetative cover) or sooner if, as the marsh develops, the sampling is deemed unnecessary (e.g., the aerial mapping is accurate enough), unsafe, or infeasible by the adaptive management team (*see* Section 7.3).

Data Analysis and Reporting
Data from the aerial vegetation mapping will be graphically depicted in a series of maps to show vegetative extent and plant dominance. Data tables for each pond will list total acreage of vegetation, estimated total percent vegetative cover, and dominant plant species. Data collected from the stratified sampling effort will be depicted in table format to show total percent cover for the 50-75% and the 75-100% cover categories, and the extrapolated total percent vegetative cover for the study area. The quantitative sampling results will be compared to the visual cover estimates made during the aerial mapping effort to verify their accuracy and aid in the adaptive management decision of whether further quantitative sampling is necessary. As multiple years of data are obtained, the tables will be organized to allow comparisons between years and to show progress towards the mitigation performance criteria.

Evaluation of Progress toward Performance Criteria
Progress towards attaining vegetation-related performance criteria (*see* Restoration and Mitigation Performance Criteria, Section 5.1) will be measured by: (1) total acreage of native vegetation established (success criteria: total of 75 acres) and (2) percent total vegetative cover (success criteria: 75% vegetative cover).

Clapper Rail Protection Measures during Sampling
California clapper rails are not expected to appear at the Island Ponds until the site is heavily vegetated (e.g., >75% cover). When this level of native vegetation cover develops, the vegetation-related performance criteria will be satisfied. However, if clapper rails are detected while vegetation monitoring is on-going, the timing of vegetation surveys will be altered (to occur between September 1st and January 31st of each year) to avoid impacts; *see* Adaptive Management Framework for Mitigation Compliance, Section 7.3).

5.2.5 Levee Breach and Outboard Marsh Channel Width

The levee breaches and channels through the outboard marsh are expected to erode naturally over time until equilibrium conditions are achieved. The breach monitoring will document the response of breach width to either tidal scour or sedimentation and aid management decisions regarding breach maintenance.

The District will analyze the width of the levee breaches and outboard tidal channel using aerial photographs. The area of the breach and channels will be calculated and the results compiled from year to year to quantify change. Monitoring will be conducted in years 1, 2, 3, 5, 10, and 15 following project construction. Combined with as-built surveys of the levee breaches and outboard marsh channels, subsequent monitoring will allow documentation of anticipated breach and channel erosion. Monitoring will also include a status of side-cast materials at Pond A20; the dimension and condition of side-cast berms and presence of perennial pepperweed will be reported. If monitoring indicates that perennial pepperweed may be adversely effecting the restoration effort or the existing outboard marsh, then the agencies may request an adaptive management meeting to address the issue.

5.2.6 Invasive Plant Species Establishment

Colonization of the Island Ponds restoration site by non-native invasive plant species would jeopardize the success of the island ponds mitigation and restoration. Many of the important ecological benefits of restored tidal marsh vegetation will not be provided by invasive species. In particular, invasive non-native plant species may prevent establishment of native tidal marsh vegetation. Annual monitoring for invasive smooth cordgrass and its hybrids will occur for the duration of the mitigation project (i.e., until vegetation covers 75% of 75 acres). This effort will provide early detection and trigger prompt control efforts, before invasive cordgrass can dominate any portion of the Island Ponds. Other non-native plant species that may occur with increasing frequency in high marsh zones include Perennial Peppergrass, Russian thistle *(Salsola soda),* and New Zealand spinach *(Tetragonia tetragonioides)*. Observations of these and other non-native species will be recorded during the aerial photo monitoring and field-truthing, conducted under the native vegetation development section (*see* section 5.2.4).

Although the Island Ponds are currently at relatively low risk of invasion by non-native cordgrass, invasion of this area in the future is a real possibility. Invasive smooth cordgrass and its hybrids are most likely to colonize the low-marsh vegetation zone as they can grow lower in the tidal zone than native cordgrass. No more than 30 days prior to construction, invasive cordgrass locations identified near Pond A21 in the District's October 2005 surveys and control activities will be re-surveyed for signs of patch spread. Since excavated marsh materials are not being disposed off-site, the breaches at Pond A21 have been aligned so that stands of invasive cordgrass will not be affected by construction activity (> 50 meters away) and hence will not purposely contribute to invasion of the restoration area.

Long-term monitoring and treatment activities will occur annually between September 1st and January 31st to avoid the California clapper rail breeding season. Cordgrass populations that are taller, darker in color, have larger inflorescences, or are growing in a circular pattern will be examined more closely as these signs may indicate the presence of non-native cordgrass. Upon detection, patch size and percent cover will be documented for each stand and sub-one meter GPS coordinates will be collected so that individual locations can be re-evaluated in successive years to determine treatment efficacy. All invasive cordgrass identified in the monitoring efforts will be treated in accordance with the Refuge and the District's Site Specific Invasive Spartina Control Plans prepared by the San Francisco Estuary Invasive Spartina Project (San Francisco Estuary Invasive Spartina Project, 2005).

5.2.7 Wildlife

The ISP anticipates that restoration of the Island Ponds to tidal marsh will provide long-term ecological benefits to native bird (particularly California clapper rail) and mammal species (particularly SMHM). In addition, the District has chosen presence of California clapper rail as a performance criterion to measure success of their SMP mitigation requirements. Although there are no performance criteria or success criteria associated with the presence of other wildlife species, the project partners agreed it was prudent to incorporate a wildlife component into this monitoring program. Monitoring for bird and mammal species will reveal whether restoration of tidal exchange at the Island Ponds produces the anticipated benefits to native wildlife species.

A) California Clapper Rail Monitoring – The Refuge will monitor for California clapper rail use within the Island Ponds using a standard call count protocol (e.g., Point Reyes Bird Observatory protocol). This survey will be conducted annually during the breeding season (per protocol January 1st to April 15th) as soon as suitable habitat (e.g., tidal marsh with 75% cover of native vegetation) develops on the Island Ponds, though the District and Refuge may elect to start monitoring sooner. Once California clapper rail has been detected within the Island Ponds via the call count protocol, this monitoring requirement will end (*see* Adaptive Management, Section 7.3). The Refuge may then continue monitoring for clapper rail use of the Island Ponds as part of their larger California clapper rail survey program (which involves winter airboat surveys of different parts of the Refuge at least once every 3 years).

B) SMHM Monitoring – The Refuge will monitor the Island Ponds for SMHM using a standard trapping protocol for this species. Trapping will begin as soon as 5 acres of contiguous suitable habitat (as defined in The SMHM and California Clapper Rail Recovery Plan, USFWS 1984) has become established at this site and will occur once every 5 years until SMHM use of the Island Ponds is confirmed. Surveys will occur between June and August. Survey locations will be determined by the location and accessibility of potential SMHM habitat that develop at the site. The Refuge will develop the survey to meet conditions that are established at the site. Once SMHM are detected on the restored Island Ponds, this monitoring requirement will end, although the Refuge may continue to monitor these Ponds as part of their regular wildlife monitoring activities.

C) Waterfowl and shorebird species – The Refuge will monitor shorebird and waterfowl use of the Island Ponds using standard protocols (e.g., Point Reyes Bird Observatory protocols for monitoring birds on salt ponds). These surveys will begin within one year of breaching and will continue quarterly at both low and high tide to track shorebird and waterfowl use of the ponds. Non-threatened and endangered bird species monitoring will end five years after the Island Ponds have been breached.

D) Black Rail Monitoring – Unlike California clapper rail, black rail require well-vegetated mid- and high-marsh and marsh-upland transition zones. Although the Island Ponds Restoration Project should eventually lead to black rail foraging habitat (and such habitat is called for under the District's SMP permits), this habitat is not expected to evolve during the time-frame of this RMMP. Thus, no formal monitoring for black rail will be conducted at the Island Ponds as part of the Island Ponds Restoration Project monitoring program.

5.2.8 Aerial Photography

Aerial photographs or satellite images at a consistent scale of 1 inch = 200 feet will be obtained for use in several monitoring activities. Images will be taken during the mid-day hours, at low tide in the months of July or August in order to capture peak vegetation production, minimize shadows and glare from sunlight, and maximize visibility of vegetation and tidal channels during the tidal regime. Images will be obtained annually in years 1 through 5, 10 and 15. In years 6 through 15, images will be obtained biennially to correspond with the vegetation monitoring (*see* Native Vegetation Development, Section 5.2.4). Photos will be ortho-rectified to ensure spatial comparability from year to year. The spatial extent of the images will include all three Island Ponds plus both sides of Coyote Creek inclusive of levees opposite the Island Ponds; Figure 3 represents the minimum spatial extent necessary to meet all monitoring needs.

Imagery will be collected by airplane-mounted, calibrated, metric cameras or by purchase from a commercial satellite vendor (e.g., Ikonos, which is used by the City of San Jose). Since several other monitoring programs are currently capturing the area needed for this monitoring program, the District and Refuge will coordinate with these other monitoring efforts (City of San Jose and the South Bay Salt Ponds) to share imagery and avoid duplicative work whenever possible.

5.3 Possible Off-Site Post-Restoration Adverse Impacts Monitoring

Another goal of the Island Ponds Restoration Project is to detect adverse impacts of the project. The permits and environmental documents for the ISP document the potential for several off-site adverse impacts. Detection of these potential adverse impacts will trigger evaluation of the need for and approach to corrective measures. Early detection of such adverse impacts (if they occur) will allow for increased management flexibility in addressing these potential problems before they become serious (*see* Adaptive Management Framework for Mitigation Compliance, Section 7.3). Monitoring activities designed to permit early detection of adverse impacts are described below.

Four of these potentially adverse impacts are related to changes in the hydrology of Coyote Creek that may occur after the connection between the Creek and the Island Ponds is restored. At high tides, the Island Ponds will store a volume of water that will flow out Coyote Creek as the tide ebbs. This ebb-flow will produce increased velocities in Coyote Creek after tidal action is restored to the Island Ponds. These additional ebb-tide flows from the Island Ponds will be greatest early in the restoration process, before sedimentation fills some of the volume of these ponds; thus, these potential adverse impacts will become less likely as restoration proceeds.

Two other potential adverse impacts are related to the concern that water in the Island Ponds may overtop remaining levees. Prior to sedimentation and vegetation establishment in the Island Ponds, exceptionally high water levels in the ponds (caused by very high tides) could overtop the remaining levees if high tides correspond to large storm events with high winds. Water overtopping the levees adjacent to the UP rail line levee could lead to erosive damage to the levee, the rail line, the abandoned town of Drawbridge, or some combination of these. The rail line currently is adjacent to tidal marsh and the town of Drawbridge currently sits in tidal marsh. The potential for erosion of the UP rail line levee was not identified in the ISP but was identified by the Consultant Team and the Refuge as a potential adverse impact worth monitoring. As with the other off-site, potential adverse impacts, the likelihood of these problems will decrease as restoration proceeds because sedimentation and vegetation development on the pond will reduce the size of wind-driven waves on the pond surface (i.e., because of reduced wind fetch and increased flow resistance).

5.3.1 Rail Bridge Scour

The ISP EIR/EIS identified scour at the railroad impacts as a possible impact. Additional modeling of scour at the railroad bridge was conducted by Schaff and Wheeler (2003) and described in Section 3.3 of the ISP EIR/EIS (ISP 2004) as "Hydrology Impact -3".

The following two mitigation measures related to the railroad bridge were identified in the ISP EIR/EIS and will be implemented as part of this monitoring program:

> "Hydrology Mitigation -1a: A qualified engineer should conduct regular inspections of adjacent mudflats and the railroad bridge piers during the first 5 years following breaching to look for evidence of scour or damage to bridge pier supports. This inspection should be coordinated with regular bridge inspections conducted by Union Pacific. The engineer should prepare inspection reports documenting the results of the inspection and any recommendations for additional work."
>
> "Hydrology Mitigation -1b: If bridge inspections identify excessive scour or damage to bridge piers not related to weather patterns or upstream changes, then a qualified engineer shall develop a plan for protecting the piers and USFWS work with the railroad to implement the plan."

The District will conduct the inspections required by mitigation measure 1a (above) quarterly during the first five years following restoration construction at the Island Ponds and following each major (10-yr) storm event in the first five years. Monitoring activities will be coordinated with UPRR personnel to the extent practical to avoid duplicative efforts. Mitigation measure 1b (above) will be conducted if necessary jointly by the District and Refuge. If problems are detected, then the duration of monitoring will be extended to cover a period of five (5) years following implementation of any corrective measures to ensure their efficacy.

5.3.2 Fringing Marsh Scour in Coyote Creek

The increased tidal prism and associated increased velocities in Coyote Creek that will follow restoration of tidal action to the Island Ponds could result in scour of the fringing marsh along the margins of Coyote Creek. Previous modeling of breaches at the Island Ponds (Schaff and Wheeler 2003) predicted limited erosion of approximately 2-3 feet in depth at the UPRR railroad bridge (discussed separately in Section 5.3.1, Rail Bridge Scour).

The extent of scour of the outboard fringing marsh will be monitored along Coyote Creek, by calculating the area of marsh from aerial photographs taken each year in the first five years following construction and at the final year of monitoring and the results compiled from year to year to quantify change. This analysis will cover the reach of Coyote Creek from the eastern end of Pond A19 to the western end of Pond A21 and include marsh on both sides of Coyote Creek.

5.3.3 Scour of Levees Opposite Breaches

In order to determine if flows out of the Island Ponds levee breaches cause unacceptable erosion to the levees across Coyote Creek (much, but not all, of which currently has outboard fringing marsh), these levees will be monitored.

The levees in-board of fringing marsh will be evaluated from the annual aerial photography and from an annual visual inspection for the first three years. Where these photographs or inspections indicate outboard marsh retreat to any section of levee, those levee sections may be surveyed if deemed necessary for a three-year period. Data between years will be compared to determine if there is any change.

5.3.4 Rail Levee Erosion

Following breaching of the Pond A21 levee, full tidal exchange will raise water levels in the pond. Wind and wave run-up under high tide conditions in concert with large storm events may produce erosion and localized flooding along the east side of Pond A21 adjacent to the UP Railroad. Monitoring of the rail levee is designed to detect the earliest indication of any erosion caused by water from A21 so that the problem can be remedied before any significant erosion has occurred.

Levee erosion along the east side of Pond A21 will be visually assessed on an annual basis between April and June for the first five years following construction. In addition, a visual inspection will be performed following major (10-yr) storm events that, in concert with high tides, might lead to levee erosion in the first five years. This schedule will allow time to develop plans to correct areas of significant erosion.

The visual inspections will consist of looking for signs of erosion and debris markers of flow elevations. If problems are detected, then an automatic water level recorder may be installed in the area adjacent to the railroad line and Pond A21 in order to determine whether water levels are increasing erosion of the rail line levee. This automatic water level recorder would remain deployed for a minimum of one rainy season.

5.3.5 Accelerated Deterioration of Town of Drawbridge

The remnants of the historic town of Drawbridge are located between Coyote Slough and Mud Slough. The ISP EIR/EIS (2004) found that although introduction of tidal waters to the ponds would not likely affect these remnants, the Refuge is responsible for documentation of cultural resources. Any documentation needed to address potential effects on Drawbridge or other cultural or archaeological resources will be created by the Refuge through correspondence with the California State Historic Preservation Officer.

Deterioration of the town of Drawbridge will be assessed visually by the same registered Civil Engineer surveying the rail line. Thus, this survey will happen on an annual basis between April and June for the first five years following construction. Any evidence of accelerating erosion will be reported to the Refuge.

5.3.6 Water Quality

In coordination with water quality monitoring performed by USGS, the Refuge will perform grab samples within one-foot of the surface and within one-foot of the bottom upstream and downstream of the first breach site (but not for the second breach on A21 and A19) for each of the three ponds. Therefore, testing would be done for three breaches, the first breach on each island. The samples will be tested for salinity, DO, pH, turbidity and temperature. The sampling would occur the day after breaching, 7-days after and then weekly as necessary until the salinity levels return to normal.

In addition, grab samples within one-foot of the surface and within one-foot of the bottom will be taken between the Pond A14 receiving water sample site and the downstream breach on Pond A21; and the Pond A18 intake structure and the up stream breach of Pond A19. Samples will be tested for salinity, DO, pH, turbidity and temperature. The sampling would occur once a month from May to October in the year of breaching. Based on the results of the first year's water quality sampling, the RWQCB may require sampling in future years.

6 ONGOING MAINTENANCE

In addition to ongoing monitoring and maintenance activities related to levees and other infrastructure features, the project sponsors will need to plan for recurrent biological management issues. Foreseeable recurrent issues include invasive plant species management and mosquito control.

6.1 Invasive Plant Species

Newly identified stands of invasive cordgrass will be treated aggressively to prevent populations from becoming established in the newly forming marsh. Existing treatment approaches identified in the Refuge and the District's Site Specific Invasive Spartina Control Plans prepared by the San Francisco Estuary Invasive Spartina Project (San Francisco Estuary Invasive Spartina Project, 2005) will be utilized. Surveys and control activities will be performed annually as described in the Invasive Species Monitoring, Section 5.2.6 until they are deemed unnecessary through the adaptive management process, or the success criteria for the mitigation is met.

6.2 Mosquito Control

Salt marsh mosquitoes oviposit primarily in vegetated mid- and high-marsh areas. Tidal salt ponds in the South Bay may provide mosquito breeding habitat, although this potential is reduced in ponds with significant tidal fluctuation (Maffei 2005). Tidal fluctuation of about 1.5 feet will minimize the potential for mosquito breeding throughout the majority of the ponds. Potential breeding habitat will occur primarily in vegetation on the edges of the Island Ponds, where surface water disturbance is lowest, or in those salt pannes that are inundated only at the highest tides. At Island Ponds, the existing borrow ditches are deep; this makes them poor mosquito breeding habitat since mosquito breeding usually makes takes place in shallow water.

Once tidal marsh vegetation patterns can be determined for the Island Ponds, the Refuge will consult with the Alameda County Mosquito Abatement District on mosquito control issues and take action as necessary following the established mosquito control program on the rest of the Refuge.

Because these ponds may be susceptible to breeding of both the summer salt marsh mosquito *(Aedes dorsalis)* and the winter salt marsh mosquito *(Aedes squamiger*), monitoring and control will occur year round (Maffei 2005). Minimal mosquito control will be required prior to development of vegetated mid- and high marsh areas (these are projected to develop no sooner than 5 years after breeching). Since the use of chemical insecticides in tidal areas is generally discouraged, control methods will include (where possible) ditching to improve water circulation or use of bio-control methods. Such methods include use of Altosid (which prevents sexual maturation) and release of insect pathogens, including various strains of bacteria.

7 REPORTING AND ADAPTIVE MANAGEMENT

The annual mitigation and monitoring report deadline is February 1st of each monitoring year, with the first annual report due in 2007. The final monitoring report is due 6 months after field monitoring activities conclude, which is currently projected to occur after completion of year 15 of the project. Reporting and adaptive management consist of as-built surveys (Section 7.1), annual monitoring reports (Section 7.2), adaptive management checkpoints based on annual monitoring results (Section 7.3), and final monitoring (Section 7.4).

7.1 As-Built Surveys

Within 90 days of the completion of construction at the Island Ponds, the District will submit documentation of the as-built surveys to all regulatory and resource agencies involved in the Island Pond Restoration Project. These as-built surveys will be conducted in manners sufficient to form the basis for evaluating geomorphic changes at the Island Ponds following levee breaches. The following as-built survey data will be collected and provided:

- **Levee breaches** will document that construction of these features met the design elements specified in the District's Engineering Plans;
- **Constructed outboard marsh channels** will document that construction of these features met the design elements specified in the District's Engineering Plans;
- **Pond surface topography** including both the existing condition and the altered conditions where excavated material has been placed. Surveys of the pond bottom elevations may rely on topographic data developed previously by USGS and/or the District; however, areas where excavated material has been placed will need to be surveyed in order to track the fate of that material and to account for this material in calculations of sedimentation rates.
- **Levees within 50 yards of the removed pumps at Pond A19 and A21** will document the condition of these levees so that any future degradation of these levees can be detected and (if necessary) corrected.

All survey documentation will contain 1 foot topographic contours. A mix of aerial and on-ground optical survey techniques will be used to survey the as-built condition of the features listed above.

7.2 Annual Monitoring Reports

The District and Refuge will submit annual monitoring reports to USACE, USFWS, BCDC, CDFG, and RWQCB by February 1st of each year beginning in 2007, the District for the first five year, and the Refuge for the next five. The annual monitoring report format will be based the 2004 Mitigation and Monitoring Proposal Guidelines developed by the San Francisco District of the US Army Corps of Engineers (USACE 2004). The outline below provides an annual report structure that will include the necessary content and detail to evaluate: (1) the status of the Island Ponds Restoration Project; (2) the restoration progress with respect to the performance criteria; and (3) the overall progress toward meeting the restoration and mitigation objectives of the project. Essential components of the annual monitoring report include the following:

Project Information

Including: project name; applicant information; consultant information (if appropriate); permit file number for all agencies; acres of impact and type(s) of habitat impacted; construction start date; and mitigation monitoring year.

Mitigation Site Information

Including: location of site (including a regional map); specific goals/purpose for the compensatory mitigation site; date mitigation site constructed; summary of dates of previous maintenance and monitoring visits; name, address, and contact phone number for District and Refuge; and, as needed, a summary of remedial action.

Figures

Including a location map and site map. The site map will include: habitat types as described in the approved mitigation plan and locations of any photographic stations, landmarks, or sample points. Additional figures will present monitoring results graphically, where applicable, if these figures facilitate data interpretation and analyses.

Performance Criteria

Including a list of the performance criteria for the project as described in this report.

Tabular Results

Including: tabulated results of monitoring visits, including previous years, for evaluation versus quantifiable success criteria (e.g., unrestricted tidal exchange, acceptable sedimentation levels establishment of appropriate vegetation). Additional tables will also be included, where applicable, to facilitate data interpretation and analyses.

Summary of Field Data Collection

Including: a summary of the field data taken to determine compliance with success criteria. The On-Site Restoration section of the monitoring report will include *Methods, Results and Discussion,* and, where applicable, *Lessons Learned* for each of the following:

On-Site Restoration Monitoring:

- Inundation regime
- Substrate development/sedimentation
- Channel network evolution
- Native marsh vegetation establishment
- Levee breach and outboard channel geometry
- Invasive plant species
- Wildlife

Off-site Possible Adverse Impacts Monitoring:

- Rail bridge pier scour
- Fringing Marsh Scour in Coyote Creek
- Scour of levees opposite breaches
- Rail levee erosion
- Drawbridge structures deterioration

Problems Noted and Proposed Remedial Measures

The monitoring report will contain a discussion of problems noted during the previous monitoring year and discussion of proposed remedial measures to address these problems.

7.3 Adaptive Management Framework for Mitigation Compliance

The District, Refuge, and the regulatory and resource agencies agree that restoring the Island Ponds to tidal action will lead to formation of desirable tidal marsh habitats as the ponds fill with sediment, native marsh vegetation colonizes, and a natural community becomes established. Each of these parties also expects that the mitigation requirements of the District and Refuge can be met within the larger 475-acre Island Pond restoration effort. The District, Refuge, and regulatory agencies understand that if initial progress towards compliance is too slow, then the Island Ponds Restoration Project may not succeed in achieving mitigation performance criteria and corrective measures may be necessary.

Based on rough calculations, the time frame necessary for attaining the desired mitigation outcomes is approximately 15 years (*see* Anticipated Outcomes, Section 2.4). Because this project employs a passive restoration approach to the restoration of a complex natural tidal marsh ecosystem, the actual timing of development of the restored marsh could vary from these projections by a wide margin in either direction. Therefore, it will be of great benefit to all parties to utilize an adaptive management approach in carrying out mitigation monitoring.

The goals of this adaptive management approach will be to:

1) Provide for periodic progress checkpoints between the District, Refuge, and regulatory and resource agencies to define and evaluate acceptable positive progress, to make adjustments to the monitoring effort (parameters monitored and monitoring frequency and start/end times), and to determine if any corrective measures are necessary. These determinations will be based on evolving site conditions and monitoring results.
2) Provide for the appropriate level of compliance monitoring in the face of continually evolving site conditions such that monitoring captures restoration progress while avoiding unnecessary efforts.
3) Determine when performance criteria and overall mitigation requirement compliance have been achieved, regardless of numbers of years following breach.

Based on the updated restoration outcome projections described in Anticipated Outcomes (Section 2.4), the monitoring program schedule anticipates that some mitigation monitoring will occur for the entire 15-year period and longer if all performance criteria are not met within 15 years. Within this 15-year period, the following adaptive management steps will take place (some of these adaptive management steps may occur simultaneously if appropriate):

Adaptive Management Action #1 – Fixed checkpoint at Year 3: At the conclusion of the third year of monitoring and after submission and review of the Year 3 Monitoring Report, a progress checkpoint meeting will take place between the District, Refuge, and resource and regulatory agencies (including, at least, ACOE, CDFG, RWQCB, BCDC, and USFWS). At this checkpoint, it will be determined whether to initiate, reduce or suspend any monitoring activity and whether any corrective measures are warranted to address any undesirable conditions at or near the Island Ponds (*see* Contingencies, Chapter 8).

For this and all subsequent checkpoint meetings, resource and regulatory agencies may identify performance criteria that have been attained and reduce or eliminate the related mitigation monitoring requirements.

Adaptive Management Action #2 – Floating checkpoint(s) to discontinue adverse impacts monitoring activities: Within a few years after restoration, monitoring for potential off-site adverse impacts will no longer be necessary as these problems, if they occur at all, are expected to manifest soon after the Island Ponds are restored to tidal action. No *a priori* predictions of the duration of adverse-impact monitoring are possible; but, the monitoring data will provide clear information for determining whether adverse impacts are developing and thus whether further monitoring is still required. Based on field conditions determined during monitoring, some adverse-impact monitoring activities may stop sooner than others. The District or Refuge will petition the resource and regulatory agencies to cease adverse-impact monitoring activities when monitoring results support such a change. The regulatory and resource agencies will review the monitoring results and petition to determine whether to cease or continue monitoring. This meeting may be waived by the agencies if they determine that a discussion of the petition is unnecessary.

Adaptive Management Action #3 – Floating checkpoint at initiation of ground transect monitoring of vegetation: When vegetation colonization has progressed to the point of initiating ground-based sub-sampling efforts (*see* Native Vegetation Development, Section 5.2.4), a progress checkpoint meeting will occur between the Refuge, District, and the resource and regulatory agencies (including, at least, ACOE, BCDC, CDFG, and USFWS). At this checkpoint, the feasibility of initiating ground-based quantitative vegetation sampling should be discussed in addition to any suggested modifications to the sampling methodology.

Adaptive Management Action #4 – Floating checkpoint one year after the initiation of ground-based quantitative vegetation sampling: One year after ground-based quantitative vegetation sampling efforts have commenced (*see* Native Vegetation Development, Section 5.2.4), a progress meeting will occur between the Refuge, District, and the resource and regulatory agencies (including, at least, ACOE, BCDC, CDFG, and USFWS). At this checkpoint, it will be determined whether to modify, reduce or discontinue quantitative vegetation monitoring based on the prior years data collection and analysis.

Adaptive Management Action #5 – Floating checkpoint at detection of California clapper rails: When California clapper rail surveys identify presence of this organism in the Island Ponds, a progress checkpoint meeting will take place. At this point in time, all monitoring results will be reviewed to provide a comprehensive determination of overall progress toward meeting the full suite of performance criteria (*see* Restoration and Mitigation Performance Criteria, Section 5.1). If vegetation monitoring is ongoing at this point, all parties may consider whether the timing of vegetation monitoring should change so as to avoid disturbing California clapper rails.

Adaptive Management Action #6 – Fixed checkpoint at Year 10: At the conclusion of the 10th year of monitoring and after submission and review of the Year 10 Monitoring Report, a progress checkpoint meeting will take place between the District, Refuge, and resource and regulatory agencies (including, at least, ACOE, CDFG, RWQCB, BCDC, and USFWS). At this checkpoint, it will be determined which, if any, performance criteria have not been attained and whether to initiate, reduce, or suspend any monitoring activity. This meeting should provide all parties with a clear understanding of the restoration trajectory to that point and allow for refined projections of the probable time required to attain mitigation requirements.

It is possible that all performance criteria for the Island Ponds will have been attained prior to 10 years after restoration construction is completed at the Island Ponds. In this case, Adaptive Management Action #6 supersedes the need for this checkpoint.

Adaptive Management Action #7 – Final floating checkpoint at compliance with all performance criteria: When the District and Refuge believe all mitigation performance criteria have been attained, they will request a final checkpoint meeting to review this determination with each of the regulatory and resource agencies that have issued permits for the ISP, SMP, and LGRP. Prior to that meeting, the Refuge and District will prepare and submit a draft Final Monitoring Report (*see* Final Monitoring, Section 7.4). If the regulatory and resource agencies concur that all performance criteria have been attained, then the mitigation monitoring activities identified in this RMMP will cease.

7.4 Final Monitoring

The final monitoring report will be prepared when all performance criteria have been satisfied or when regulatory agencies release the Project Proponents from their mitigation obligations. No more than six months after the final monitoring activities conclude, this report will be submitted to the USACE, BCDC, USFWS, CDFG, and RWQCB. This final report will provide a summary of the on-site mitigation monitoring and off-site adverse impact monitoring. The report will compare the site conditions to the performance criteria established in this RMMP. As with annual reports, the final report will present a schedule of monitoring activities performed, monitoring methods, monitoring results, and a discussion of lessons-learned for each monitoring parameter. The final monitoring report will present this information in sufficient detail that regulatory agency staff can evaluate progress against performance criteria established for the Island Ponds and assess the success or failure to of this project in meeting its mitigation goals. The final monitoring requirement will be submitted to the agencies prior to the Final Checkpoint Meeting (*see* Adaptive Management Framework for Mitigation Compliance, Section 7.3)

8 CONTINGENCIES

This section presents contingency measures that could be implemented if desired outcomes fail to materialize or if adverse outcomes occur. Because actual future conditions impairing restoration outcome cannot be predicted in their entirety, additional or alternative corrective measures not described here may be most appropriate. From a pragmatic perspective, relatively few corrective actions can be implemented for a reasonable cost and thus the District and Refuge will confer with the regulatory and resource agencies to determine whether to implement contingency measures, taking into account the specific conditions of the Island Ponds and the state of knowledge about field conditions. Thresholds of action are built into every contingency measure. These thresholds are part of the performance criteria (Section 5.1); field monitoring data (Section 5.2) will reveal restoration and mitigation status and conditions relative to these criteria. Any action taken would be to address the underlying cause(s) of the problem. Addressing the underlying cause requires having the field data necessary to evaluate the range of possible causes. Funding of possible contingency measures will come from the District and/or the Refuge.

8.1 On-site

Contingency measures for the following on-site problems have been identified:

1) Inadequate tidal circulation (Section 8.1.1)
2) Inadequate substrate for plant growth (Section 8.1.2)
3) Non-native invasive species (Section 8.1.3)
4) Inadequate native vegetation cover establishment (Section 8.1.4)

8.1.1 Inadequate Tidal Circulation

One possible problem in achieving the restoration targets would occur if tidal circulation did not reach levels sufficient to facilitate the natural sedimentation rates necessary to: (1) raise pond elevations, (2) provide a natural substrate for plant colonization, and (3) provide intertidal habitats within channels and on the marsh plain. Inadequate tidal exchange would be due to one or more of the following problems: (1) undersized levee breaches, (2) undersized channels across the outboard marsh, or (3) constricted tidal circulation inside the ponds due to post-restoration sedimentation within the existing channels and borrow ditches or channel capture by the invasive *Spartina alterniflora* and its hybrids with the native *S. foliosa*.

Monitoring of the inundation regime inside the Island Ponds (*see* Inundation Regime, Section 5.2.1) will provide the data to determine whether inadequate tidal exchange is occurring. Monitoring levee breach and outboard marsh channel morphology (*see* Levee Breach and Outboard Marsh Channel Geometry, Section 5.2.5), interior channel network evolution (*see* Channel Network Evolution, Section 5.2.3), and non-native plant species establishment (*see* Invasive Plant Species Establishment, Section 5.2.6) would provide the data to determine which of these problems was causing inadequate tidal exchange and they would also inform decisions regarding potential corrective management options.

Corrective measures for undersized levee breaches or undersized outboard marsh channels would be to mechanically enlarge these openings to allow more tidal exchange. This excavation work would require mobilizing appropriate construction equipment and determining appropriate disposal of excavated material (presumably in the same manner as at the time of breach and outboard marsh channel construction; *see* Design Elements, Section 4.1). These corrective measures will bear comparatively high costs. Therefore, it will be critical to evaluate the annual trends in levee breach and outboard channel geometry over time to determine whether natural processes, if allowed to continue without intervention, would resolve the problem within a time-frame acceptable to all parties.

Corrective measures for constricted tidal circulation within the Ponds that is not due to undersized breaches or outboard marsh channels would be to control the invasive cordgrass (*see* Non-Native Invasive Plants, Section 8.1.3) or to dredge deposited sediment within the existing channels. Dredging the channels would require equipment mobilization and material disposal as described above and likely would be fairly costly. Interior channel dredging may prove to be infeasible except perhaps just inside each levee breach. Consequently, more detailed field topographic data of the channels would be warranted before considering any dredging, to determine the necessary extent of this work. Dredging interior channels would be considered a comparatively extreme action and it will be implemented only if its beneficial outcome is nearly certain and its absence is clearly a significant detriment to achieving target ecological outcomes.

8.1.2 Inadequate Substrate for Plant Growth

One possible impediment to achieving the restoration targets would occur if suitable substrate for plant growth (assumed to be a minimum of about 1 foot of natural sediments) failed to develop. This substrate could derive from natural deposition (sedimentation) and/or the natural marsh soils beneath the gypsum. Inadequate substrate would interfere with marsh vegetation establishment and the ecological targets would not be met. These problems could be caused by (1) inadequate tidal exchange (*see* Inadequate Tidal Circulation, Section 8.1.1), (2) pond elevations being too high relative to the tides (a better understanding is anticipated with completion of the District's December 2005 topographic survey; *see* Section 3.5.1, Pond Elevations), or (3) lack of gypsum dissolution (if pond elevations higher than currently believed).

Pond Elevations Too High. Our limited understanding of baseline conditions could mean that Island Pond elevations are too high relative to the tidal regime. No corrective measures can be taken if this cause is determined to be the underlying problem. Validating the baseline USGS pond bathymetric survey data relative to a geodetic datum (*see* Pond Elevations and Local Tides, Section 3.5) would provide the data to determine whether high pond surface elevations relative to the tides is the source of the problem. At the time of preparing this Draft RMMP, this data validation step has not occurred though it is expected to be completed prior to production of the Final RMMP (N. Nguyen, District, *personal communication*, December 2005).

Lack of Gypsum Dissolution. If the gypsum layer does not dissolve at an adequate rate *and* pond elevations are comparatively low *and* inadequate sedimentation is occurring on the pond surface *and* there is sufficient tidal exchange, then further examination of gypsum dissolution would be warranted. Sedimentation monitoring (*see* Substrate Development, Section 5.2.2) will yield data on gypsum dissolution at each monitoring location and thus provide insight into this possible problem.

The only corrective measure for lack of gypsum dissolution is mechanical breakup of the gypsum. Engineering review of appropriate equipment and methods would be necessary to determine what approaches, if any, were feasible. However, before any such measures are considered, more precise data on gypsum dissolution would be appropriate in order to determine whether natural processes, if allowed to continue without intervention, would resolve the problem within a time-frame acceptable to all parties. Obtaining more precise gypsum dissolution data would entail developing and implementing a scientifically valid monitoring protocol that minimizes uncertainties in data interpretation and application.

This potential cause may be eliminated pending the results of the District's December 2005 topographic survey; *see* Section 3.5.1, Pond Elevations).

8.1.3 Non-native Invasive Plants

In the event that measures prescribed in this plan are insufficient to control smooth cordgrass (*see* Section 5.2.6), the District and the Refuge will continue to coordinate with the San Francisco Estuary Invasive Spartina Project and/or other bay-wide control efforts to ensure the most effective treatment regime possible.

In the event that perennial pepperweed or other invasive plant species threaten the success of the mitigation project, the District and the Refuge will discuss the feasibility of adding a control component through the adaptive management process for this project. Coordination with adjacent landowners and/or bay-wide control programs will be vital to the success of an effective treatment program for the island ponds.

8.1.4 Inadequate Native Vegetation Establishment

One barrier to achieving the restoration targets would be if native tidal marsh vegetation failed to establish to a suitable extent. This problem could be caused by (1) inadequate tidal exchange (*see* Inadequate Tidal Circulation, Section 8.1.1), (2) inadequate substrate formation (*see* Inadequate Substrate for Plant Growth, Section 8.1.2), (3) excessive non-native invasive plant species establishment (*see* Non-native Invasive Plants, Section 8.1.3), or (4) lack of colonizing source material (not likely a concern for the major plant species due to extent of tidal marsh near the project site).

The corrective measures for inadequate native vegetation cover are to implement all the appropriate contingency measures listed above following careful review of all monitoring data to determine the source of the underlying problem. If native tidal marsh vegetation fails to establish within a timeframe that is acceptable to the regulatory and resource agencies following implementation of corrective measures, then further investigations into underlying causes not considered here would be warranted. Such other possible causes could include substrate quality (e.g., chemical composition), water quality (e.g., chemical composition, salinity), or extreme grazing on vegetation.

8.2 Off-Site

Contingency measures for the following off-site problems have been identified:

1) Railroad Bridge Scour (Section 8.2.1)
2) Sedimentation in Adjacent Tidal Waterways (Section 8.2.2)

3) Scour of Levees Opposite Breaches (Section 8.2.3)
4) Rail Line Erosion (Section 8.2.4)
5) Accelerated Deterioration of the Town of Drawbridge (Section 8.2.5).

8.2.1 Railroad Bridge Scour

Railroad bridge scour contingencies were developed as described in Section 5.3.4 above. The primary contingency consists of retaining a qualified engineer to develop a bridge pier protection plan and implementing that plan before the bridge piers are undercut.

8.2.2 Fringing Marsh Scour in Coyote Creek

If monitoring detects loss of fringing marsh in Coyote Creek on either bank that reaches a significant level (e.g., 10% the area of the Island Ponds, or about 48 acres), then the Refuge and District will confer with the regulatory and resource agencies to determine if unanticipated conditions at the Island Ponds are causing excessive scour and whether any corrective measures may be warranted. If these higher levels of marsh scour are detected, they will be evaluated within a larger temporal and spatial context to account for other possible causes of marsh scour.

8.2.3 Scour of Levees Opposite Breach

If the monitoring program indicates that the fringing marsh opposite the breaches is eroding as a result of high-velocity cross-channel flows emanating from the Island Pond levee breaches, then an analysis will be performed to determine the cause and possible solutions to the problem. For example additional levee breaches may be added on the larger ponds to reduce the duration of focused cross-channel flows. Alternatively, levee strengthening may be employed to protect the adjacent pond levees. A technical report and evaluation of management alternatives will be developed and submitted to the resource and regulatory agencies for approval.

8.2.4 Rail Line Erosion

In the event that monitoring of the railroad line or ballast indicates excessive erosion along the tracks then the east side of the Pond A21 levee will be raised and/or repaired as needed to protect the RR tracks. Construction design or plans will be developed by a registered Civil Engineer to provide the existing level of protection to the railroad tracks.

8.2.5 Accelerated Deterioration of Town of Drawbridge

In the event that unforeseen impacts occur among the remnants of the town of Drawbridge, USFWS archaeological staff will consult with the California State Historic Preservation Office promptly.

8.3 Financial Assurance

The District and the Refuge share financial responsibility for implementation and monitoring of this project. Some of the monitoring will be performed by District and Refuge staff as part of their assigned tasks. For other tasks requiring large expenditures or contracted labor, the Refuge has special funding set aside, in addition to its yearly congressional allocation, to assure implementation. The District has budgeted construction costs for the current fiscal year, and will fund projected monitoring and maintenance costs related to District mitigation requirements as part of annual budget items.

9 COMPLETION

When the required monitoring period is complete and the District and Refuge believe that their respective mitigation requirements have been fulfilled, they shall each notify the resource and regulatory agencies in writing of their proposed completion status at the time of submitting their proposed Final Monitoring Report (*see* Adaptive Management Framework for Mitigation Compliance, Section 7.3). The District and Refuge will be released of their respective mitigation requirements only upon receipt of written notice from the regulatory agencies.

REFERENCES CITED

BCDC (SF Bay Conservation and Development Commission). 2003. Lower Guadalupe River Flood Prevention Program, Permit 5-02. June 26.

_____. 2004a. Letter of Conditional Concurrence for Consistency Determination No. CN 10-03 (as amended 11/19/04). November 19.

_____. 2004b. Amendment Nos. One and Two to BCDC Consistency Determination No. CN 10-03; U.S. Fish and Wildlife Service's Initial Stewardship Plan for the South Bay Salt Ponds. November 19.

_____. 2004c. Checklist for Permit Compliance. Permit No. CN 10-03. Permittee: USFWS. April 29.

CDFG (California Department of Fish and Game). 2003. Draft Agreement for Lower Guadalupe Flood Prevention Project. Notification Number R3-2002-0732. April 28.

CDFG and USFWS (US Fish and Wildlife Service). 2004. South Bay Salt Ponds Initial Stewardship Plan (ISP), Section 7 Consultation with NOAA Fisheries. (memo to USACE re: avoidance of adverse effects of treated wood leachate on migrating salmonids). April 30.

City of San Jose. 2005. Water Pollution Control Plant. Environmental Services Division. Website located at http://www.sanjoseca.gov/esd/wpcp.htm. Accessed on November 22, 2005.

Collins, J., May, M., Smith, D., Klohr, S., and K. Zaremba. 2001. Guidelines to Monitor the Distribution, Abundance, and Treatment of Non-Indigenous Species of Cordgrass in the San Francisco Estuary.

Evens, Jules. 2005. Personal Communication with Stuart Siegel. November 7, 2005.

Foxgrover, Amy C. and Bruce E. Jaffe. 2005. South San Francisco Bay 2004 Topographic LiDAR Survey: Data Overview and Preliminary Quality Assessment.

Gill, S.K. and J.R. Schultz, eds. 2001. Tidal datums and their applications. NOAA Special Publication NOS CO-OPS 1. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Springs, MD. February.

HT Harvey. 2003. Marsh Plant Associations of South San Francisco Bay: 2003 Comparative Study. Prepared for City of San Jose Environmental Services Department. November 25.

_____. 2005. Island Ponds (Ponds A19, A20, A21) Tidal Marsh Establishment Projections: Project Number 2456-01 Final Report. Prepared for Santa Clara Valley Water District. January 14.

_____ 2005. Marsh plant associations of South San Francisco Bay: 2005 Comparative Study. Prepared by Ronald R. Duke, Patrick Boursier, John Bourgeois, Donna Ball, Brian Cleary, and Mark Lagarde. Prepared for City of San Jose, Environmental Services Department, San Jose / Santa Clara Water Pollution Control Plant. Project No. 477-28. San Jose, CA. Available at: http://www.sanjoseca.gov/esd/PDFs/ComparativeStudy-Final2005.pdf

Hansen S.R. and Associates. 2003. Evaluation of the Potential for Salinity Impacts on Bay Shrimp Associated with Circulation of Saline Pond Water During the Initial Stewardship Period. Located in Appendix G of the Final Initial Stewardship Plan EIR/EIS. March 2004.

ISP (Interim Stewardship Plan). 2003. South Bay Salt Ponds Initial Stewardship Plan. Prepared by Life Science! Woodland, CA. Prepared for US Fish and Wildlife Service and California Department of Fish and Game. December.

_____. 2004. Environmental Impact Report/Environmental Impact Statement for the South Bay Salt Ponds Initial Stewardship Plan. Prepared by Life Science! Woodland, CA. Prepared for US Fish and Wildlife Service and California Department of Fish and Game. March.

Maffei, Wes. 2005. Personal communication with Tetra Tech ecologist David Munro. Director, Napa County Mosquito Abatement District.

Mitsch, W.J. and J.G. Gosselink. 2000. Wetlands. Third edition. John Wiley and Sons, New York. 920pp.

NGS (National Geodetic Survey). 2005. VERTCON - North American Vertical Datum Conversion Utility. Website accessed http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html. November 2005.

NMFS (National Marine Fisheries Service - National Oceanic and Atmospheric Administration). 2002a. Section 7 Consultation under the federal Endangered Species Act.

_____. 2002b. Section 7 Consultation under the federal Endangered Species Act. Biological Opinion regarding the USACE issuance of 10-year permit to SCVWD Stream Maintenance Program. July 3.

_____. 2003. Section 7 Consultation under the federal Endangered Species Act. Biological Opinion regarding the USACE issuance of permit to SCVWD Lower Guadalupe River Flood Protection Project. April 17.

_____. 2004. ESA Section 7 Consultation for South Bay Salt Pond Initial Stewardship Program (ISP) re: threatened *Oncorhynchus* spp. potential effects. Reference 151422SWR04SR9172. May 12.

NOAA (National Oceanographic and Atmospheric Association). 2000. Tidal Datums and Their Applications, NOAA Special Publication NOS Co-Ops 1, Silver Spring, Maryland.

PWA (Philip Williams & Associates, Ltd.) 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. December 29.

PWA. 2005. Flood Management and Existing Conditions Report. Prepared by PWA with Brown and Caldwell, EDAW, HT Harvey. Submitted to California State Coastal Conservancy, US Fish and Wildlife Service, California Dept. of Fish and Game. March.

RWQCB (Regional Water Quality Control Board) San Francisco Bay Region 1993. Standard Provisions and Reporting Requirements for Non-NPDES Wastewater Discharge Permits. August. Included as Attachment E of Waste Discharge Requirements for: US Fish & Wildlife Service and California Dept. of Fish & Game South San Francisco Bay Low Salinity Salt Ponds, Alameda, Santa Clara, and San Mateo Counties. Order # R2-2004-0018.

_____. 2002a. Waste Discharge Requirements and Water Quality Certification for: Santa Clara Valley Water District, Lower Guadalupe River Flood Protection Project, Cities of San Jose and Santa Clara, Santa Clara County

_____. 2002b. Santa Clara Valley Water District Multi-Year Stream Maintenance Program, Santa Clara County.. Site No: 02-43-C0332. File No. 2188.07 (PFA). March 05

_____. 2004a. Waste Discharge Requirements for: US Fish & Wildlife Service and California Dept. of Fish & Game South San Francisco Bay Low Salinity Salt Ponds, Alameda, Santa Clara, and San Mateo Counties. Order # R2-2004-0018. March 17.

_____. 2004b. Waste Discharge Requirements for: US Fish & Wildlife Service and California Dept. of Fish & Game South San Francisco Bay Low Salinity Salt Ponds, Alameda, Santa Clara, and San Mateo Counties. Order # R2-2004-0018. March 17. Attachments A, B.

_____. 2004c. Self-monitoring Program for US Fish & Wildlife Service and California Dept. of Fish & Game, South San Francisco Bay Low Salinity Ponds Alameda, Santa Clara, and San Mateo Counties; Order # R2-2004-0018. Attachment C.

_____. 2004d. Fact Sheet for Waste Discharge Requirements for US Fish & Wildlife Service and California Dept. of Fish & Game South San Francisco Bay Low Salinity Salt Ponds Alameda & Santa Clara County. Order # R2-2004-0018. Attachment D.

_____. 2004e. Water Quality Certification for the South Bay Salt Ponds Initial Stewardship Project, in Alameda, Santa Clara, and San Mateo Counties. File No. 2188.7 (bkw), Site No. 02-43-C0458. ACOE No: 27701S. May 12.

_____. 2004f. Addendum to Water Quality Certification for the South Bay Salt Ponds Initial Stewardship Project, in Alameda, Santa Clara, and San Mateo Counties. File No. 2188.7 (bkw), Site No. 02-43-C0458. ACOE No: 27701S October 5.

San Francisco Estuary Invasive Spartina Project. 2005. Invasive Spartina Control Plans for the San Francisco Estuary 2005-2007 Control Seasons: Site 5 Control Plan: Coyote Creek and

Mowry Slough Area, Alameda County; and Site 15 Control Plan: South San Francisco Bay Marshes, Santa Clara County. Available at http://www.spartina.org/control/sites.php

SBSPRP (South Bay Salt Pond Restoration Project) Science Plan. 2004. South Bay Salt Pond Restoration Project Draft Science Plan. Accessed from www.southbayrestoration.org/pdf_files/ national_sci_panel/03NSP_ SciPlanOct014.pdf. October 1. Accessed on November 14, 2005.

SCBWMI (Santa Clara Basin Watershed Management Initiative) 2001. Watershed Characteristics Report. Watershed Management Plan, Volume One (Unabridged). Prepared by the Santa Clara Basin Watershed Management Initiative - a stakeholder group organized to protect and enhance the Santa Clara Basin watershed. February.

Schaff and Wheeler. 2003. Alviso Island Pond Breach Initial Stewardship Plan Study. Prepared by Ed Gross of Schaff and Wheeler. Prepared for Cargill Salt. September 2003. Included in Technical Appendices (Appendix K) of South Bay Salt Ponds Initial Stewardship Plan Draft Environmental Impact Report/Environmental Impact Statement Technical Appendices. December.

SCVWD (Santa Clara Valley Water District). 2001. Stream Maintenance Program; Mitigation Monitoring and Reporting Program.

_____. 2002a. Coyote Creek Watershed Stewardship Plan. First Compilation. February.

_____. 2002b. Draft Lower Guadalupe River Flood Control Protection Project Mitigation and Monitoring Plan. (J&S 09-230.) August 7.

_____. 2005a. Stream Maintenance Program, Manual of Best Management Practices. 2005 Version.

_____. 2005b. Tidal Wetland Mitigation/Restoration Project (Island Ponds) Preliminary Design Memorandum. November.

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.

Trulio, Lynne A. and D. Clark (Lead authors) 2005. South Bay salt pond restoration project draft adaptive management plan. Developed by South Bay salt pond restoration project Science Team. October 28.

Tucker, Thomas J. 2004. Moffatt Nichol-Coastal Conservancy South Bay Salt Pond Restoration Project Survey Report.

USACE (U.S. Army Corps of Engineers). 2002a. Nationwide Permit General Conditions. March 18.

_____. 2002b. 2002 Nationwide Permit #27: Stream and Wetland Restoration Activities. March 18.

_____. 2002c. Nationwide Permit #33: Temporary, construction, access, and dewatering. March 18.

_____. 2002d. Long-term Stream Maintenance Program File Number 22525S. August 7.

_____. 2002e. Hydrographic Surveying Manual EM- 1110-2-1003. January.

_____. 2003. Section 404 Permit. April 28.

_____. 2004. Mitigation and Monitoring Proposal Guidelines. Special Public Notice. December 30.

USFWS (US Fish and Wildlife Service). 1984. Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan. Portland, Oregon. 141 pp.

_____. 2002. Biological Opinion re: Santa Clara Valley Water District's Stream Maintenance Program Formal Endangered Species Consultation on the Santa Clara Valley Water District Ten-Year Maintenance Permit, PN 22525S. July 5.

_____. 2003a. Informal section 7 Consultation on the Proposed Lower Guadalupe River Flood Protection Project. February 27.

_____. 2003b. Drawbridge, CA – Re-turning the Tides. September. Website www.fws.gov/desfbay/pdf/Drawbridge4. pdf. Accessed November 2005

_____. 2004a. Formal Consultation on the Initial Stewardship Project for Salt Ponds in South San Francisco Bay, Alameda, Santa Clara and San Mateo Counties, California (Corps File No. 27701S). Reference 1-1-03-F-0359. March 16.

_____. 2004b. Response Memo Re: Section 401 Water Quality Certification for South Bay Salt Pond Initial Stewardship Project in Alameda, Santa Clara and San Mateo Counties (PWQCB File No. 2188.07 (bkw), Site No. 02-43-C0458) August 25.

_____. 2004c. Response Memo Re: Consistency Determination No. CN 10-03, U.S. Fish and Wildlife Service's Initial Stewardship Plan for the South Bay Salt Ponds. (re: Prevention of Flooding). May 7.

_____. 2004d. Notification memo: Nationwide Permit for South San Francisco Bay Initial Stewardship Plan. (re: revised dredge material estimate). Margaret T. Kolar. September 24.

USGS (US Geological Survey). 2005. Correction Notice: USGS South Bay Salt Pond Bathymetry Elevation Survey. John Takekawa, Western Ecological Research Center. Vallejo, CA. 31 May 2005.

Vasey, M., J. Callaway, and V.T. Parker. 2002. Wetlands Regional Monitoring Program Plan 2002. Part 2: Data Collection Protocols Tidal Wetland Vegetation. Website located http://www.sfei.org/wetlands/wetreports.html. Accessed on November 14, 2005.

Ver Planck, W. E. 1958. Salt in California. State of California, Division of Mines. Bulletin 175.