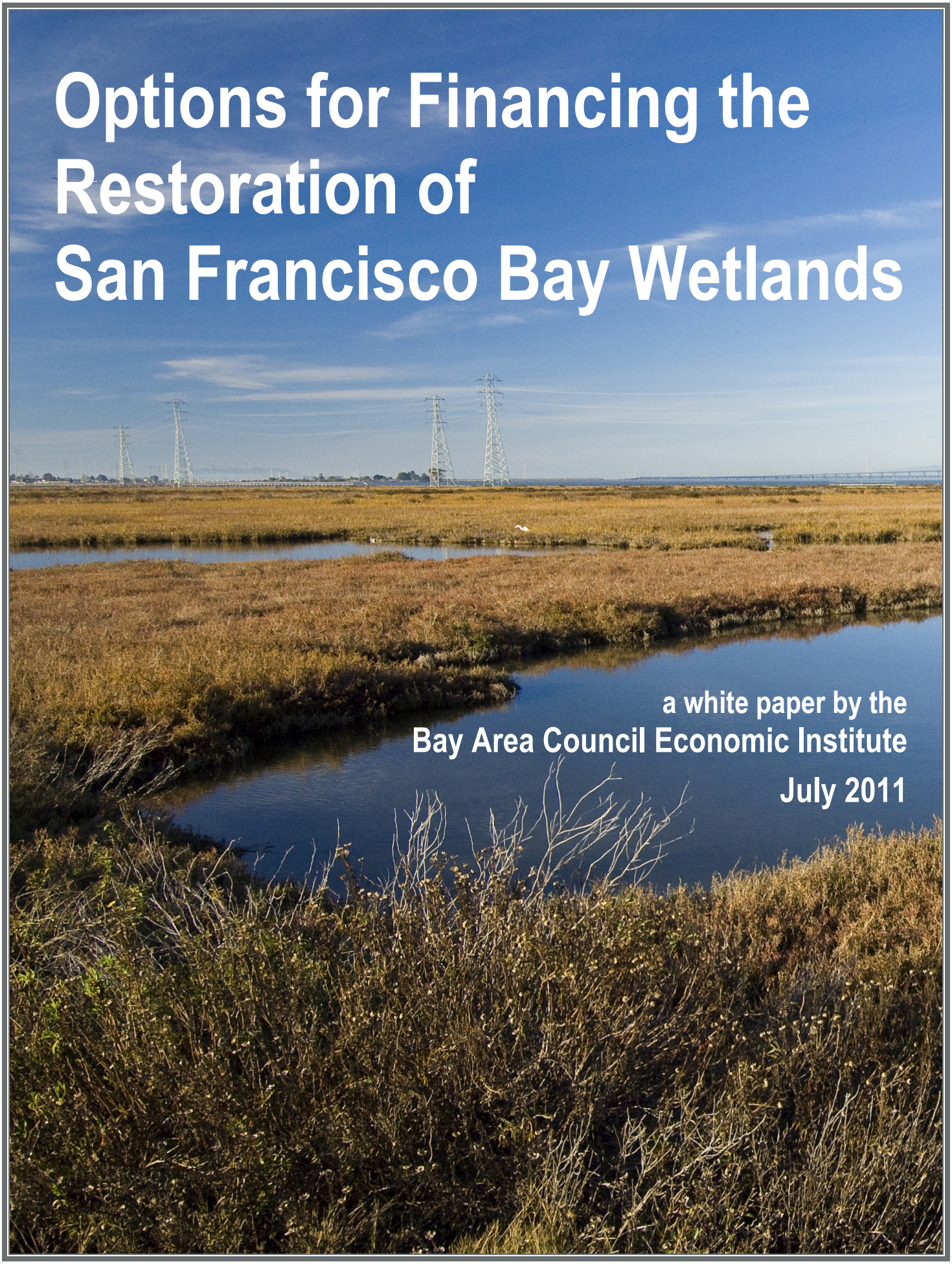
Options for Financing the Restoration of San Francisco Bay Wetlands



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Executive Summary

This analysis summarizes recent reports on wetlands restoration and finance in the San Francisco Bay Area, identifies options for financing wetlands restoration, and assesses which option or options appear most feasible. It is presented as a framing document for policymakers and other Bay Area leaders in considering legislation or other initiatives to meet regional wetlands objectives.

San Francisco Bay is the largest estuary on the West Coast and is home to 500 wildlife species, of which 128 are threatened or endangered. The Bay provides a resting spot for migratory birds and spawning grounds for fish. Its wetlands absorb and filter agricultural, industrial, and urban runoff (equal to about 70% of Bay pollution) before it reaches the Bay and buffer against high tides and storm surges, providing protection against flooding and erosion. Wetlands also capture carbon, mitigating greenhouse gas emissions. Beyond their ecological value and positive role in adaptation to rising sea levels, the Bay's wetlands also have important aesthetic value and provide significant recreational opportunities.

Bay wetlands have been diked, filled, and developed to the point that the Bay is one-third the size it was historically, with less than 10% of its original wetlands remaining. In the 1800s, large sections of Bay shoreline were diked with levees to enable various kinds of development, most notably commercial salt production in huge evaporation ponds. Development has brought residences and businesses closer to the water's edge in low-lying shoreline areas and near waterways that feed the Bay. In parts of the South Bay, groundwater extraction has caused subsidence, as a result of which some diked areas are now below high tide level. With a significant part of the South Bay and parts of the North Bay within the 100 year flood plain, and sea level rise predicted, restoring wetlands and improving flood protection will be critical to protecting communities surrounding the Bay.

To date, wetlands restoration has been primarily financed with a mix of state and (predominantly) federal funds, as well as private resources. The California Coastal Conservancy and San Francisco Bay Joint Venture have led this effort. With the

recent creation of the San Francisco Bay Restoration Authority, a vehicle now also exists to generate additional funds at the regional level.

In the past decade, the amount of San Francisco Bay shoreline acreage acquired for wetland habitat restoration has greatly expanded. The 40,000 acres of wetland habitat currently fronting the Bay account for 80% of total wetlands remaining in California. There is broad agreement among government agencies, conservationists, hunting and fishing enthusiasts, and community groups that an additional 60,000 acres should be restored in order to sustain a healthy Bay ecosystem. Of that, 36,000 acres have been identified and acquired.

Three categories of cost are associated with wetland restoration: acquisition; construction; and operation/maintenance (OM) and monitoring. Acquisition and construction are one-time costs. Among many things, construction involves planning, design and permitting; building new levees and raising old ones; grading of ponds and removal of salts or other potentially harmful sediment; reinforcing transitional slopes connecting to upland areas; installing drainage, pumps, valves, pipes, filters, fish screens and other water control structures; transporting equipment and materials; moving rail beds, power lines and other infrastructure as needed; grading or paving the tops of levees; and installing benches, lighting and signage for public access. OM costs are ongoing and typically involve maintenance and management of public areas; repair and replacement of equipment and amenities; monitoring; removal of vegetation and invasive species such as spartina; and vector control (mosquito eradication).

Active concern with San Francisco Bay wetlands restoration dates back to the 1970s, with restoration of Faber Tract (1972), Alameda Creek Pond 3 (1975), Muzzi Marsh (1976) and Warm Springs (1986). Momentum increased with the creation of San Francisco Bay Joint Venture in 1994. Since 2006, stakeholders have focused renewed attention on identifying stable, reliable funding sources for restoring the wetlands that have come under public control, particularly by state and federal conservation agencies whose mandates and responsibilities have increased dramatically while budgets and staffing have stagnated. In 2009, Governor Schwarzenegger signed AB 2954, establishing the San Francisco Bay Restoration Authority, to raise

and receive funds from public and private sources to close the funding gap for restoration on properties already acquired and to explore future acquisitions.

The following studies, papers and data sets, all developed since 2006, identify existing and potential wetland restoration projects; the scope of work required; long-term 50-year and short-term three-to-five-year costs; and additional Bay planning and study required in the future.

Comprehensive Restoration Studies

Greening the Bay: Financing Wetland Restoration in San Francisco Bay Save The Bay, 2007

This document frames the broad policy discussion regarding the financing of wetland restoration around San Francisco Bay. It lists the major wetland projects fronting the Bay shoreline and establishes the most comprehensive estimate of long-term project costs: $1.43 billion for 13 projects over 50 years, including acquisition, construction and OM. This is in addition to $370 million already invested ($254 million for acquisition and $116 million for planning, construction, study and operations/maintenance).

It outlines the benefits of wetland restoration and the principal challenges to restoration efforts: inadequate budget and staffing to manage 33,000 acres in acquisitions placed under state and federal management; lack of centralized monitoring of project and funding status; and absence of a formal regional authority established to raise, receive and distribute funds from new sources. (This last challenge has been addressed with the creation of the San Francisco Bay Restoration Authority in 2009.)

Save The Bay recommends tapping a greater share of funds from applicable state resource bonds and from local water quality, waterfront/habitat restoration and public access measures; and it calls for increased funding of the San Francisco National Wildlife Refuge Complex, which includes the South Bay Salt Ponds, Bair Island, Skaggs Island and Cullinan Ranch.

San Francisco Bay Restoration Authority Funding Options Report
Save The Bay, July 2009

Save The Bay commissioned this report by SCI Consulting to advise the newly-created Restoration Authority on dedicated funding streams it might pursue and administer.

SCI recommends a blended approach with a parcel tax at its center, based on the conclusion that a parcel tax can raise the most money with the greatest flexibility in uses of the funds and the least legal or political uncertainty. Two-thirds voter approval would be needed; a 2006 poll showed 83% of voters willing to pay $10 annually for wetland restoration and conservation.

The report offers three parcel tax scenarios ($4, $8 and $15 annually) and assesses the potential revenues across the Bay Area counties' combined 1.74 million taxable parcels. Potential revenues range from $7.0 million to $39.2 million.

Even at the high end, a parcel tax would not fully close the long-term restoration funding gap. SCI recommends supplemental funding raised through a combination of future state bonds; various user, regulatory and development impact fees; and private gifts and grants.

Funding Needs for Ready to Go or In Progress Tidal Wetland Projects in San Francisco Bay
San Francisco Bay Joint Venture, September 2010

San Francisco Bay Joint Venture (SFBJV) tracks viable wetland projects in the nine Bay Area counties—whether on the Bay or not—that are slated for, or are in the process of, restoration. Its assessment includes total acreage, acreage scheduled for restoration, lead agencies and organizations for each project, and estimated unfunded costs over 3–5 years. This analysis specifically identifies 23 projects fronting San Francisco Bay, totaling 19,086 acres, with unfunded costs estimated at $127.4 million.

Some new sites are expected to come onstream and perhaps get funded sooner—for example, the 3,600-acre Skaggs Island site in the North Bay being transferred

from the U.S. Navy. SFBJV has information in its database from lead partners about specific sites for future projects, but the data isn't firm.

South Bay Salt Pond Studies

South Bay Salt Pond Restoration Project: Updated Preliminary Cost Estimate
September 2006

This study lays out the potential scope of work to restore three South Bay salt pond complexes—Alviso in Santa Clara County, Ravenswood in San Mateo and Eden Landing in Alameda, together covering more than 13,000 acres. It outlines two restoration scenarios—one with 50% tidal restoration and 50% managed ponds (Alternative B); and a less expensive scenario with 90% tidal restoration and 10% managed ponds (Alternative C)—measured against a baseline of no action (Alternative A).

Total projected costs for construction and OM, including a 50% contingency to allow for uncertainties regarding site conditions and other variables, is $108 million for Alternative A, $650 million for Alternative B, and $657 million for Alternative C.

South Bay Salt Pond Restoration Project Phase 1 Funding and Construction Status
Update, September 2010

Phase 1 refers to seven initial funded projects in the three South Bay salt pond complexes. Five are fully funded and scheduled for completion by mid 2011. The remaining two have portions of their funding identified but not yet finalized, or face cost uncertainties but are scheduled for completion by 2013. Phase 1 project costs total $38.2 million, 75% currently funded and the remainder with funding identified and approvals pending.

[Note: In the absence of more planning and study, assessments regarding scope of work and restoration costs of South Bay salt pond non-Phase 1 wetland sites are still considered moving targets in terms of scope of work and costs.]

Flood Control and Related Issues

South Bay Salt Pond Restoration Project:
Flood Management and Infrastructure Existing Conditions Report
March 2005

South San Francisco Bay Shoreline Flood Risk Management Feasibility Study: Without Project Economics Draft Errata/Update Report
U.S. Army Corps of Engineers (USACE), August 2010

Preliminary Study of the Effect of Sea Level Rise on the Resources of the Hayward Shoreline
for Hayward Area Shoreline Planning Agency, March 2010

Flood hazard exists in two forms: tidal flooding from the Bay itself, whether from wave action in normal seasonal conditions or from tidal surge during storms; and flooding from inland runoff, particularly during rainy periods, as streams and creeks swell and runoff meets with urban and suburban stormwater and water treatment plant overflow.

Development has also encroached on creek banks, adding to erosion. While maintenance costs have risen, property taxes that funded county water and flood districts have been curtailed under Proposition 13 and subsequent measures. Most flood control districts today are fighting a holding action in meeting their flood channel maintenance obligations, with dredging and other big-ticket costs deferred.

As a result, in the shoreline fronting the Bay, flood channels now back up more quickly. Over time, rising tide levels and increasing storm severity will begin to overtop levees unless they are both raised and reinforced. As water levels in the Bay rise over the

next 50 – 100 years, the cost of maintaining existing infrastructure—and the risks and cost of doing nothing—will increase.

The challenges are most acute in the South Bay. Some 15,000 acres of former salt pond properties, ringing the Bay on both sides from Highway 92 south, were transferred from private ownership to state and federal conservation agencies in 2003, with the goal of restoring most of the ponds to tidal wetland habitat. With that transfer has come responsibility for, at minimum, maintaining the level of flood protection provided by the original salt pond levees and structures. The California Department of Fish and Game and the U.S. Fish and Wildlife Service have not seen proportionate increases in staff and budget to adequately manage the ponds, let alone undertake improvements.

Current bayside ("outboard") levees do not meet federal engineering flood prevention standards as enforced by the Federal Emergency Management Agency (FEMA), which administers the National Flood Insurance Program. Over time, it is expected that rising tide levels and increasing storm severity will begin to cause regular overtopping of existing levees, unless they are both raised and reinforced, at considerable cost. Any other change to existing conditions, such as breaching the outboard levees to restore tidal marshes while reinforcing inland ("inboard") levees for flood control, would trigger stricter FEMA engineering certification standards designed to protect against a "100-year flood" (i.e., a flood with a 1% chance of occurring in any given year over a century). Meeting FEMA standards, as written and applied to a project of this size and scope, would almost certainly be cost-prohibitive. To the extent that the defined floodplain expands inland, land uses could be restricted, more properties could be required to take out flood insurance, and insurance premiums could rise.

Under current federal law, the U.S. Army Corps of Engineers participates in federally-funded flood control projects—with funds expressly authorized by Congress—and is tasked with finding the least cost, most environmentally acceptable engineering solution. Projects must have significant national, state or regional economic benefit and are ranked based on cost-benefit analyses. The Corps also implements wetland restoration projects that are not subject to cost-benefit analysis.

Cost-benefit analyses are likely to show that some salt pond areas warrant federal engineering and funding support more than others, meaning that some areas of the Bay will neither be restored as wetlands nor have their existing levee infrastructures hardened unless local, regional or state funding sources can be identified. Where such funding sources are not forthcoming, policymakers will face difficult land use choices regarding both existing and future development.

Costs and Benefits

The cost of protection is substantial, but so is the cost of inaction. An August 2010 U.S. Army Corps of Engineers draft report estimates potential flood damage to South Bay structures and contents (including vehicles) over 50 years and at differing amounts of sea level rise. It finds that 1,149 structures are currently at risk of significant flood damage; 1,973 will be at risk by 2067 assuming a historical rate of sea level rise (.34 feet); 2,118 will be at risk by 2067 with a forecast rise of .72 feet; and 3,754 will be at risk by 2067 if sea level rises 2.13 feet. While most of these are residential structures, commercial structures have twice the structure and content value of residences. Detailed estimates of the anticipated costs of flooding will be available when the final report is released in mid to late 2011. These numbers, which are likely to be substantial, will cover damage to structures and their contents, but not emergency costs or lost business revenue.

More recent study of the flood control potential of restored tidal wetlands at the Hayward Shoreline indicates that 100-year flood protection from a restored wetland solution would cost in the range of $216–289 million or $304–405 million for a traditional engineered solution of heightened, reinforced levees.

These costs were estimated in 2010 dollars to meet an assumed 55-inch sea level rise by the year 2100. In this scenario, the shoreline would be allowed to move inland, an approach that would modify the existing shoreline and existing wetlands to allow them to accommodate higher sea level rise within the existing footprint. This strategy might also impose limits on future land uses within the designated area.

ESA PWA is in the process of preparing an additional analysis for the Bay Institute that will examine tidal and fluvial flood control benefits from specific wetlands restoration projects around the Bay. It will include economic benefits, including estimates of avoided costs from a restored wetland versus an engineered approach (levees or berms, flood channel dredging, etc.). Consultants expect the report to be completed by mid to late 2011.

Other Documents and Studies Relating to Wetlands

Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and its Shoreline
San Francisco Bay Conservation and Development Commission, April 2009

The Impacts of Sea Level Rise on the California Coast
California Climate Change Center, May 2009

2009 California Climate Adaptation Strategy
California Natural Resources Agency, 2009

These documents discuss long-term shoreline planning and wetland issues in the context of potential sea level rise due to climate change.

Restoration Costs Summary

The following table summarizes regional restoration costs derived from five of the reports mentioned above. The numbers vary from study to study, based on variables such as timelines, the scope and geography of the projects being analyzed, and whether or not operations and maintenance costs or other contingencies are included. In some cases, the estimates are for a range of options. The most comprehensive figure is the $1.43 billion estimate from Save the Bay.

Regional Wetlands Restoration Estimated Costs

Source	Scope	Projects	Time	Cost
Greening the Bay: Financing Wetland Restoration in San Francisco Bay Save the Bay, 2007	Bay Area Region	30	50 yrs.	$1.43 billion
Funding Needs for Ready to Go or In Progress Tidal Wetland Projects in San Francisco Bay San Francisco Bay Joint Venture, September 2010	Bay Area: Projects Slated or Underway	23	5 yrs.	$127.4 million
South Bay Salt Pond Restoration Project: Updated Preliminary Cost Estimate September 2006	South Bay: Three Salt Ponds	—	50 yrs.	$650–657 million
South Bay Salt Pond Restoration Project: Phase 1 Funding and Construction Status September 2010	South Bay: Three Salt Ponds, Phase 1	7	50 yrs.	$38.2 million (funded/pending)
Preliminary Study of the Effect if Sea Level Rise on the Resources of the Hayward Shoreline March 2010	Hayward Shoreline	—	100 yrs.	$243–405 million

Restoration Financing Options

Bay wetlands restoration will likely require some form of regional financing.

Of the public funding mechanisms identified in the above reports, observers see a parcel tax as the most promising option, applied on either a county-by-county or (preferably) a regional basis. Analysis by the Economic Institute suggests that this has the potential to generate annual revenues of $34–39 million, supporting bond

proceeds of $288–$577 million. Recent polling and focus groups conducted by the San Francisco Bay Restoration Authority suggest that while a sales tax would fall short, a parcel tax could potentially gain the necessary two-thirds voter approval.

At the state level, natural resource bonds offer the most reliable vehicle for funding. Given its current fiscal condition, however, California's ability to float bonds may be constrained.

Private transfer fees might be considered as a source of revenues to supplement public funding. The scale of benefit would vary with the size of the developments in question, the value of the properties being conveyed, and changes in property values over time. One limitation of this option is that it would not be a resource against which bonds could be issued.

While this analysis focuses primarily on funds that could be generated from within the region and does not attempt to explore detailed strategies for obtaining funds from state and federal sources, a number of state and federal sources with the potential to significantly contribute to wetlands restoration are identified in the body of the paper.

Two possible sources—one state and one federal—should be particularly noted. A 2012 state water bond may contain funding for wetlands restoration through the California Coastal Conservancy. At this writing, no funds in the anticipated bond are earmarked specifically for the Bay Area. The bond would have to be placed on the ballot by the legislature, which has yet to occur. A water bond appears, however, to offer the best prospect for near-term funding by the state.

At the federal level, Rep. Jackie Speier introduced the San Francisco Bay Improvement Act (H.R. 5061) in 2010 to authorize $100 million annually over ten years for the U.S. Environmental Protection Agency to fund efforts to restore and improve the environmental health of San Francisco Bay, including projects, programs and studies relating to wetland and estuary restoration and protection and adaptation to climate change. However, given the debate over federal debt levels and an unbalanced federal budget, prospects for passage are uncertain.

Several other sources that have traditionally funded wetlands restoration include the North American Wetlands Conservation Act, the U.S. Fish and Wildlife Service, the Army Corps of Engineers, the Water Resources Development Act, USEPA, and NOAA.

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The costs of a failure by the region to restore its wetlands are potentially substantial. Properties at risk from flooding include commercial and industrial facilities, research parks, residences, roads, railways, airports and other key infrastructure such as electrical transmission lines, gas pipelines and water treatment plants, many of which are adjacent to wetlands. In the South Bay, flood risk is high in areas that include NASA Ames Research Center, Google, Texas Instruments, Fujitsu Corp. and other high value facilities with billions of dollars in structures and equipment. Total potential property loss in the region from a 1.4 meter rise in water levels in the Bay has been estimated at $61.87 billion, primarily concentrated in San Mateo, Alameda, Santa Clara and Marin Counties. Income losses to businesses in floodplain areas and emergency costs further increase the costs of inaction. Direct impacts could affect 270,000 Bay Area residents, again primarily in San Mateo, Alameda, Santa Clara and Marin Counties.

In addition to their important ecological value, wetlands are an effective buffer against shoreline erosion caused by storms and tidal action—a benefit that will grow as Bay levels rise due to climate change. In this respect their value as buffers that protect key property and facilities against the effects of tides and water may exceed their value as aesthetic and recreational resources. The funding of wetlands restoration in the Bay Area—from state, federal or regional resources—therefore has significant economic implications and should be considered an important regional priority.

Options for Financing the Restoration of San Francisco Bay Wetlands

a white paper by the
Bay Area Council Economic Institute

Introduction

A series of core documents and data sets provide the essential background for any consideration of wetland restoration on San Francisco Bay, from potential benefits, to work required, to policy choices about appropriate levels of restoration at specific sites, to funding. These are each summarized below.

It should be noted that these documents incorporate the impact of sea level rise to a greater or lesser degree, depending on when they were written. The most recent estimates of 16 inches by 2050 and 55 inches by 2100 have only been available since 2008, prior to which there was little consistency. These variations, however, can have a significant impact on costs.

Also in recent years, there has been a greater understanding of issues relating to sediment supply to the Bay, suggesting a deficit that will impact both future restoration efforts and the ability of wetlands to respond to sea level rise. Both sea level rise and variation in the deposit of sediment will make the shoreline more dynamic and will increase the tension between static restoration and flood protection strategies.

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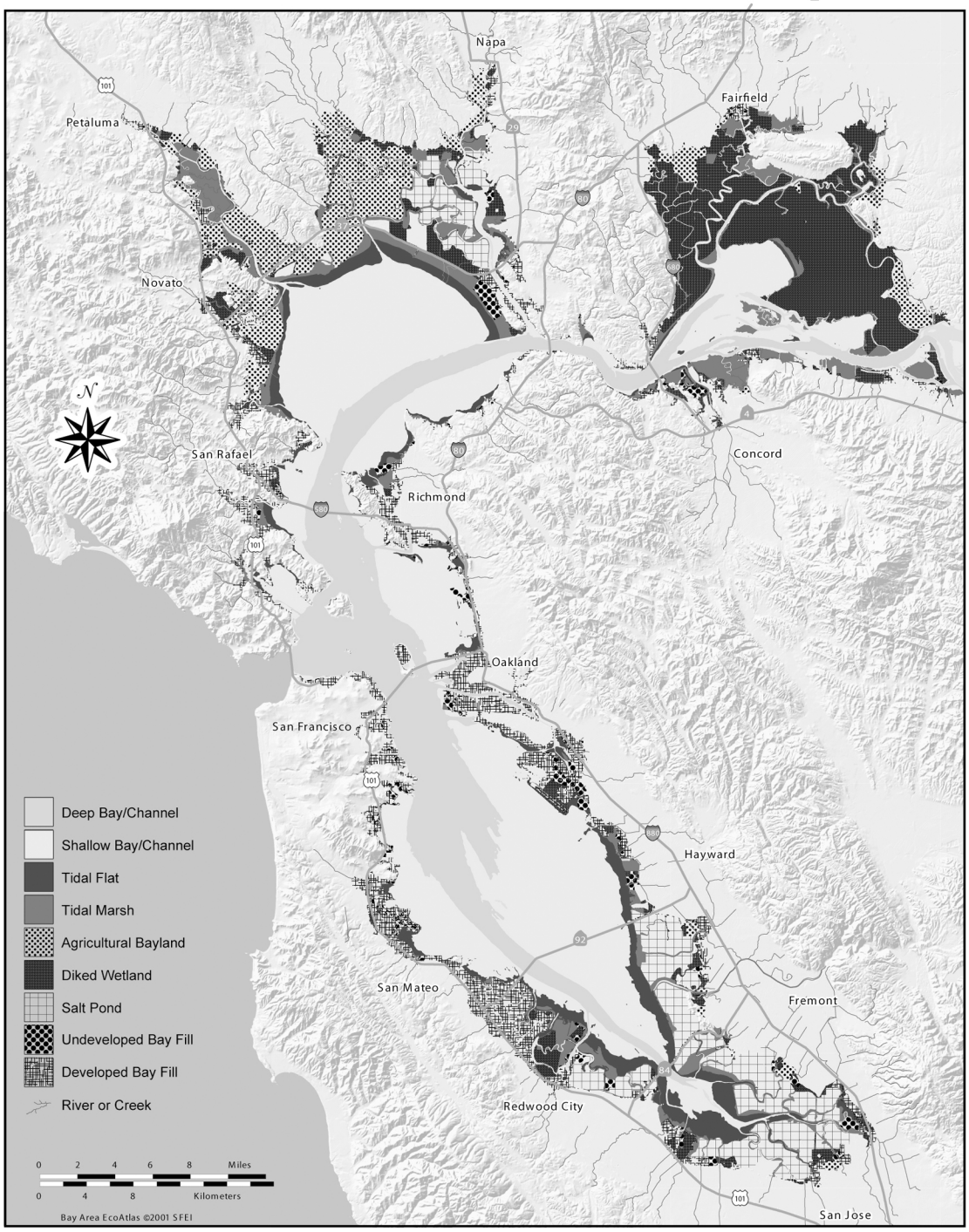
Modern Baylands



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Comprehensive Restoration Studies

Greening the Bay: Financing Wetland Restoration in San Francisco Bay
Save The Bay, 2007

Save The Bay prepared this 2007 report as a follow-up to the 1999 study, *Baylands Ecosystem Habitat Goals*, part of the San Francisco Bay Area Wetlands Ecosystem Goals Project. The earlier study identified 100,000 acres along San Francisco Bay that should be restored to their original wetland habitat state, in order to strengthen and sustain the Bay ecosystem.

Greening the Bay addresses the specific issue of financing for wetlands restoration, arguing that "the lack of steady, reliable funding to implement wetland restoration opportunities already in hand is the greatest obstacle to success." The report specifically focuses on funding for some 36,000 acres of shoreline property already acquired and designated for wetland restoration.

San Francisco Bay is the largest estuary on the West Coast—home to 500 wildlife species, of which 128 are currently threatened or endangered. The Bay provides a resting spot for migratory birds and spawning grounds for fish.

Today, the Bay is one-third of the size it was before the area saw mass settlement and urbanization beginning with the Gold Rush era; only 5% of the Bay's original wetlands remain, yet these account for 90% of remaining California wetlands. By the 1960s, the Bay was being filled in at a rate of two square miles per year, and dumping of sewage and industrial runoff was largely unregulated.

A number of public and citizen efforts around the Bay have gradually contributed to cleanup and restoration of specific sites. The 1999 study's habitat goals have served as a restoration template for scientists, government agencies, environmentalists and community groups.

Wetlands provide significant benefits to the Bay ecosystem:

Clean Water

Wetlands absorb and filter out agricultural and industrial runoff before it reaches the Bay. This runoff accounts for 70% of Bay pollution.

Economic Benefits

Wetlands contribute $4,650 per acre in flood control and dredging cost savings. Wetlands are so effective at purifying water that they are used in some areas for tertiary sewage treatment. Wetlands-based tourism and recreation generates $200 million annually; 71% of fish caught in California waters are habitat-dependent on wetlands.

Climate Change Mitigation

An acre of healthy salt marsh captures and converts 870 kilograms of carbon dioxide each year—the vehicle emissions equivalent of driving 2,280 miles—while releasing only negligible amounts of methane.

Flood and Erosion Control

Wetlands retain large quantities of runoff and sediment during storms and tidal surges, reducing flood risk and the need for Bay dredging.

Wildlife Nurseries

Wetlands offer shelter and protection from waves, fast-moving current and predators, thereby creating ideal nursing grounds for salmon, birds, seals, raptors and other wildlife.

Progress to Date

In 1999, San Francisco Bay had approximately 40,000 acres in use as wetland habitat. The *Habitat Goals* study identified about 60,000 more. Since 1999, more than 4,200 more acres have been restored in Napa, Hayward, Oakland and elsewhere.

Nearly 33,000 acres of restorable shoreline have been acquired by government agencies—primarily the U.S. Fish and Wildlife Service, the California Department of

Fish and Game, and the California Coastal Conservancy—as well as by private organizations and land trusts. Another 4,700 acres have been identified for potential acquisition. A total of just under 36,200 acres are in hand, designated for restoration and awaiting funding.

Restoration Projects in Process

South Bay	
South Bay Salt Ponds	13,000 acres
Pond A4	310 acres
Pond A18	856 acres
Bair Island	1,400 acres
North Bay	
Napa-Sonoma Marsh	10,000 acres
Hamilton Field/Bel Marin Keys	2,434 acres
Montezuma Wetlands	1,876 acres
Sears Point	970 acres
Cullinan Ranch	1,564 acres
Napa Plant Site	1,460 acres
Dutch Slough	1,166 acres
Bahia	418 acres
East Bay	
Eden Landing Ecological Reserve	722 acres

Save The Bay estimated in 2007 that it will cost $1.43 billion to restore the above sites over 50 years. This is in addition to $370 million already committed ($254 million for acquisition and $116 million for planning, construction, study and operations/maintenance), primarily from statewide resources bonds ($167 million) but also federal and private sources. The $1.43 billion figure does not include funding for acquisition or restoration of the remaining 23,000 acres to meet the long-term 100,000-acre goal and also does not include funding for the more recently acquired Skaggs Island.

Funding Challenges

The full estimated restoration cost is significant but achievable: $4 annually for each Bay Area resident over 50 years. More than 80% of the total cost is a one-time investment in planning, construction and initial monitoring; ongoing operation and maintenance (OM) costs are relatively low but may increase with accelerating rates

of sea level rise. The public supports wetland restoration: more than 83% of Bay Area residents participating in a 2006 poll said they would pay $10 a year in taxes or fees toward restoration initiatives.

[Note: More recently in 2010, the San Francisco Bay Restoration Authority conducted a similar poll with comparable but slightly lower results.]

Save The Bay identified several obstacles to effective funding of wetlands restoration, however. Most relate to the fragmented and piecemeal way in which projects have evolved and sites have been acquired:

1. Six projects alone, totaling nearly 32,000 acres, are on state or federal property, most acquired in the past decade. Despite increasing responsibilities for site management and for moving forward with restoration, public agency staffing and budgets have remained largely static since 2003.

2. Federal funds have effectively leveraged private foundation matching grants toward restoration, most notably in the 2003 acquisition of the South Bay Salt Ponds from Cargill Inc. No comparable public mechanisms have been in place at the local or regional levels to raise or commit funds directly or to leverage funds by attracting private support within the Bay Area.

3. There has been little formalized regional coordination in assigning project priorities based on consistent funding and project readiness, nor has there been centralized accounting of Bay restoration funds from all sources. This has made it difficult for advocates to apply for funds from an expanded universe of private sources.

4. To move forward, individual restoration projects often rely on support from fragmented, parochial interests. Work is defined and funded based on a range of missions, mandates and jurisdictional considerations. Without a sense of shared priorities in the sequencing of projects and funding, funds and ongoing work are not directed effectively.

Recommendations

Establish a regional special district to oversee Bay wetland restoration funding.

The district would:

- explore, promote and coordinate local and regional fundraising mechanisms;
- develop priorities and sequencing for allocation of funds.

Modeled after similar parks and open space districts and the San Francisco Bay Conservation and Development Commission (BCDC), such a district could be attached to the California Coastal Conservancy's San Francisco Bay Area Conservancy Program through a joint powers arrangement (the Conservancy includes Bay wetland restoration for the nine-county region in its mandate but does not have authority to raise or receive funds).

[Note: Creation of such a district has been subsequently achieved through creation of the San Francisco Bay Restoration Authority, which is jointly managed by the Association of Bay Area Governments and the California Coastal Conservancy.]

Target state and local resource bonds and other public sources to fund restoration.

Bay projects have to date received a small proportion of funds disbursed from four state bond issues passed since 2000 for open space/park protection, water quality improvements, acquisition of public lands and wetland restoration. Of $13.5 billion in total funding through state bonds, San Francisco Bay restoration projects have received $167 million; another $108 million in Prop. 84 funds is still available for allocation.

Various local measures have also been overlooked as potential funding sources. Examples are Oakland Measure DD in 2002 (water quality, creek/waterfront restoration, parks and recreational facilities), and East Bay Regional Park District Measure CC (habitat restoration/public access infrastructure parcel tax).

[Note: Measure DD funds have been used primarily for restoration of Lake Merritt and associated wetlands, but not wetlands more generally. Save The Bay's report

was published in 2007. As of this writing, of the $108 million earmarked for open space protection, public access and habitat restoration in the nine-county Bay Area, 20% is for coastal projects. Of the remaining 80%, approximately half has been encumbered or reserved. Other Proposition 84 funds allocated to specific agencies—the Integrated Regional Watershed Management Plan (IRWMP), the State Coastal Conservancy (SCC), and the Department of Fish and Game's Wildlife Conservation Board (WCB)—may also be available. As noted above, a state water bond being considered for 2012 includes funds for the State Coastal Conservancy, plus $20 million for wetlands restoration at Bolsa Chica, in Southern California. Through negotiations in the Legislature, there is an opportunity to also secure an explicit allocation for San Francisco Bay wetlands.]

The Bay Area congressional delegation should make full funding of the San Francisco Bay National Wildlife Refuge Complex a high priority.
More than 13,000 acres of Bay wetland restoration projects fall within the boundaries of the Refuge Complex, among them the South Bay Salt Ponds and Bair Island. As the Refuge has been expanded over time, funding has remained flat or decreased, leading to a 2007–2012 budget shortfall of $2.4 million in permanent baseline budgeting and $28 million in one-time expenditures.

Acquisition of the South Bay Salt Ponds alone increased the size of the Don Edwards San Francisco Bay National Wildlife Refuge by a third, adding operations and maintenance responsibilities and costs for 70 miles of levees; water control structures; evaluation, monitoring and other compliance procedures; and environmental education outreach.

More than 2 million South Bay residents live within 10 miles of the Don Edwards Refuge, which has 700,000 visitors annually. In its current condition, it is one of the nation's 10 most endangered wildlife refuges, in part due to inadequate federal funding.

San Francisco Bay Restoration Authority Funding Options Report
Save The Bay, July 2009

The San Francisco Bay Restoration Authority was established in August 2008 by the California State Legislature through Assembly Bill 2954. The Authority—created as a response to Save The Bay's 2007 recommendations—is charged with restoring San Francisco Bay's critical tidal wetlands by generating dedicated funding and then distributing that funding to local agencies for specific projects and programs. The Authority sunsets on December 31, 2028.

Reiterating the need for wetlands restoration and related funding as outlined in *Greening the Bay*, this report, prepared by SCI Consulting Group, notes that funding to date has been primarily distributed through state and federal agencies with jurisdiction over tidal wetlands. In addition, federal agencies have obtained limited grant funding from private foundations with respect to restoration of specific wetlands in the South Bay. The report goes on to propose alternative funding strategies, structured around using a parcel tax to generate a stable revenue stream for restoration.

The Parcel Tax Mechanism

SCI identifies a range of local funding options, but goes on to recommend a parcel tax because it:

- can be applied regionally or in specific counties;
- entails minimal legal risk;
- offers the greatest flexibility in both the tax formula and use of proceeds.

While a parcel tax would have to go before voters and would require a two-thirds vote for enactment, there is widespread support for funding of wetlands restoration as evidenced by the 2006 Save The Bay poll cited earlier.

The report recommends further public opinion research before proceeding, to better understand whether conditions for a proposal are favorable and where sentiment stands with respect to the scope of the measure and the optimum tax/assessment/fee rate.

SCI weighs the relative positives and negatives of a single regional parcel tax versus a more surgical county-by-county approach, as follows.

Regional Parcel Tax

Strengths
Stable long-term funding source.
A relatively low tax can raise significant revenue.
Weaknesses
More initial work and research required, higher upfront cost, greater risk.
If measure fails, subsequent efforts will be more difficult.

County by County Approach

Strengths
Greater likelihood for successful outcome.
Lower election cost.
Opportunity to start small; demonstrate effectiveness toward a later, regional proposal.
Weaknesses
Some counties may never adopt a tax, leading to potential inequities.

A countywide or regional parcel tax could also be adopted in combination with a package of narrowly drawn, specific fees or assessments, in a "portfolio' approach that, if drawn properly, can maximize funding while minimizing political risk. A portion of the portfolio might also be tax-supported bonds that would allow for more immediate construction of capital improvements. The report recommends the portfolio approach.

Because a parcel tax is distributed across a very broad base, a relatively low tax can raise significant revenue. The report includes a table showing the nine Bay Area counties, the number of parcels in each and the potential revenues raised based on three annual parcel tax rate alternatives: $4, $8 and $15.

Annual Revenue by Rate, Flat and Tiered Methods*($ millions)*

County	Taxable Parcels	$4.00 Rate		$8.00 Rate		$15.00 Rate	
		Flat	Tiered	Flat	Tiered	Flat	Tiered
Alameda	353,000	$1.41	$2.12	$2.82	$4.24	$5.29	$7.94
Contra Costa	293,000	$1.17	$1.76	$2.34	$3.52	$4.39	$6.59
Marin	77,000	$0.31	$0.46	$0.62	$0.92	$1.16	$1.73
Napa	46,000	$0.18	$0.28	$0.37	$0.55	$0.69	$1.03
San Francisco	157,000	$0.63	$0.94	$1,26	$1.88	$2.35	$3.53
San Mateo	175,000	$0.70	$1.05	$1.40	$2.10	$2.62	$3.94
Santa Clara	383,000	$1.53	$230	$3.06	$4.60	$5.74	$8.62
Solano	112,000	$0.45	$0.67	$0.89	$1.34	$1.68	$2.52
Sonoma	145,000	$0.58	$0.87	$1.16	$1.74	$2.17	$3.26
Total	**1,741,000**	**$6.96**	**$10.45**	**$13.93**	**$20.89**	**$26.11**	**$39.17**

Alternative Mechanisms

Even if a $15 parcel tax was assessed, it would only collect a portion of the estimated total restoration price tag. There will inevitably be the need for some combination of funding sources that is weighted toward construction costs in earlier years and OM costs over the longer term. The report goes on to assess various other funding mechanisms available for wetlands restoration:

General Obligation Bonds

may only be used to fund capital improvements, not ongoing operations and maintenance. They can be issued by state or local governments, which can set parameters for funding levels and types of projects to be financed. For qualifying projects, tax exempt bonds offer a low-interest means of raising capital. The Restoration Authority can issue bonds, but subject to a two-thirds voter approval.

Sales Taxes

can be levied by cities and counties as well as by the State. The Restoration Authority could also propose a sales tax increment. While an incremental sales tax increase could potentially raise millions of dollars annually, two-thirds voter approval is needed. Reaching this threshold would be difficult in light of current economic conditions and the recent state sales tax increase passed to help balance the state budget.

Mello-Roos Community Facilities Districts (CFDs)
can be created to levy special taxes to fund public improvements and/or services. Establishment of a CFD is by two-thirds approval of voters within the proposed district (or of landowners in undeveloped or unincorporated areas where there are fewer than 12 registered voters). A CFD can fund services as well as construction. It can leverage tax revenues by using a portion to guarantee general obligation bonds. It can include multiple localities through a joint powers agreement. But the flexibility of a CFD leads to complexity and, at times, political controversy in the setup process, how it is structured, how boundaries are drawn, etc.

Property-Related Fees and Charges
are typically cost-recovery fees for public services delivered to property owners such as water, sewage, garbage and stormwater services. These fees must be compensatory, in the amount of the cost of the specified services rendered. Fees may be imposed after affected property owners are notified, a public hearing is held at least 45 days after notice was given, and no property owners protest. If there is a protest, the public agency may opt for either an election (requiring two-thirds approval from registered voters in the affected area) or a mail-in ballot for affected property owners (requiring majority approval).

Fees could also theoretically be levied, in the context of mitigating Bay pollution from stormwater runoff, through the restoration of wetland buffer zones. Advantages include a stable, long-term revenue stream and majority approval from property owners by mail-in ballot. Use of the funds, however, would be extremely limited—only for curbing stormwater pollution, not general restoration, and only charged to properties contributing to stormwater runoff and pollution. Finally, this option potentially places the Restoration Authority in competition for funds with other public agencies specifically charged with treating stormwater runoff.

Benefit Assessments
are levied for public improvements or services that provide special benefits or advantages to property owners above and beyond those provided to the public. Typically, improvements and services cover sidewalks, streets, water, sewers, flood control, drainage and vector control. Approval is by mail-in ballot and a

majority vote from property owners, with each vote weighted according to the amount of assessment determined for each parcel.

Recent court rulings curtail the use of benefit assessments in cases where public benefits extend regionally or wider. However, it is possible that benefit assessments could be targeted to local wetland restoration projects that offered flood control or other applicable benefits to surrounding property owners.

User or Regulatory Fees
may be an option in the future—more so for the public agencies that own wetland parcels than for the Restoration Authority, which does not have authority to collect such fees. An example would be a per person or per vehicle fee charged to recreational visitors.

Development Impact Fees
may be assessed by cities and counties to cover one-time infrastructure and/or facilities costs incurred as a result of new development. The Restoration Authority does not currently have the ability to impose such fees but could be granted authority by eligible municipalities. Imposition may be politically difficult since similar, possibly overlapping fees are already widespread in many cities and counties.

Private Gifts and Grants
from foundations and other private donors can be obtained at little up front cost, but intense competition for limited funds often results in partial funding on a one-time or annual basis that makes budget planning difficult, especially with large projects.

State Revolving Funds (SRF)
were established under the Clean Water Act amendments of 1987 and are administered by the State Water Resources Control Board. They provide long-term, low-interest loans for water quality projects, including both direct mitigation measures (demonstration projects, retention/detention basins, wetlands for stormwater treatment, etc.) and associated activities (training, education, technology transfer, etc.). SRF loans are made at half the interest rate of general obligation bonds, have a 20-year amortization and can cover 100% of project costs. But competition for loans is stiff and funding would likely be restricted to stormwater runoff treatment.

State Bonds

Since 2000, California voters have passed four bond measures—Propositions 12, 40, 50 and 84—to fund open space and parks protection, water quality improvements, acquisition of public lands, and wetland restoration. These measures authorize the issuance of bonds totaling $13.5 billion. Of that, to date, restoration projects on San Francisco Bay have received some $167 million, a little more than 1% of the total funds.

Projects funded have included:

- $1 million for restoration of Hamilton Field in Marin County (Prop. 12);
- $2.25 million for Napa-Sonoma Marsh restoration planning, design and monitoring (Props. 12, 40);
- $1 million for Sears Point restoration planning (Prop. 50);
- $12.9 million for restoration planning for the South Bay Salt Ponds (Props. 40, 50).

Statewide competition for these bond funds is intense, and a large portion of this funding has ended or is expected to end in the near future. Prospects for future bond issues, given the state's precarious financial condition and voter resistance, are uncertain (Prop. 21 in 2010, to fund state parks through a vehicle license fee, failed by a 57 to 43 margin). Some $108 million in funds from the most recent measure enacted, Prop. 84, are still available and should be seriously evaluated.

Federal Funds

Key funding considerations at the federal level involve annual appropriations for wetland restoration and flood levee maintenance and adequate funding for the U.S. Interior Department's Fish and Wildlife Service and for the San Francisco Bay National Wildlife Refuge Complex to cover added wetland restoration and operations/maintenance obligations.

Funding Needs for Ready to Go or In Progress Tidal Wetland Projects in San Francisco Bay
San Francisco Bay Joint Venture, September 2010

San Francisco Bay Joint Venture (SFBJV) is one of 18 designated habitat joint ventures established nationwide under the North American Waterfowl Management Plan for the purpose of wetland and waterfowl conservation. It is made up of 26 Bay conservation stakeholders including public agencies; private environmental, recreational and other organizations; landowners; businesses; utilities; and others.

SFBJV has identified 23 tidal wetland projects on San Francisco Bay that are either in the process of being restored or are ready for restoration. Current restoration activity is being supported through a mix of state, local, NGO and federal funds (from the U.S. EPA, Fish and Wildlife Service, and Army Corps of Engineers). The work includes the Save The Bay list of projects, plus a number of lesser projects, and new projects that have been (or are being) acquired since 2007, such as Skaggs Island, a 6,600 acre site transferred from the U.S. Navy to the U.S. Fish and Wildlife Service.

SFBJV focused on near-term funding needs for the 23 projects, identifying the scope of work and lead agencies/organizations. The total funding required in the next 3–5 years, according to the group, is nearly $127.4 million. For projects scheduled further out into the future, the SFBJV database attempts to track project and funding status through lead agencies and partners, but project cost, scope and schedule estimates are tentative and/or incomplete.

Along with the funding options cited above, SFBJV has provided a list of possible other sources that have funded wetland restoration, water quality, wildlife habitat conservation, open space/recreation and other related activities, which might be explored by the San Francisco Bay Restoration Authority and others.

State

Over the long-term, the State Coastal Conservancy has made the largest investment in San Francisco Bay wetlands restoration. This occurs through the sale of bonds. The bulk of current funding comes from Proposition 84, the most recent bond measure.

California State Coastal Conservancy – San Francisco Bay Area Conservancy Program
is a consistent source of funding for major restoration efforts as well as smaller projects. The Conservancy manages some projects and provides funds to NGOs and local assessment districts for other projects that are priorities for the Conservancy and SFBJV. Funding comes through voter-approved bonds. Funding flow from past bonds—particularly Proposition 84—is currently stable, but future flows could be significantly reduced should the state fail to pass another water bond.

California Department of Fish and Game (CDFG)/ Wildlife Conservation Board
has supported restoration on CDFG-owned lands as well as lands owned and managed by NGOs and national wildlife refuges. Wetland areas not on CDFG-owned lands, but that support CDFG's mission, are higher priorities for the Wildlife Conservation Board (WCB) and the California Joint Ventures. The Wildlife Conservation Board has been a stable source of restoration funds. As with the Coastal Conservancy, funding for WCB-approved projects depends on voter-approved bonds.

CalTrans
has primarily provided mitigation funds, which are unreliable as a steady source but are valuable when received.

California Department of Water Resources
does not actively fund projects in San Francisco Bay, but has a lead role in some Delta projects, including the Dutch Slough restoration.

CALFED
has funded some programs in the past.

Federal

Most federal funding sources depend on one-time appropriations, either for specific projects or through inclusion of projects in larger programs such as the Water Resources Development Act (WRDA).

North American Wetlands Conservation Act (U.S. Fish and Wildlife Service)
Although limited to $1 million per application, this has been a consistent funding source. To date, the North American Wetlands Conservation Act (NAWCA) and U.S. Fish and Wildlife Service Coastal Program (see below) have delivered about $10 million to Bay Area projects. Projects are nationally competed, and a 1:1 non-federal match is required. NAWCA has supported 1 or 2 projects annually in the Bay Area, a number limited by the match requirement and the further requirement that a project be completed before additional funds in the same area can be applied for. NAWCA is unlikely to deliver large-scale funds but can contribute to a project's funding portfolio.

U.S. Fish and Wildlife Service
provides support to state resource agencies. Like NAWCA, a 1:1 non-federal (state) match is required, and grants are limited to $1 million per application. In December 2010, two regional projects were approved for funding at $1 million each: Breuner Marsh and Dutch Slough. This has been a consistent funding source, but appropriations have not been large and projects are nationally competed.

Water Resources Development Act (WRDA)
authorizes funding for the Army Corps of Engineers. WRDA has provided major funding for large-scale projects, primarily Hamilton Field (authorized at $128 million) and the Napa River (authorized at $40 million). The non-federal cost share for restoration projects is typically 35%.

National Fish and Wildlife Foundation
provides a mix of federal and private funding. In other areas of the country, some EPA appropriations have gone through NFWF. Grants are in the $1 million range, and there is potential to grow that number through a focused San Francisco Bay program. With that objective, San Francisco Bay Joint Venture is working with NFWF to create a San Francisco Bay Keystone Initiative.

U.S. Environmental Protection Agency (via San Francisco Estuary Partnership)
funding ranges in the millions and is dependent on authorizations and appropriations. As noted above, in other areas of the country some EPA appropriations have gone through NFWF. In recent years, the San Francisco Bay Estuary Partnership has received EPA funding for a number of restoration projects. The principal focus of this funding is on water quality, as opposed to wetlands restoration, and restoration projects compete with other water quality projects.

U.S. Army Corps of Engineers (USACE)
in partnership with local, state and other federal agencies, is implementing major wetlands restoration projects in the region, including the 998-acre Hamilton Field wetland restoration project in Novato (Marin County), and the transition of 9,800 acres of former salt ponds to wetlands in the Napa Salt Marsh. As discussed below, the Corps is actively involved in the South Bay wetlands restoration project. Supported by a staff of 350 in the San Francisco District, it has also provided feasibility analysis and construction funds for a range of smaller projects.

National Oceanic and Atmospheric Administration (Restoration Center, Partnership Program, Resource Damage Assessment Funds)
also depends on authorizations and appropriations, but can generate funding in the $10–20 million range.

Other Regional / Local

San Francisco Bay Restoration Authority

Oakland Measure DD

The East Bay Regional Parks District

East Contra Costa County Habitat Conservancy

County-based fish and wildlife committees

County and regional open space districts

Land trusts (mainly acquisition)

Local water and vector control agencies

Salt Pond Studies

South Bay Salt Pond Restoration Project: Updated Preliminary Cost Estimate
September 2006

In 2006, the South Bay Salt Pond project management team released this study with revised estimates of preliminary costs involved in restoring the 15,100 acres of salt ponds acquired in 2003 from Cargill Inc. in three South Bay salt pond complexes:

- Alviso, in Santa Clara County;
- Ravenswood, in San Mateo County at the foot of the Dumbarton Bridge; and
- Eden Landing in Alameda County just south of the San Mateo Bridge.

The South Bay Salt Pond (SBSP) Restoration Project is a joint effort of the California Department of Fish and Game, the Coastal Conservancy and the U.S. Fish and Wildlife Service.

The study was prepared by Philip Williams & Associates (PWA); Brown & Caldwell; H.T. Harvey & Associates; and EDAW, with the objective of developing and comparing costs for three alternative restoration approaches: (A) no action; (B) managed pond emphasis; and (C) tidal emphasis.

Background

This study followed a March 2005 document, *South Bay Salt Pond Restoration Project: Flood Management and Infrastructure Existing Conditions Report*, by the same consulting team. The earlier report assessed coastal flooding, wave action and fluvial storm runoff conditions in the South Bay and inventoried the various flood levee, water control structure and other flood management infrastructure in place and managed by local water districts or municipalities.

The South Bay has elevated tide levels relative to the rest of the Bay and the ocean. Sea level has been rising 0.5 feet per century, according to 2001 data from the Intergovernmental Panel on Climate Change, as cited in the study. Recent El Nino events have raised tidal levels in the Bay by as much as a foot during the winter and by 2–3 feet during storms. Land subsidence patterns in the South Bay, coupled with forecast climate change impacts to the bay tidal level of 0.5 feet in the next 50 years, (twice the historic level), further add to flood risk. *[Note: This report was written before the higher rates of sea level rise currently in use were available.]* With salt pond restoration and its associated costs assumed to be spread over a 50-year span, long-term climate change impacts are particularly relevant. Two important cost factors in SBSP restoration will be to (1) maintain or improve existing levels of flood protection in the South Bay and (2) protect power line, railroad, wastewater treatment and other infrastructure within restoration project areas. The updated preliminary estimates address the costs associated with integrating those elements into overall restoration.

Methodology

Project construction costs were developed for the following components:

- Tidelands restoration
- Managed ponds
- Upland transition zone
- Flood control
- Infrastructure
- Public access

Operations and maintenance (OM) costs were estimated for:

- Outboard (tidal) levee management
- Adaptive management

Because the scope of work at the time of the report was still unclear, construction cost estimates were based on a conceptual level of design (1–15% project definition)

and a civil engineering Class 4 scale of accuracy (Class 1 being the most accurate and Class 5 being the least), meaning a -20% to +50% margin of error. As a result, a 50% contingency was built into construction estimates.

Construction Assumptions

The type and extent of work required to restore the pond complexes was estimated based initially on a set of pond characteristics: with wave breaks, without wave breaks, or with starter channels. Costs were assessed on a "typical pond" basis. Assumptions, by design feature, were as follows:

Levee Breaches

- 3 breaches per pond at Alviso and Ravenswood.
- 2.5 breaches per pond at Eden Landing.
- Average breach watershed area equal to approximately 100 acres.
- A 100-foot starter channel at each levee breach to increase tidal exchange.
- One interior levee breach per pond to enhance tidal connectivity.

Ditch Blocks

- Ditch blocks to regulate tidal flow equal in number to levee breaches (or as needed, from 0–2 per breach).

Levee Lowering

- 25% of internal levees lowered, and 30% of external slough levees and publicly maintained flood control levees lowered, in all three complexes.
- Fill generated from lowering to be used for ditch blocks, wind-wave berms or upland transition habitat; no off-site disposal; disposal of hazardous materials not included.

Wave Break / Wave Berms

- Breaks required for ponds with fetches over 900 m (3,000 ft) in summer wind conditions, and bottom depths below mean tide level; breaks constructed with

barge-based hydraulic excavator, concurrent with excavation of antecedent or starter channels; no dewatering of ponds necessary.

Starter Channels

- Starter channels for all ponds at Eden Landing and ponds with gypsum layer at Alviso and Ravenswood; ponds with gypsum layer on the pond bed may require further starter channel excavation.
- Starter channels may be excavated as a precaution, with spoils used for wave breaks.
- Cost assumes 50% land-based excavation and 50% barge-based excavation.

Gypsum Removal

- No additional cost required beyond possible starter channel excavation.

Mobilization / Site Preparation

- Poor access from the Bay and unfavorable site conditions may require dredging of access channels or construction of landing facilities for equipment at one or more sites.
- Site preparation may require clearing debris or pumping of the site.
- At least one water control structure per pond is assumed, for draining, flooding, pumping.

Tidal Restoration OM Cost Assumptions

Once construction is completed and a salt pond is restored, operation and maintenance costs should address vegetation, invasive species and vector (mosquito) control. *[Note: Sea level rise should now be added to this list.]* Here cost is assessed based on number of acres restored and the following assumptions:

Vegetation Management/Invasive Species

- An ongoing 50-year program to eradicate invasive spartina, treating 0.2% of total area per year.
- Three person crew, $1,000 per day; two acres per day = $500 per acre.

Vector Control

- $8 per acre; less for tidal areas than managed ponds; more for backshore ponds or areas with poor drainage.

Typical construction costs for tidal restoration are: $2.3 million per pond with wave breaks; $500,000 per pond without wave breaks; $700,000 per pond with starter channels.

Typical OM costs are $510 per acre for vegetation/invasive species management; $8 per acre for vector control; and 3% of construction for adaptive management.

Managed Pond Construction Cost Assumptions

Managed ponds are intended to be restored for ongoing, more intensive management to sustain wildlife foraging, roosting and breeding. For purposes of assessing costs, potential managed ponds were evaluated first on whether they would require pumping or not.

Next, they were categorized either as “enhanced,” to be generally improved and managed to encourage bird nesting, foraging and/or breeding, but not substantially altered; or as “reconfigured” with berms and water control structures to provide greater control over water levels and create nesting islands.

Other factors influencing cost include:

- Size (grading to create berms, nesting islands);
- Bottom elevation (size and quantity of water control structures, pumps);
- Proximity to major levees or roads (mobilization of heavy equipment).

Construction assumptions involve levee repair and improvements; grading; equipment needs and costs; demolition of existing water control facilities; equipment mobilization, and planning and design.

Managed pond OM cost assumptions cover pump maintenance; water management; equipment replacement; equipment and structure maintenance; vegetation management/invasive species removal; vector control; and adaptive management.

Typical managed pond costs are as follows:

Pumped	
Construction	$3.2–$9.7 million
OM (Annual)	$82,000–$529,000
Non-pumped	
Construction	$1.5–$3.4 million
OM (Annual)	$27,000–$46,000

Other Restoration Components

Beyond direct construction and OM activities, the study evaluates a number of subsidiary improvements that protect the ponds, during and after their transformation to wetland habitats, and that ensure public accessibility.

Flood control

The study envisions a series of new levees at pond-bottom elevations, and assumes upgrades to existing berms and levees in certain locations. Depending on their relative levels of tidal exposure, levees must be armored with rock. Costs are influenced by soil composition, potential for subsidence and need for additional earthwork such as stability berms. The study establishes guidelines for levee design and maintenance/repair of “inboard” (landward) and “outboard” (bayside) levees.

Public Access

Access to restored wetlands typically involves bridges or walkways coupled with trails. Levee trails utilize flood control levees with paved surfaces and safety railings for foot/bicycle traffic or even vehicles. Tidal trails are above mean high water levels, but are designed to withstand inundation. Both construction and OM trail costs include signage, security gates, landscaping, benches and lighting.

Upland Transition Areas

Fill is needed to create natural levee contours and construct stable slopes linking wetlands to their surrounding landward areas. That fill will mostly be purchased from outside sources and delivered to and distributed within the site.

Infrastructure

The study assumes one underground utility per pond, which must be relocated or abandoned. In addition, PG&E transmission lines and towers cross the SBSP project area at intervals of one every 450 feet. Some towers could remain in their current locations and be raised, but others would have to be moved.

Total and Relative Costs of Alternatives

Total construction costs for the three alternative approaches are shown in the table below.

Cost Component	**Alternative A**[1] ($ millions)	**Alternative B** ($ millions)	**Alternative C** ($ millions)
Tidal Habitat Restoration	–	41	78
Managed Pond Restoration	–	97	46
Upland Transition Zone[2]	–	25	80
Flood Control Levees[2]	–	356	356
Infrastructure	–	10	13
Public Access	–	24	27
Total Construction	**15**	**553**	**601**

[1]Alternative A (no action) construction costs were not broken down into the various cost components.

[2]Note that shared upland transition and flood control costs are allocated to upland transition.

Values are in 2006 dollars. Totals may not match exactly due to rounding.

Again, a 50% contingency is applied to compensate for the relatively large margin of error in estimating costs, absent more detailed information about site conditions, adaptive management considerations and cost-benefit decisions, prior to work beginning. Access and water control costs are included in mobilization costs folded into each component.

For Alternative B, the managed pond option, the average tidal restoration cost is $5,500 per acre, while managed pond restoration averages $13,000 per acre. For Alternative C, the tidal option, tidal restoration averages $5,800 per acre, and managed pond restoration averages $28,500 per acre. The higher average managed pond restoration cost in Alternative C is because there are fewer, more intensely managed ponds. As expected, total tidal restoration costs are higher in Alternative C, while managed pond restoration costs are higher in Alternative B. The higher upland transition zone estimate for Alternative C is because certain flood control costs are allocated differently.

Total OM costs are broken out by component in the following table, based on annual OM cost for each component.

Total Annual Operations and Maintenance Costs
(including 50% contingency)

Cost Component	**Alternative A** ($ thousands)	**Alternative B** ($ thousands)	**Alternative C** ($ thousands)
Managed Ponds	–	3,800	1,300
Tidal Ponds	–	82	160
Upland Transition Zone	–	0.8	3
Flood Control	–	520	510
Outboard Levees	–	630	630
Public Access	–	335	377
Adaptive Management	–	25	80
Total Yearly	**5,100**	**5,400**	**3,100**

Values are in 2006 dollars. Totals may not match exactly due to rounding.

Alternative A (no action) construction costs were not broken down into the various cost components. OM costs for the no action alternative do not ensure that there will not be gradual deterioration of sites and systems.

Levee and upland transition earthwork costs do not include earth purchase or transportation from offsite. Design requirements and costs to be updated by the Shoreline Study being performed by the U.S. Army Corps of Engineers.

Managed pond costs add significantly to the annual OM cost in Alternative B relative to Alternative C and are only slightly offset by higher tidal pond costs in C. Alternative B is 75% higher in terms of OM cost than Alternative C but only 5% higher than the no action alternative. Alternative C is 40% less expensive in terms of annual OM cost than taking no action.

A final table sums up the total cost differentials among the three approaches, estimated over a 50-year period:

Total Construction and OM Costs *(including 50% contingency)*

Cost Component	**Alternative A** ($ millions)	**Alternative B** ($ millions)	**Alternative C** ($ millions)
Construction[1]	15	553	601
OM (present worth 50 years)[2]	93	97	56
Total Construction and OM	**108**	**650**	**657**

[1]Note that shared upland transition and flood control costs are allocated to upland transition.

[2]Present worth of OM costs were calculated using the equal series present worth formula, with an annual interest of 5% for 50 years.

Values are in 2006 dollars. Totals may not match exactly due to rounding.

South Bay Salt Pond Restoration Project: Phase 1 Funding and Construction Status Update, September 2010

Three island ponds in the Alviso complex were restored in 2006 as part of an Initial Stewardship Plan. Another seven projects—four in Alviso, two in Eden Landing and one in Ravenswood—have been designated Phase 1 projects scheduled for early completion over 2010–2013. The total value of these projects is $38.2 million.

Phase 1 restoration is currently 75% funded. Five of the seven SBSP projects have full funding and are either complete or on schedule to be completed in 2011. For the remaining two projects, together valued at $17.6 million, funding sources have been identified but commitments are not finalized and project cost estimates are approximate. If projected funds for the two projects come through as planned, Phase 1 projects will be fully funded and on track for completion in 2013.

Phase 1 projects are the initial SBSP projects for which funding has been identified and/or committed, and which are ready to go or in process of restoration. These represent only a portion of the three SBSP complexes slated for long-term restoration.

Longer-term SBSP projects are in varying stages of study and preparation, some with full or partial funding sources identified and/or committed, others with no site assessments having been done or funding identified. They are included as sites in the general SFBJV database.

Flood Control and Related Issues

A variety of factors converge to produce flood risk along the San Francisco Bay coastline. Storm surges and wind/wave action have the capability to cause significant flooding in low-lying areas along the Bay. Impacts are compounded during storms, where tributary sloughs overflow, as fluvial upland runoff (from rivers, streams, creeks, culverts, pump stations, etc.) collects at low points, where it meets tidal surge from the Bay and where stormwater drainage systems back up.

Flood risk is present in many areas along the Bay, among them Napa-Sonoma Marsh; Cullinan Ranch and Sears Point on San Pablo Bay; Corte Madera Creek in Marin; and Wildcat and Pinole Creeks in Contra Costa County. In cases involving smaller watersheds and runoff from one or more creeks and their tributaries, flood control is typically addressed at the local or county level by water or flood control districts. But that is getting harder to do, as encroaching development limits upstream access to dredge or expand channels, as costs increase, and as cities and counties face tight budgets.

Upstream Costs

Bay Conservation and Development Commissioner James McGrath describes Pinole Creek as a textbook example and in a paper entitled *The 50 Year Plan: From Channels to Creeks*, Contra Costa Flood Control and Water Conservation District Deputy Chief Engineer Mitch Avalon discusses the challenges involved. The creek was improved as a flood control channel in the 1960s, to accommodate what was then viewed as a 50-year flood, following actual floods in 1955 and 1958 that caused

significant damage throughout the county. The Contra Costa Flood Control and Water Conservation District received federal engineering and funding support through the U.S. Army Corps of Engineers to build the channel, covering about 90% of total costs.

In the years that followed, development has encroached on the creek, adding to run-off and sediment deposits while making access for dredging and other maintenance more complex and costly. Downstream, sediment drops out of the creek in low-lying areas, constricting capacity and adding to flood risk.

The flood control district has no land use regulatory authority to restrict growth or require mitigation. Meanwhile, the capping of property taxes that followed passage of Prop. 13 in 1978 cut its budget by 58%, and the district has not kept pace with costs since; its current flood control budget of $8–9 million annually does not cover routine maintenance, let alone investment in new facilities. New FEMA requirements for recertification of levee systems will entail engineering and study costs of $300,000 per levee mile—money the Flood Control District does not have. Finally, the lower-income communities and lower-value uses along Pinole Creek do not meet the federal cost-benefit formulas justifying expenditure on new or upgraded local drainage systems.

Taken together, the converging challenges noted above make it increasingly difficult for local and county entities to meet their upstream flood control obligations in traditional ways.

At the Water's Edge

Tidal flooding from the Bay has historically been addressed in isolated areas by water and flood control districts in cooperation with private landowners, perhaps the best known example being the South Bay Salt Ponds, where Cargill Corp. built and maintained outboard and inboard levees to allow for evaporation and collection of mineral salts, while local entities such as the Santa Clara Valley Water District (SCVWD) and the Alameda Flood Control and Water Conservation District (ACFCWCD) maintained inland flood control channels collecting fluvial runoff. Many existing flood control

channels, dating back to the 1950s and 1960s were built by the U.S. Army Corps of Engineers (USACE).

For large shoreline tracts with significant flood risk that cross multiple jurisdictions, the scope and cost of flood control has necessitated federal involvement. The Federal Emergency Management Agency (FEMA) maps coastal floodplains and, together with USACE, assesses flood risk within a designated floodplain for purposes of administering the National Flood Insurance Program. Floodplain boundaries determine who is required to buy flood insurance and who is not. Premiums are based on determinations of risk within the flood zone. USACE also manages federally-funded flood control projects in cooperation with a non-federal sponsoring partner—typically a state, county or regional pubic agency. USACE can become involved at one or more stages of project development: reconnaissance, feasibility and/or construction.

Because of the long lead times required to apply for federal funding and the uncertainty of continued funding support from year to year, the Corps tends to be invited in to participate in large projects that cross multiple jurisdictions or where the scope of work and cost are beyond what a state or local agency can handle. USACE has a program for assisting with smaller projects, but this represents only a small portion of the Corps' work on San Francisco Bay.

Two other constraints limit USACE involvement in projects. In evaluating projects, the Corps first looks for specific need or benefits relating to national or state economic development as a priority and applies a cost-benefit analysis. Second, flood control projects undertaken by the Corps must meet FEMA engineering criteria for flood protection against a 100-year flood event—a major flood with a 1% risk of occurring in any given year—which adds significantly to project cost. These and other factors have led to a complex set of public policy choices when it comes to flood control, particularly in the South Bay.

At the southern end of the Bay, south of the San Mateo Bridge, topography and development patterns have combined to create a troubling convergence of public policy

questions relating to flood risk and flood control costs and jurisdiction. Among the unique concerns facing policymakers are:

- Natural contours that amplify normal tidal surge and wave action during storms.
- Decades of upstream development increasing fluvial and storm drain runoff.
- Rising tidal currents and water levels from the Bay encountering increased run-off in the channels to the Bay, backing up and depositing sediment in channels.
- Packed mud levees and berms built for salt pond evaporation, not flood control.
- Accelerating sea level rise and increased storm activity due to climate change.
- Lowered elevations from subsidence in some floodplain areas, due to groundwater extraction in past decades.
- Shoreline residential and commercial development, some in the floodplain and involving nationally significant uses (NASA, Lockheed Martin, Yahoo, Texas Instruments, etc.).
- Large tracts of shoreline (some 13,000 acres) transferred to state and federal agencies, shifting responsibility for maintenance and improvements to those agencies.
- Upland flood control costs that may exceed what local or regional districts can afford.
- Increased flood risk from inaction, that in turn expands FEMA floodplain boundaries, exposing new residents and businesses to higher insurance premiums.
- A potential for USACE risk determinations that land uses in some areas may not justify federal flood control expenditure, given potential mitigation costs.

Topography

As the Bay naturally fills during heavy storms and tidal flows gather uninterrupted southward momentum, the enclosed nature of the South Bay causes waves to reflect back on themselves, increasing tidal amplitude. This amplification causes the Bay

tidal range (absent any storm surge) to increase southward, from 7.8 feet at the Presidio, to 8.5 feet at the Dumbarton Bridge, to 9.01 feet at Coyote Creek, according to U.S. National Oceanic and Atmospheric Administration measurements.

More severe El Nino storm patterns have raised overall risk levels, as does the longer-term potential for sea level rise in the coming century due to climate change. Over time, some areas of the South Bay have experienced subsidence due to groundwater extraction, lowering relative ground elevation by as much as 8 feet over the 34-year period from 1934 to 1968. Subsequent reductions in withdrawals and artificial recharging have partially reversed subsidence. In other areas, seepage under levees has raised the groundwater table with risk of flooding salt ponds themselves.

Flood mapping done by the Federal Emergency Management Agency and the U.S. Army Corps of Engineers indicates that much of the South Bay lies within a 100-year coastal floodplain. As noted previously, a 100-year flood event is the basis for federal flood mapping, hazard assessment and setting flood insurance premiums in a given area.

Changing Jurisdiction

Not surprisingly, flood control studies relating to San Francisco Bay have tended to focus on the South Bay and, in particular, the thousands of acres that have transferred from private hands and local jurisdictions to federal or state ownership and management during the past decade. The most important of these properties include the South Bay Salt Ponds and surrounding parcels that have been acquired with public funds and are now the responsibility of the U.S. Department of the Interior Fish and Wildlife Service and the California Department of Fish and Game.

Salt ponds have been a historic use along San Francisco Bay since its settlement beginning in the mid-1800s. Private businesses acquired tidal properties and then leveed off shallow ponds that were allowed to evaporate, leaving massive salt deposits. Over time, salt pond levees had the added public benefit of protecting inland areas from bay flooding. Later, they would additionally protect the Bay from inland runoff and storm drain overflow.

Typically, county and regional flood control districts initiate, fund and maintain flood control projects. The exception has been salt ponds, for which levees and flood control structures have typically been designed, maintained and operated by private owners as part of salt production operations.

Today, with operations and maintenance responsibilities shifted to federal and state government, local and private funding resources are gone. OM costs going forward, meanwhile, are likely to be higher than in the past. Overall costs for replacement of fill material, structures and equipment continue to increase, and levees will likely need to be enlarged and reinforced to meet long-term flood prevention needs. Added work will likely involve raising or relocation of public utility activities sited on or crossing ponds, such as power transmission lines, railroad tracks or water treatment plants.

Serving the dual function of providing flood control as well as wildlife habitats or recreational areas accessible to the public will increase OM costs over time. Wetland ponds, particularly managed ponds that serve as wildlife habitats, require more sophisticated pumping, filtering and screening systems, as well as greater hands-on maintenance. Providing public access entails paving, lighting, signage, benches, parking, safety and other amenities that, once installed, must be regularly maintained.

The first public policy priority in flood risk areas, however, is safety. For wetlands that have historically served a critical flood control function, the key policy questions are:

- What improvements, upgrades and/or expansions to existing levee systems and structures are needed to manage anticipated flood risks in the coming 50-100 years?
- What will those modifications cost and how will that added cost be funded?
- Are there alternative, less engineered and less costly strategies that increase flood protection through restoration of tidelands to their natural state?
- What are the potential costs in dollars and added risk if we do nothing but maintain and replace existing flood control assets?

A March 2005 study by the South Bay Salt Pond Project assesses the South Bay flood control infrastructure and existing site conditions of the salt ponds. An August 2010 study by USACE analyzes potential physical damage to various South Bay coastal uses, assuming no new wetland restoration projects and maintenance of the current baseline infrastructure.

South Bay Salt Pond Restoration Project: Flood Management and Infrastructure Existing Conditions Report March 2005.

Philip Williams & Associates (PWA) prepared this report, in conjunction with Brown and Caldwell, EDAW and H.T. Harvey & Associates, for the California State Coastal Conservancy, the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

PWA begins by noting that, while South Bay Salt Pond levees have to date been effective in dissipating incident wind/wave action and storing overtopped water, no formal study of their flood management effectiveness had been done. In addition, the most recent flood risk assessments by USACE at the time of the report dated back to 1988–89, about midway between two major El Nino storm events that each raised water levels in the Bay by one foot on average and 2–3 feet during peak periods, throughout an entire winter season. Those assessments assumed that storm surge in the South Bay would be the same as that measured at the San Francisco tide gauge in the Presidio, which may have underestimated the southward tidal surge. It was not clear, therefore, whether current levee systems, designed more for commercial purposes than for flood management, would be adequate to withstand potentially stronger and more sustained storm surges going forward.

With respect to the three primary South Bay salt pond areas—Alviso in Santa Clara County, Ravenswood in San Mateo County and Eden Landing in Alameda County—USACE assessed the flood risks as follows:

Alviso

- Major flooding in developed areas.
- Reduced fluvial flood risk as a result of flood projects along major channels.

Ravenswood

- Significant localized flooding in the vicinity of the ponds and areas to the south.
- Fluvial flood risk due to insufficient channel capacity that prevents drainage runoff from reaching the Bay.

Eden Landing

- Minimal coastal flooding risk.
- Alameda Creek control channel flow constrained by sediment.

A proposed FEMA project for re-mapping San Francisco Bay coastal flooding hazards would include both coastal flood risks (from surge and wind/wave action) and inland flood risks (from fluvial runoff and stormwater overflow). FEMA notes that, while salt pond berms and levees have so far been effective in mitigating coastal and inland flooding—with ongoing maintenance by Cargill—they do not meet current federal flood protection criteria. Many would require improvement, enhancement or replacement to meet the standards.

Retrofitting old levees or constructing new ones to meet FEMA certification standards would increase flood protection for surrounding communities while lowering South Bay flood insurance premiums for residents and businesses.

Risk Assessment Criteria

FEMA engineering standards, set forth in Title 44 of the Code of Federal Regulations, Section 65.10 (National Flood Insurance Program regulations), require that levees exceed Base Flood Elevation (BFE)—the anticipated maximum water level reached during a 100-year flood event for the area in question—by at least 3 feet of

freeboard, or exceed by at least one foot the calculated total water level (wave run-up for outboard levees on the Bay; still-water tide levels for inboard levees). FEMA further requires geotechnical analyses certifying that levee foundations and embankments will remain stable during the base flood, as well as an operation and maintenance plan to ensure levee flood protection capacity in future.

USACE certification criteria are slightly different (more flexible) and under an agreement between the two agencies, USACE may certify levees that do not meet FEMA standards, provided that proper risk-based analysis is done to ensure that levees as designed will adequately withstand waves, overtopping and erosion.

FEMA and USACE also differ in their assessments of the size of the South Bay 100-year floodplain. This is largely because FEMA assumes the salt pond levees as currently designed would offer protection from wave action but not from an overall rise in water levels, so that the ponds would ultimately overflow. USACE assumes flooding would be less because of the salt ponds, but that assumes a sustained level of maintenance as historically provided by Cargill.

[Note: While not discussed specifically in this South Bay Salt Ponds Project report, interviews done for this paper reference the discrepancy between FEMA and USACE risk assessment methodologies as the tension between a pure civil engineering perspective versus an actuarial one based on specific minimum standards set by federal statute. This difference, it has been suggested, pushes FEMA to err on the side of caution from the standpoint of both potential exposure and premiums. Thus, USACE may find existing structures sufficient, at least in the near term, for flood control while the absence of FEMA certification of those structures raises insurance risk, thereby expanding the floodplain map and/or raising premiums. FEMA compliance, on the other hand, potentially raises project costs and may in turn affect USACE risk assessments as to whether federal project funding is justifiable in a given area.]

Coastal Flooding and Sea Level Rise

Any discussion of a 100-year floodplain must also take into account sea level rise as a result of climate change. Research published by the U.S. National Oceanic and Atmospheric Administration in 2004 places sea level rise at the entrance to San Francisco Bay at about 0.7 feet per century, based on readings taken in the Presidio over 1906–1999. This is roughly consistent with 2001 forecasts by the Intergovernmental Panel on Climate Change that global eustatic sea levels will rise 0.5 feet in 50 years and by 1.3 feet in 100 years. More recent analyses suggest much higher levels, projecting that sea level rise from warming oceans over the next 100 years may be 1.4 meters (about 55 inches) or even higher, depending upon the rate at which glaciers and other ice sheets on land melt. This range of numbers forms the basis of generally accepted assumptions about sea level rise on San Francisco Bay during this century. *[Note: For a summary of the latest guidance from the State of California (January 2011) see http://www.opc.ca.gov/2010/12/climate-adaptation-and-sea-level-rise.]*

In specific areas marked by a major tectonic zone and tributary earthquake faults, sea level rise will be affected by geologic activity. To the extent that there is uplift in surrounding land formations, sea level falls; to the extent that there is subsidence, sea level rises. While these factors may not be significant in and of themselves, over time they must be factored into measurements of sea and tidal levels. For example, portions of the South Bay show mean high tide levels increasing at a faster rate than sea level. One contributing factor could be that at the far southern end of the Bay, tectonic uplift may be offsetting sea level rise in previous measurements.

Inland Runoff and Infrastructure

Fluvial flooding is a problem throughout low-lying areas around the entire Bay. Most flood control channels in the South Bay and elsewhere were constructed in the 1950s and 1960s, when levels of residential and industrial development were still relatively modest. They were not constructed with adequate capacity to anticipate eventual population and housing growth associated with normal regional growth, let alone the emergence of Silicon Valley.

Runoff from upland areas, particularly coastal mountains to the west, is much greater today, as those areas have been cleared and built up. As runoff reaches the large, flat, low-lying areas nearer to the Bay, runoff velocity decreases and meets with inflow from the Bay as well as lowland storm drain and water treatment plant overflow. Sediment drops out of the runoff, collecting in flood channels and constraining capacity, in turn causing the channels to overflow and, in heavy storms, overtop levees on the inland side of ponds.

Assuming a further sea level rise of 0.5 feet (6 inches) by 2050 and anywhere from 0.7 feet (8.4 inches) to 1.3 feet (15.6 inches) during this century *[see above notes regarding more recent estimates of sea level rise]*, storm activity is likely to increase and ordinary wave activity will push existing flood control systems to their limits. All of the solutions—replacement of flood channels, ongoing channel dredging and pumping, expanding and reinforcing inboard and outboard levees—entail significant costs. It is unlikely that any one of these approaches will be sufficient; rather, the long-term solution is probably an "all of the above" approach.

Another attractive option is a system of culverts diverting channel overflow into salt ponds, either for temporary storage or on an ongoing basis, with the dual benefit of expanding effective channel capacity while increasing water circulation to scour the ponds. However, the transfer of the salt ponds and other properties to public ownership and management represents a considerable shift of operational and funding responsibility to state and federal agencies from private owners and from county and regional flood control districts—many of whom would not in any case have the funds available on their own to upgrade flood control infrastructure over time.

Project Setting

PWA begins its assessment of flood risk and existing infrastructure at the three South Bay salt pond complexes—Eden Landing, Alviso and Ravenswood—by providing an overview of the South Bay and the location and types of typical flood risks.

Flooding in the South Bay is not typically the result of levee failures. Rather, it is the result of moderate to high tides in the Bay meeting greater than average fluvial runoff in channels with limited capacity and causing inland system backups.

To the extent that the salt ponds, as now configured, serve as a buffer by capturing overflow, their value in terms of flood control overlaps—and for the time being is at cross purposes with—their potential value as restored wetlands. In fact, restoration efforts have been delayed in areas of high flood risk, so that more planning can be undertaken to design systems that will simultaneously achieve long-term restoration and flood control goals.

Major fluvial runoff events take place during the rainy winter and spring seasons. During summer months and dry years, most freshwater inflow is from municipal wastewater treatment plants. Wastewater effluent flows affect South Bay salinity, but not the magnitude of winter flood flows.

Eden Landing

The Eden Landing Pond Complex is a 23-pond complex on 4,800 acres on the south-eastern shore of the Bay, bounded by the eastern end of the San Mateo Bridge and by the Alameda Flood Control Channel. The Mt. Eden and Alameda creeks divide the site into three subsections of mud flats and tidal marshes. Bordering the ponds on the in-land side are the cities of Hayward, Union City and Fremont.

Eden Landing is owned and managed by the California Department of Fish and Game (CDFG). CDFG has been restoring a portion of the Eden Landing Ecological Reserve on the northeast boundary of the South Bay Salt Pond restoration site. CDFG is also building a flood protection levee around the ecological reserve and, to protect recent development in the Eden Shores Community, additional high ground flood protection is being created for the residential and commercial inland developments.

Eden Landing is exposed to persistently elevated wind wave action from westerly and northwesterly winds crossing the Bay, leaving outboard levees and exposed marshes prone to erosion.

Wind data from the San Francisco Airport during 1948–1995 shows approximate 100-year wind speeds of 67–90 mph (depending on precise direction), capable of producing waves of 6–8 feet that could cause significant overtopping and erosion of the outboard levees.

Portions of outboard levees in the Eden Landing Pond Complex have been reinforced with riprap and were reported by engineering firm Moffat & Nichols in 2004 to be in serviceable condition.

USACE flood studies completed in 1988 found little risk of coastal flood damage in the vicinity of Eden Landing, given the absence of development at the time and an assumption that existing levees would be maintained for salt production. Where salt ponds are reopened to tidal action as part of wetland restoration, CDFG is constructing a new inboard levee fronting developed areas to the east. It is unclear whether this levee meets FEMA criteria to remove these areas from the 100-year floodplain map.

The Eden Landing complex is located within the 633-square mile Alameda Creek Watershed, which stretches from Mt. Diablo in the north to Mt. Hamilton in the south, and east to Altamont Pass. The watershed includes remote wildlands; communities such as Livermore, Pleasanton, Dublin, and San Ramon, and the tri-city area of Fremont, Union City and Newark. Most of the watershed is undeveloped rangeland, public lands and parks, or agricultural. Some 200,000 people live within the watershed boundary; only about 7% of the total acreage is used for residential, commercial, and industrial purposes.

Alameda County Flood Control and Water Conservation District has jurisdiction over the watershed and all drainageways leading to the Eden Landing ponds. Alameda Creek is currently diverted into the Alameda County Flood Control Channel; the original Old Alameda Creek tidal slough now drains an area of about 22 miles. Current creek capacity is estimated at the 15-year flood measurement, roughly 4,000 cubic feet per second (cfs). The downstream Potrero pump discharges pumped flows collected from areas to the south and east.

[Note: Waterway conveyance capacity is measured in relation to the capacity required to accommodate a 100-year flood; to the extent that channel capacity is constrained, it is characterized as capable of accommodating a proportionately less severe, more frequently occurring flood, .e g. a "15-year flood".]

The Flood Control Channel extends 12 miles from the west end of Niles Canyon to the terminus at San Francisco Bay. It was designed by USACE and constructed over 1965–1975, following damaging floods in 1955 and 1958. It provides flood protection for Union City, Fremont, and Newark, preventing inundation of nearby agricultural areas, railroads and highways. The lower 4 miles cross the Eden Landing Pond Complex.

Peak discharge of the 1955 flood was estimated at 21,000 cfs near Niles District; runoff from storms in 1986 (16,400 cfs) and 1995 (15,000 cfs) did not result in flooding. The USACE flood control project originally provided protection from the "Standard Project Flood" (SPF = 52,000 cfs); maximum current capacity is 29,000 cfs (a 100-year recurrence interval) due to sedimentation.

Sediment has been removed from the channel several times since construction was completed, most recently in 1998–2001, when 367,000 cubic yards of sediment were removed at a cost of over $3 million.

In 2003, the Flood Control District retained Watershed Sciences to evaluate existing sedimentation data and to develop a fluvial sediment source and sediment budget methodology; a first-year progress report was completed.

Under an operations and maintenance agreement with USACE, the District is required to restore channel flow capacity to the 4-mile stretch crossing the salt ponds, in order to ensure adequate flood protection; excavation of approximately 1 million cubic yards of accumulated sediment was estimated by URS Corp. in 2002 to cost around $30 million.

In a 2004, Phase 2 Study, URS identified and evaluated three concepts for flood channel levee reconfiguration:

- breaching the channel levee and allowing the excess flows to be conveyed through the restored salt ponds along the north side of the channel;
- breaching Old Alameda Creek through both the north and south levees to reduce maximum water levels; and
- creating a 700 ft long “spillway” in a levee notch that would discharge into one salt pond.

Excavation of levee breaches and major slough channels in the former salt ponds would generate about 300,000 cubic-yards of dredge material that could be used elsewhere in the project. A new inboard levee approximately two miles long may be needed to protect the existing homes east of the Eden Landing Complex, or an outboard levee between the restored salt ponds and the open Bay could be widened and heightened to improve flood protection without having to build an inboard levee.

Alviso Pond Complex

The Alviso Pond Complex is made up of 24 salt ponds totaling 7,500 acres, owned and managed by the U.S. Fish and Wildlife Service. The western boundary of the Alviso Complex is the Charleston Slough in Santa Clara County. The complex overlaps the border between Santa Clara County and Alameda County. The Alameda County ponds are north of Coyote Creek and divided by Mud Slough. As a result of land subsidence, flood hazards in the Alviso area are the highest in all of the South Bay Salt Pond project areas.

Predictions for extreme tide events, tidal benchmark data and tidal floodplain elevations are derived from two distinct 18-year time periods, 1960–1978 and 1983–2001.

A 1988 shoreline study by the USACE analyzed tidal flooding for two separate reaches that front the Alviso Pond Complex—one from Coyote Creek to Alviso Slough/ Guadalupe River and another from Calabazas Creek to Stevens Creek. Other reaches were eliminated as posing flood risk on the assumption that levees

and ponds would be maintained for salt production and thus additionally provide de facto flood protection.

USACE determined in 1988 that potential overtopping of outboard salt pond levees near Alviso Slough and lower Coyote Creek could result in tidal flooding in Alviso and surrounding areas. The capacity of the salt ponds in this area would limit flooding to undeveloped areas except during the most extreme tide and wind events. For a 100-year event, USACE estimated that Alviso could incur up to 6 feet of flooding and that most of the flooding would be limited to the area north of Highway 237.

USACE noted the potential for overtopping of outboard salt pond levees and tidal flooding at the Sunnyvale sewage treatment ponds, the northern portions of the NASA Ames Research Center, Moffett Field Naval Air Station, the Lockheed Missiles and Space Company plant, and an industrial park area north of Java Drive and west of East Sunnyvale Channel.

Inland Fluvial Flood Risk from Inland Runoff

The Alviso Complex is located at the base of four distinct watersheds: Coyote Watershed; Guadalupe Watershed; West Valley Watershed; and Lower Peninsula Watershed.

Local jurisdiction is divided among the Alameda County Flood Control and Water Conservation District (connecting waterways); the Alameda County Public Works Department (watershed planning, major maintenance, and new construction of the western Alameda County Flood Control System), and the Santa Clara Valley Water District (SCVWD), which provides flood management services throughout Santa Clara County, including much of the Alviso complex.

SCVWD has conducted flood hazard studies along all of the major drainages that enter the Alviso complex and has constructed flood protection projects along the upstream and lower sections of many of these waterways. The District also operates and maintains the Automated Local Evaluation in Real Time (ALERT) system to

monitor hydrologic data including rainfall, stream flow, and reservoir levels within its jurisdiction. This data provides the basis for much of the flood project design work.

A 2002 Final Reconnaissance Report done by SCVWD used computer modeling to test twenty flood risk scenarios with varying inflows; 10-year and 100-year tides; prevention of flows into Alviso; and protection of selected Cargill ponds. Modeling simulated several flood control strategies that included dredging, raised levees and split flows.

Land subsidence throughout the Santa Clara Valley has been observed since the early 1900s and has been linked to groundwater withdrawals for agricultural and residential uses up until the mid-1960s. Maximum subsidence was about 8 feet in San Jose; at the mouth of Alviso Slough it is nearly 3 feet. Recharging of aquifers in the area has largely halted earlier subsidence trends, but the District continues to monitor conditions countywide.

Salt pond levees constructed as part of the salt manufacturing process were built up to offset subsidence and reduce the potential for flooding from contiguous sloughs, creeks, and the Bay tide. The original levees were created using Bay mud, although subsequent improvements may have involved other fill materials. The levees have not been engineered and most do not meet FEMA flood protection requirements.

Sedimentation occurred over time as clay and silt from the outboard mud flats were carried into the sloughs with the tide. SCVWD dredged Alviso Slough in 1963 to re-align the channel and to restore storm water conveyance. Marsh vegetation began to grow between the low-flow channel and the levees; levees were sequentially raised to increase channel conveyance and offset marsh accumulation.

Conditions in the four major watersheds (Coyote, Guadalupe, West Valley, and Lower Peninsula) that drain to the Alviso Complex are described as follows, from east to west.

Coyote Watershed

Coyote Creek is the largest drainageway to intersect the pond complex, with a 322 square mile watershed encompassing Milpitas and portions of San Jose and Morgan Hill. During winter and spring, Coyote Creek delivers fresh water to the Bay from natural runoff and from the San Jose-Santa Clara Water Pollution Control Plant.

Various sloughs, channels, and creeks are tied to the Bay through Coyote Creek, such as Mud Slough, Lower Penitencia Creek, Fremont Flood Control Channel, Artesian Slough, Alviso Slough, and the Coyote Creek bypass channel. Water surface elevations in Coyote Creek, influenced by Bay tides, affect downstream water levels for these tributaries.

Flooding along Coyote Creek occurred in 1982 with 1,700 people evacuated and an estimated 360 homes and 40 businesses sustaining damage in excess of $6 million. A major channel remediation project included levee setbacks and excavation of an overflow channel. In addition, construction of an engineered levee on Bay mud across part of one pond enabled breaching of the portion of that pond adjacent to Coyote Creek, opening it to tidal action. This provided a “safety valve” for the creek that averted potential flood during record runoff in 1997–1998. SCVWD remains concerned, however, that overflows from Coyote Creek could enter behind the current protection works to the east (from Alameda County) and cause flooding.

Guadalupe Watershed

The 170-square mile Guadalupe Watershed feeds into Lower Guadalupe River as it traverses San Jose, Santa Clara and Alviso on its way to the Alviso Slough and San Francisco Bay. Outlying watershed communities include Campbell and Los Gatos. Urban storm drainage from these areas—residential and light commercial— and from storm water pump flows within the project area is also discharged into the Lower Guadalupe River, adding to the runoff volume.

Major flooding on the Guadalupe occurred in 1911, 1941, 1945, 1952, 1958, 1963 , 1967 and 1995. As development increased runoff over time, structural methods were

initiated to provide flood protection; a $12.8 million bond initiative approved in 1963 provided for flood protection including channel modifications, bank stabilization and levee construction on the Lower Guadalupe. Levees were improved and a floodwall constructed in the 1980s and 1990s.

The community of Alviso is subject to flooding not from the Guadalupe River, but rather from insufficient internal drainage backing up in zones of low elevation. Alviso subsided by as much as 6 feet between 1934 and 1967, greatly increasing flood hazards; subsidence has mostly slowed, and may be arrested, as a result of groundwater management and recharge. Ongoing flood threats include overflow from Coyote Creek and excessive floodwaters from adjacent low-lying areas.

As established and reviewed by the USACE in 2000, the Guadalupe River 100-year design storm is 18,300 cfs at the Union Pacific Railroad Bridge. The existing channel does not have the capacity to carry runoff from such a storm to the Bay; at around 6,800 cfs, the channel begins to overflow.

Part of the Lower Guadalupe River Flood Protection Project (LGRFPP) has involved reconfiguring levees to allow high flows in the Guadalupe river to exit Alviso Slough into the ponds. Flood waters will be held in the ponds and then pumped out (or conveyed via culverts with flap gates) over a period of about a month. SCVWD estimates that downstream from this diversion the Alviso Slough channel has a capacity of approximately 11,000 cfs.

In addition to allowing Lower Guadalupe/Alviso Slough overflow into the Alviso pond complex, other project work has included:

- Construction of floodwalls or raising of levees along the river banks.
- Replacement of the Highway 237 eastbound bridge (construction began in 2003).
- Modification of 19 storm drain outfalls.
- Improvement and construction of maintenance roads and under-crossings.
- Improvement of the west perimeter levee around Alviso.
- Construction of grade-control weirs (gradual drops in the stream elevation).

The downtown San Jose Guadalupe River Project, completed in December 2004, improved channels to increase the carrying capacity of the Guadalupe River to the level of a 100-year design flood.

A potential future phase of channel capacity enhancement would use culverts connecting the channel to the adjacent ponds to counter tidal inflows, increase channel scour and, ultimately, improve conveyance of flood flows.

West Valley Watershed

The West Valley Watershed covers 85 square miles. Communities within the drainage area include Sunnyvale, Cupertino, San Jose, Santa Clara and Saratoga.

The Guadalupe Slough is the primary conveyance from the watershed to the Bay; historically the Guadalupe River drained through Guadalupe Slough into the Bay. The river was diverted to Alviso Slough in the early 1900s during construction of the salt ponds and as a convenience for navigation.

The Guadalupe Slough receives flow from Calabazas Creek, San Thomas Aquino Creek, Sunnyvale East and West Channels, and Moffett Channel. Slough conveyance capacity is estimated at 6,500 cfs and continues to fall as salt marsh vegetation and sediment deposits accumulate in the channel.

Calabazas Creek near the Alviso Complex is located at the eastern edge of the city of Sunnyvale and western edge of the city of Santa Clara. Calabazas Creek drains an area of 21 square miles. The creek was constructed along its current alignment in the mid-1950s.

Since 1950, flooding in Sunnyvale has occurred after four significant rainfall events in 1955, 1958, 1963, and 1968. Sunnyvale East and West Channels were constructed in the early 1960s to convey the 10-year flood event from the tributary storm drain system. The SCVWD Calabazas Creek Flood Control Project in 1990s increased the Calabazas Creek capacity to a 100-year design flow, reduced bank erosion, and provided for long-term riparian habitat improvement.

Lower portions of the creek are subject to the backwater effects of San Francisco Bay. There are currently no federal flood-control facilities on the streams in Sunnyvale. Upstream of Highway 237, the levees along the Sunnyvale East Channel do not meet FEMA criteria for flood protection.

Lower Peninsula Watershed

The Lower Peninsula Watershed is nearly 100 square miles and includes Los Altos Hills, Palo Alto, Mountain View, Los Altos, and Cupertino. Drainageways from the tributary join sloughs in the Alviso Complex before reaching the Bay. Sloughs include Mountain View, Outer Charleston, Inner Charleston, and Mayfield.

Matadero, Barron and Adobe Creeks drain into the Palo Alto Flood Basin (PAFB) which discharges to the Bay via flap gates. Additionally, Devils Slough and Jagel Slough, within the Alviso Complex, are estimated to be completely tidal with no fresh water; Devils Slough extends to the Moffett Field Naval Air Station.

Stevens Creek flows northerly from the City of Mountain View, and enters the salt pond complex as Whisman Slough, continuing to its mouth near Long Point at the San Francisco Bay. Much of the creek as it crosses Mountain View is an engineered channel, with artificial materials used for bank stabilization and flood control. The Stevens Creek tributary area is 27 square miles.

Stevens Creek watershed, in its upper zone, is undeveloped forest or rangeland. High-density residential use predominates in the lower zone, with commercial and public developments interspersed. Contiguous commercial development is also prevalent along State Highway 82; industrial development is concentrated downstream near U.S. Highway 101.

A Stevens Creek hydraulic computer model, based on 1982 as-built conditions and updated in 1991, shows a consistent decrease in flow as drainage area increases and the channel approaches capacity. The Stevens creek channel does not currently have 100-year event capacity.

Permanente Creek encompasses 28 square miles and includes portions of the cities of Los Altos, Mountain View, Cupertino, and Los Altos Hills. Mountain View Slough extends to Shoreline Regional Park, a 750-acre park with paved trails, a golf course, a lake and historic structures. The City of Mountain View depends on an extensive levee system for its protection from tidal flooding. Shoreline Regional Park also offers additional tidal flood protection.

The Permanente Creek tributary (17 square miles) has had a history of recurring floods in Los Altos and Mountain View. Major flooding occurred in 1862, 1911, 1940, 1950, 1952, 1955, 1958, 1963, 1968, 1983, 1995 and 1998.

In December 1955, the “Christmas Storm” inundated approximately 770 acres in the lower reaches of Permanente Creek. Homes, businesses and agricultural land in Mountain View and Los Altos sustained losses. Bridges and culverts in Mountain View were extensively damaged.

In response to floods since 1955, SCVWD and other agencies have made several improvements. Channel lining and the construction of the Permanente Diversion (to Stevens Creek) were conducted in the 1960s, with significant follow-up work in the 1980s. Other flood control improvements for Permanente Creek included erosion control, structural repair, sediment reduction, and habitat restoration. Planning and design were funded as part of a Capital Improvement Plan.

Currently, Permanente Creek does not have 100-year capacity throughout the channel. SCVWD began work on additional projects in 2001, with planning and design scheduled for completion by June 2008 and construction scheduled from 2009 to 2015. Projects include channel improvements and flow reduction alternatives (such as detention). The Clean Safe Creeks Program has funded construction.

The Palo Alto Flood Basin, located in a wetland east of Bayshore Drive Freeway, was constructed in 1956. Stored floodwaters from the Matadero, Barron and Adobe creeks are discharged into San Francisco Bay during low tide periods. The flood basin has a total storage capacity of 3,000 acre-feet below an elevation of 3.2 feet.

The Adobe Creek tributary is roughly 11 square miles. Adobe Creek channel improvements were in the planning phase at SCVWD in 2005. The project, near the Alviso Complex, will provide protection from a 100-year flood event upstream from El Camino Real and additional flood protection for residents and businesses in Palo Alto, Los Altos and Los Altos Hills.

SCVWD completed improvement projects on Matadero Creek in 2005, including installation of an overflow channel, related levee adjustments, wetland and riparian mitigation areas, the installation of a floodwall around part of the Municipal Services Center, and landscaping.

Ravenswood Pond Complex

The Ravenswood Complex is a set of seven salt ponds covering 1,500 acres in San Mateo County, running along the west side of the Bay between Menlo Park and Redwood City. The U.S. Fish and Wildlife Service owns the Ravenswood Ponds.

Highway 84 (the Dumbarton Bridge) and the Ravenswood Slough divide the pond complex into three sections. Bair Island is located north of the pond complex. The Moseley Tract, a narrow stretch of tidelands on the bayside of Ravenswood Complex is owned by the City of San Jose and is slated for tidal marsh restoration.

Flooding occurs in winter or early spring when large frontal storms coincide with extreme high tides. Principal flood risks in this area are from salt pond levee failure; the salt ponds perimeter levee, which is a few tenths of a foot less than the high tide, overtops. Tidal flooding has occurred along Bayfront Canal and Ravenswood Slough in 1973, 1982, 1983 and 1986.

The 1989 USACE Shoreline Study analyzed tidal flooding for two separate reaches that front Ravenswood. Assuming that existing outboard levees fronting the Bay were maintained and that water depths in the ponds were low enough to limit local wind wave generation, the study concluded that levees on the east side of the ponds are protected from wave overtopping but not tidal overtopping.

Flood maps place Ravenswood within two distinct flood zones. Existing levees in the Ravenswood Complex do not meet FEMA standards for flood protection. As a result, the major urban areas included in the tidal flood zone include the Bohannon Industrial Park and the Belle Haven neighborhood in Menlo Park.

Ravenswood is within the San Francisquito watershed. Ravenswood Slough receives only localized runoff from the adjacent terrain, consisting primarily of stormwater flows from the east side of Redwood City. Stormwater runoff originates in an area that includes portions of Redwood City, Menlo Park, East Palo Alto, and an unincorporated section of San Mateo County along Highway 101.

The major fluvial flood problems in this area have resulted from the inability to convey local drainage into the Bay during periods of concurrent high tide.

In Redwood City, local runoff is conveyed to the Bayfront Canal, which conveys flow south to Flood Slough (which is tidal). During high tides, the water backs up in the Bayfront Canal and causes local flooding.

Atherton Creek drains a narrow oval-shaped basin, flowing northwesterly through Atherton, Redwood City, and Menlo Park. Development in the basin ranges from medium density residential in the hills to high density residential, commercial, and industrial near the Bay. In January of 1973 Atherton Creek overflowed due to a 100-year tide occurring concurrent with a 5-year storm. Storm drain overflow resulted in ponding up to 4 feet deep.

The San Francisquito Creek Joint Powers Authority (SFCJPA) was created in 1999 to develop solutions to flooding problems and provide for a coordinated approach to planning in the San Francisquito Creek Watershed. The SFCJPA members include Palo Alto, East Palo Alto, Menlo Park, the Santa Clara Valley Water District and the San Mateo County Flood Control District.

The San Mateo County Flood Control District is a countywide special district that was created by state legislation in order to provide a mechanism to finance flood control projects in both the cities and unincorporated areas within the county. However,

because of staff and funding constraints, flood hazards in the Ravenswood area are primarily dealt with at the local level by the cities of Redwood City, Menlo Park and East Palo Alto.

South Bay Salt Pond Flood Protection Infrastructure and Related Costs

Approximately 150 total miles of internal and external levees are located within the South Bay Salt Pond restoration area.

Outboard levees adjacent to tidal waters were built to enclose evaporation ponds on former tidal marshes and mudflats and to protect the salt ponds from Bay inundation. These levees are typically constructed with dredged Bay mud with little or no compaction.

Bay mud fill has been added to these levees to compensate for land subsidence, and they have been periodically maintained to address levee erosion and settlement from consolidation and/or displacement of the compressible levee-fill material and weak underlying Bay mud deposits.

The levees are typically low to moderate in height, have fairly flat slopes and are stable. Some dikes in the restoration area were constructed from imported soil, riprap, broken concrete and other inorganic debris. The dikes typically have steeper slopes than levees constructed of Bay mud. Generally, the salt pond levees were not designed, constructed, or maintained following a well-defined standard, and they may require retrofit to provide an adequate level of inland flood protection.

Inboard shoreline levees offer the last line of defense against flooding of low-lying, inland areas. They separate the individual salt ponds from each other and are typically smaller than the outboard levees.

Some have been modified or raised to improve flood protection but, as with the outboard levees, they have not been constructed to a well-defined standard. Bay mud constitutes the basic construction material, but in some instances along readily

accessible alignments, imported fill and various types of concrete rubble have also been used.

For planning purposes, the South Bay Salt Pond report notes other infrastructure located within salt pond areas which must be taken into account in planning future restoration or flood control measures:

PG&E electrical transmission lines.
Above ground towers require access for heavy vehicles. PG&E levee access points need to be preserved for wire restringing and for repair or replacement of wooden utility poles where present. If water levels increase, tower footings may need to be raised to provide appropriate clearance beneath the wires; height increases above 10 feet often require construction of a new tower. Below ground transmission lines require a minimum depth of cover.

PG&E natural gas pipelines.
A minimum depth of cover must be maintained on the pipelines, and the lines require vehicular access.

Sewer force mains and outfall pipes.
The East Bay Dischargers Authority, the South Bayside System Authority, the Union Sanitation District, and the cities of Palo Alto, Sunnyvale, San Jose and Santa Clara all manage sewer mains that require minimum depths of cover and vehicular access. Discharge from the outfalls may affect water quality.

Railways.
Added protections may be needed to prevent inundation of tracks or increased settlement problems. Changes in channel velocities and elevations may result in scour of railroad bridge foundations.

Storm drain systems.
Drainage systems include pipelines, outfall pipes and pump stations. Local cities, counties and flood control districts own this infrastructure. Accommodating these

systems may require special protection or relocation of facilities and provision of access for maintenance.

Proposed and completed levee maintenance is documented in Cargill's annual "maintenance work plan" and "completed maintenance" reports. Estimated maintenance costs were provided to the U.S. Fish and Wildlife Service at the time of land transfer. These costs are rough estimates only and represent general maintenance guidelines.

Estimated Levee Maintenance Costs

	Maintenance Frequency	Due	Duration	Cost*	Annual Allocation
Eden Landing	7 years		9 months	$480,000	$69,000
Ravenswood	7 years		9 months	$480,000	$69,000
Alviso					$206,000
A1–A8	7 years	June 2006	9 months	$480,000	
A9–A15	5 years	Feb. 2007	9 months	$480,000	
AB1	3 years	Oct. 2004	1 month	$53,000	
A16–A17	10 years	Sept. 2005	2 months	$106,000	
A16–A17	10 years	Sept. 2015	8 months	$240,000	

Source: Cargill staff estimates, February 2002.
* Does not include provisions for major storm damage.

South San Francisco Bay Shoreline Flood Risk Management Feasibility Study: Without Project Economics Draft Errata/Update Report
U.S. Army Corps of Engineers (USACE), August 2010

Given the transfer of some 15,000 acres of South Bay shoreline from private ownership and use (the South Bay Salt Ponds) to public ownership and management responsibility, coupled with subsequent assessments of the scope of work and cost required to restore this acreage to its natural tidal wetlands state, USACE is developing an economic analysis to determine likely flood-related damage and costs in the absence of restoration.

Analysis is focusing on potential flood damage to structures, contents, vehicles, and infrastructure, and to costs incurred as a result of flood-fighting, evacuation and clean-up, based on an inventory of current uses within the relevant federally-designated flood zones. Later study phases will weigh the magnitude of the without-project damages against the cost of various alternative projects, and will estimate and compare net economic benefits to the nation resulting from each of the projects.

USACE flood risk management feasibility reports evaluate flood risk and related mitigation measures against four "accounts": National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). This analysis focuses on the NED account, concentrating on "increases in the net value of the national output of goods and services" and contributions to "the direct net benefits that accrue in the planning area and the rest of the Nation."

The primary NED damage categories evaluated for this study are as follows:

- Structure and content damages
- Cost to temporarily displaced residents
- Automobile damages
- Traffic delay and detour costs
- Emergency and cleanup costs

In addition to considering flood risk based on assumption of a 100-year (1% chance per year) flood event, USACE also considers four sea level rise scenarios with 2017 as the base study year (Year Zero): 2067 levels assuming historic sea level rise of 0.34 feet (Curve H); 2067 levels assuming sea level rise of 0.72 feet (Curve 1); and 2067 levels assuming sea level rise of 2.13 feet (Curve 3). Curve 3 tracks with the State of California's latest projections.

Finally, the report notes that three water pollution control plants in the study area are at risk of flooding and severe physical and operational damages. It further notes that none of those facilities currently have plans for specific flood mitigation measures and therefore assumes current levels of risk exposure going forward.

USACE defines 14 environmental impact areas (EIAs) within the South Bay flood-plain area. Twelve are in Santa Clara County and two are in Alameda County.

EIAs 1–4

EIA 1 is primarily residential; over 95% of the structures at risk from flooding are single-family and multi-family residences. Palo Alto Airport and the Palo Alto Water Quality Control Plant are also located in this area. Highway 101 runs through it, with more than 400,000 trips daily. Below a water surface elevation level (WSEL) of approximately 9 feet, flooding is limited to the commercial and industrial structures on the Bay side (east) of the freeway. Between the highway and the Bay, structures are expected to sustain damage at a WSEL of around 6.5 feet. Floodwaters higher than 9 feet will overtop the freeway, causing traffic impacts and damaging residential structures west of the freeway.

EIAs 2 and 3 are almost completely residential, with a few commercial and industrial structures located near Highway 101. Nearly all of the structures that are at risk from flooding are on the inland side of Highway 101, and water is not expected to overtop the freeway at a WSEL of less than 8 feet. EIA 4 is almost exclusively commercial and industrial, and includes many IT and Aerospace companies such as Oracle and

Space Systems Loral, which designs and manufactures satellites. There are no damages expected outside of the Curve 3 scenario.

EIAs 5–8

EIA 5 contains a mix of high-tech companies from the pharmaceutical, biotechnology, and IT industries. Flooding in EIA 5 is confined to the west side of Stevens Creek Trail, with no flooded acres on developed property. EIA 6 is NASA Ames and Moffett Field. Several relatively low-value structures in the floodplain near the Bay and low in elevation are expected to sustain damage from high probability storm events.

EIA 7 includes several IT companies such as Yahoo! and aerospace/defense companies such as Lockheed Martin. Flood modeling predicts a damaging in-basin WSEL from very frequent storm events under all scenarios. Several large commercial structures are subject to significant flood risk due to the combination of an outboard levee that is in relatively poor condition and an inboard levee that is at a low elevation. EIA 8 contains a mix of research and manufacturing facilities, and includes such companies as Fujitsu Components America, Infinera Corporation and Texas Instruments. The area also includes the Sunnyvale Water Pollution Control Plant. Under year 2017 conditions, flood risk is low but increases under later sea level rise scenarios.

EIAs 9–11

EIA 9 includes a mix of industrial, commercial, and residential structures. Some of the companies include Honeywell, Contec Microelectronics, Venturi Wireless, Communication Systems Inc., and FedEx. The residences are all manufactured housing units. No flooding damages are expected short of the most extreme scenario.

All flooding of EIA 10 under base year and future conditions is confined to a low area north of Highway 237. No structures or vital infrastructure are at risk and no economic impacts from flooding are expected in this area.

EIA 11 is a mix of residential, industrial, and commercial structures that includes Alviso, a town of approximately 2,200 residents and 500 housing units. Alviso is at a very low elevation and, as a result, significant damage is expected to occur at in-basin WSELs of just over 5 feet. After the last major flood, many homes were rebuilt or remodeled to stand several feet above ground level to meet the FEMA 100-year flood elevation for mortgage purposes. EIA 11 includes the San Jose/Santa Clara Water Pollution Control Plant.

EIAs 12–14

EIA 12 is a mix of residential and industrial land use types. Flooding in EIA 12 under the base year condition is confined to an area with no structures to the east of Interstate 880 and north of Dixie Landing Road. The majority of the structures in EIA 13 are small-scale R&D and office facilities engaged in high-tech IT activities and green energy business. EIA 14 is exclusively large industrial structures. There is very little flood risk outside of the most extreme scenario.

Valuation Methodology

USACE used a combination of satellite mapping and real estate databases to inventory structures wholly or partially within the floodplain boundaries. It next placed structures within one of 20 building classifications, and used a Depreciated Replacement Cost approach to valuation based on field surveys and the Marshall & Swift Valuation Service per square foot valuation model.

The report first assesses the depreciated replacement value (DRV) of structures only within the South Bay floodplain, by category of structure:

Depreciated Replacement Value of Structures *($ thousands)*

Structure Type	Mean DRV	Median DRV
Commercial	$4,110	$1,957
Industrial	$2,202	$995
Public	$1,342	$450
Residential	$119	$114

Next, the aggregate value of potential damage to structure and contents was assessed under each of the sea level rise scenarios against the 2017 Year Zero baseline, using a USACE model developed for New Orleans after Hurricane Katrina.

USACE found that 1,149 structures are currently at risk of significant flood damage; 1,973 are at risk assuming historic sea level rise of 0.34 feet by 2067; 2,118 are at risk under the 2067 forecast of a 0.72-foot sea level rise; and 3,754 are at risk at the 2067 level assuming a rise of 2.13 feet. While residential structures far outnumber commercial structures in the floodplain for all scenarios, commercial structures have twice the structure and content value of the residences. This is because so many of the commercial (and industrial) structures are very large and the value of their contents is higher.

Total values of structures and their contents, including vehicles, in the 14 EIAs are as follows:

Conditions	Value	Scenario
2017 historic sea level rise of 0.34 feet	$624.1 million	(Year Zero)
2067 historic sea level rise of 0.34 feet	$1.62 billion	(Curve H)
2067 sea level rise of 0.72 feet	$1.78 billion	(Curve 1)
2067 sea level rise of 2.13 feet	$3.17 billion	(Curve 3)

Damage Methodology

USACE is basing damage assumptions on flooding of a structure's first floor. Flooding can cause significant damage to structures of all types. Water can cause structural components to shift or warp. It can damage wiring, gas lines, and septic systems. Ceilings may sag under the weight of trapped water or soggy drywall, wet floorboards can bend and buckle, and the roof may leak or break altogether. Flooding in a basement can lead to foundation cracks.

In all types of residential housing, flooding will most likely destroy the interior walls. Also, floods often deposit dirt and microorganisms throughout the house. Silt and sediment can create short circuits in the electrical system as residue collects in

walls and in the spaces behind each switch box and outlet. Appliances, furnaces, and lighting fixtures also fill with mud, making them dangerous to use. Anything that gets soaked through with water may contain sewage contaminants or provide a substrate for mold. Most upholstered items must be thrown away, as well as carpets and bedding.

Damages for autos begin once flood depth has reached 0.5 feet.

NASA Ames Research Center and Moffett Field in Sunnyvale occupy a distinct EIA. Reported structures and content for the complex are valued at $39 million and $26 million, respectively, although not all structures and contents are reported or assigned valuation.

USACE has identified three water pollution/quality control plants in the study area floodplain: the Palo Alto Water Quality Control Plant, the Sunnyvale Water Pollution Control Plant, and the San Jose/Santa Clara Water Pollution Control Plant.

San Jose/Santa Clara is by far the largest of the three plants, serving 1.4 million people and 16,000 businesses. The San Jose/Santa Clara plant has a capacity of approximately 170 million gallons per day (gpd), and Sunnyvale and Palo Alto each have approximately 30 million gpd treatment capacity.

During a flood event, these plants first attempt to insulate critical mechanical and electrical components to prevent inundation, using sandbags and soil at entrances to pump stations or motor control centers. Temporary sump pumps are also used to drain any flood waters that seep in.

If flooding of the equipment seems inevitable, mechanical and electrical components are turned off immediately, resulting in limited to no treatment capabilities during inundation. When flood waters recede, components must be removed and taken off-site to undergo a baking/drying process in order to be restored to full functionality, followed by a testing and decommissioning phase that can shut down a plant for 2–3 months unless temporary components are installed. If mechanical and electrical components are not shut off before inundation, however, the impacts to the equipment

and plant operation will be more significant, mechanical and electrical components would likely require replacement, which takes 6–12 months for procurement and installation.

During larger flood events, plants will likely have to shut down, resulting in an inability to treat raw sewage and a lack of availability of recycled water to local customers who depend on it for the cooling of machinery during industrial processes. These customers include local power providers. In general, large flood events which result in plant shutdown will lead to potential sewage overflows in the communities served by the plant, degradation of the Bay, and a shutdown of recycled water customers.

According to water pollution control plant personnel, the worst case scenario resulting from inundation would include significant environmental impacts from discharge of raw sewage.

Damage estimates provided by the plants assume above ground flood depths of 1–2 feet and a coastal storm surge lasting approximately 24 hours, after which water surface levels return to current levels. Structural components of the water pollution control plants can withstand the build-up of 2 to 3 feet of flood waters without incurring any significant damage; however, extensive clean-up will likely be required.

Since most mechanical and electrical components at each plant are elevated a foot above the ground, events that flood more than a foot are expected to result in repair or complete replacement of mechanical and electrical components, while events that cause flooding of less than a foot will tend to have little to no impact except to any underground facilities.

USACE notes various ancillary costs, some of which it affixes and some which it does not. Among these are damage to Palo Alto Airport; delays on Highways 101 and 237; income losses for businesses in the floodplain area; and emergency costs.

The USACE draft study has produced preliminary cost estimates, which are currently being refined and will be reflected in a final version available later in 2011. That study will contain detailed cost estimates for each of the 14 EIAs, calibrated to differing levels of sea level rise.

New Approaches

Comprehensive flood control in the South Bay, taking into account the operations and maintenance costs likely to shift from the private sector to public agencies, poses clear problems for policy makers. To recap the cost dilemma, according to 2006 cost estimates prepared for the South Bay Salt Ponds Project by PWA, Brown & Caldwell, H.T. Harvey & Associates and EDAW, combined construction and operation/maintenance costs for the three salt pond complexes over 50 years is estimated at around $650 million, regardless of the mix of tidal and managed ponds (and as much as $1 billion allowing for contingencies in current dollars) relative to $108 million to simply maintain existing flood control infrastructure.

Figures provided by Cargill in 2002 placed the annualized cost of maintaining existing salt pond infrastructure in the three complexes, with no further improvements, at $344,000 annually ($17.2 million over 50 years)—a figure that does not appear to include repair or replacement due to storm damage, or upstream costs incurred by relevant local or regional agencies.

Estimates developed by PWA of costs for additional levees and other infrastructure needed in South Bay counties (Alameda, San Mateo, Santa Clara) to accommodate a potential 100-year event and a 1.4-meter sea level rise due to climate change, is $1.7 billion. Potential property loss assuming no additional protections would total $45.8 billion.

The bottom line for South Bay counties and public agencies involved in flood control is problematic.

While the South Bay Salt Ponds in their current configuration have provided a measure of flood control protection in the past, they were designed for commercial purposes and do not meet FEMA engineering design criteria. Nor will they necessarily continue to provide adequate protection as water levels rise, lowland flood channels become increasingly backed up and storm surges increase in severity over time, as is expected.

Federal and state agencies now charged with operating and maintaining the salt pond properties have had little or no commensurate increase in budget and staff to cover those costs; they could perhaps absorb the added Cargill costs to maintain existing infrastructure in its current form, but not projected restoration costs.

USACE is already narrowing the focus of its latest South Bay shoreline study to areas with the greatest flood risk and highest-value uses, in particular uses with national economic development priority that are centered in the Alviso Pond Complex. Absent adequate long-term funding from multiple sources, USACE faces tough choices in setting priorities for areas where federal flood control investment is justified versus those where it is not.

At the same time, flood control districts with responsibility for maintaining flood channel capacity under agreements with USACE face long-term ongoing dredging costs never envisioned—the result of decades of upstream development—for which they are not adequately funded.

Doing nothing is problematic, and not only because of the direct risk from rising sea levels and storm surge in the Bay. To the extent that no action is taken and infrastructure declines in effectiveness relative to increased risk, FEMA floodplain boundaries will necessarily expand to include more residents and businesses that will, in turn, become subject to flood insurance requirements and higher premiums.

The “Wetland Sponge” Strategy

Consensus is gradually forming among engineering and conservation professionals on a possible strategy to simultaneously achieve wetland restoration and flood control objectives, while reducing overall project costs.

In 1994, the California Department of Fish and Game (CDFG) purchased from Cargill a set of salt ponds located west of the Napa River near Vallejo in the North Bay. CDFG’s ultimate goal was habitat restoration where the Napa River and Sonoma Creek meet the Bay. From 1999–2002, the U.S. Geological Survey (USGS) was brought in to conduct scientific research on the ecosystem, monitoring water

quality, tidal flows, vegetation, and the growth and migratory patterns of birds, fish and organisms.

In August 2002, a small levee breach of unknown origin at the 1,314-acre Pond 3—the largest of 8 ponds in the 9,850-acre project area—allowed the ebb and flow of water between the pond and South Slough, a Napa River tributary. CFDG decided not to repair the breach, as an experiment to study salinity and wildlife patterns as the pond returned to its natural state.

USGS, in a 2004 report, *Initial Biophysical Changes After Breaching a Salt Pond Levee: Final Report on Napa-Sonoma Wildlife Area Pond 3 Breach*, found that a combination of normal tidal patterns in San Pablo Bay and seasonal rainfall swelling the Napa River reduced salinity in the pond as it flooded; brought back fish, shrimp and shorebird species to the pond area; and both deepened and widened the breach to create stronger currents and a scouring effect at the mouth of the slough.

After sufficient desalination and sediment collection in the ponds, it would then be possible to breach outboard levees and allow two-way tidal flow that could make lowland channel segments self-cleaning over time, with tidal marshes acting as a sponge to retain and slowly release both stormwater and Bay surge. The result over time could be a dramatic reduction in levee construction and channel dredging costs.

The “Catch-22” of Restoration

USACE supports a linkage between wetland restoration and flood control and, with its non-federal sponsors, is studying this option for projects such as the Napa-Sonoma Marsh and Hamilton Field in the North Bay, where USACE is already involved because of the scale of the projects and the use of dredged Bay sediment.

Here sponsors face a funding dilemma, however. On the one hand, USACE participation, and the potential federal funding that comes with it, would be welcome for projects of this size and complexity. Multi-purpose projects are more likely to have funds authorized, and the Corps would have greater flexibility in terms of its focus in approaching a project.

Relying on restored tidal marshes to provide flood protection for such a large section of shoreline remains a largely untested solution in the Bay, given the potential for storm surge and wave action, predictions of sea level rise over time, and the high-value uses and properties in the highest-risk areas. This strategy, however, has been used elsewhere to good effect, particularly in Europe.

USACE is charged with finding the least cost project approach that is also environmentally acceptable. At the same time, USACE involvement triggers the FEMA standard for flood protection against a 100-year flood event, which inherently tends to drive up project costs. That in turn may affect USACE cost-benefit determinations as to whether to take a project beyond the feasibility study stage, thus kicking project responsibility and cost back to the local, regional or state sponsor.

Absent federal involvement and funding, a restoration project can still go forward without FEMA certification, but at some risk. The Cargill South Bay outboard levees, for example, are not FEMA-certified but have a measurable track record of storm surge, wave action and flood protection in the past. Any change in current conditions—breaching the outboard levees—would shift liability to project sponsors and USACE, to the extent it is involved. Once subject to the requirement of 100-year flood protection, local, regional or state sponsors could face responsibility for property acquisition and removal costs in an expanded flood zone.

It should be noted that in the case of certain wetlands projects around the Bay, sponsors have opted not to seek federal support because of the added standards and costs imposed. In other cases, they have opted not to go forward with projects without federal participation because of potential project cost and/or liability exposure.

Moving Forward

A sea change has occurred in shore zone management. In the past, planners looked at the Bay shore a static line—usually defined by levees. Planners could therefore draw a line and say this is where the natural parts were, this is where development would be, and we need a levee to divide them. Flood risk was also static—wave and water levels stayed largely the same, so engineers could construct a levee with

confidence that it would only need to be maintained, not improved. This has now changed, as the static shoreline has become a dynamic shore zone. Changes in sediment deposition, combined with sea level rise, will also affect how shorelines and wetlands evolve.

In areas where the flood control challenges are not as problematic as in the highest-risk areas of the South Bay, work is moving forward on the dual track of wetlands restoration as a flood control strategy.

For the Napa-Sonoma Marsh project, the State Coastal Conservancy and USACE are exploring a hybrid strategy of connecting Napa River and Sonoma Creek tributary sloughs to restored wetlands, while maintaining certain pond levees to protect nearby residential development and not-yet-restored sites such as the 3,300-acre former Skaggs Island Navy communications station that is currently in the final stages of transfer to the U.S. Fish and Wildlife Service. Eventual restoration of Skaggs Island, the largest diked wetland in the North Bay, will involve breaching the dikes to allow natural filtering and flood control.

In addition, the Coastal Conservancy and the Sonoma County Water Agency launched in 2006 the Lower Sonoma Creek Flood Management and Enhancement Project to explore ways to mitigate flood hazards in low-lying former marsh areas where Sonoma Creek tributaries approach San Pablo Bay. Flood protection and habitat restoration solutions have been tested separately and in concert.

In southern Alameda County, a consultant team led by ESA PWA (formerly Philip Williams & Associates) has been assisting the Alameda County Flood Control and Water Conservation District with planning, analysis and design of projects to integrate three flood control channels with large-scale restoration of adjacent South Bay salt ponds. A major focus is to evaluate and recommend alternatives for connecting the Alameda Creek Flood Control Channel to the salt ponds in a way that will both facilitate restoration of tidal wetlands and reduce fluvial flood hazard.

The Hayward Shoreline, which extends north from the Alameda Flood Control Channel in the South Bay Salt Ponds project area to San Leandro Creek, poses planning

challenges found to varying degrees throughout the region: current vulnerability to flooding that is likely to increase steadily with sea level rise; split jurisdictions on either side of Highway 92 and the Hayward-San Mateo Bridge; multiple public and private landowners within the northern section; and significant infrastructure that adds to project costs, including wastewater treatment pipelines, electricity transmission lines, railroad track, high-pressure gas lines, fiberoptic cable and landfills. In addition, the Bay Trail provides public access along the shoreline.

Preliminary Study of the Effect of Sea Level Rise on the Resources of the Hayward Shoreline
Hayward Area Shoreline Planning Agency, March 2010.

This report, prepared by PWA for the Hayward Area Shoreline Planning Agency (HASPA), discusses various approaches for accommodating sea level rise over a 100-year horizon. HASPA is a joint powers authority formed by the City of Hayward, the Hayward Area Recreation and Parks District and the East Bay Regional Park District, which manages the shoreline north of Highway 92. Strategies, dependent on conditions in specific areas, include:

Hold the Line

Raise and reinforce existing levees, steepen shoreline slope, place armored rock further out on the Bay side of levees to protect against greater wave action. Pros: maintains existing structures. Cons: high construction costs; continuous maintenance of structures; erosion of mudflats and salt marsh.

Realignment

Move levees inland, let marshes and mudflats migrate inland and provide natural flood and erosion control, incrementally remove existing development and restrict new uses going forward. Pros: significant wave reduction from mudflats and marshes, 30% cost reduction for lower, less armored levees. Cons: relocation costs over time, rapid landward movement of shoreline (500 feet in 50 years; up to 1,500 feet in 100 years) because of flat subsided land behind levees.

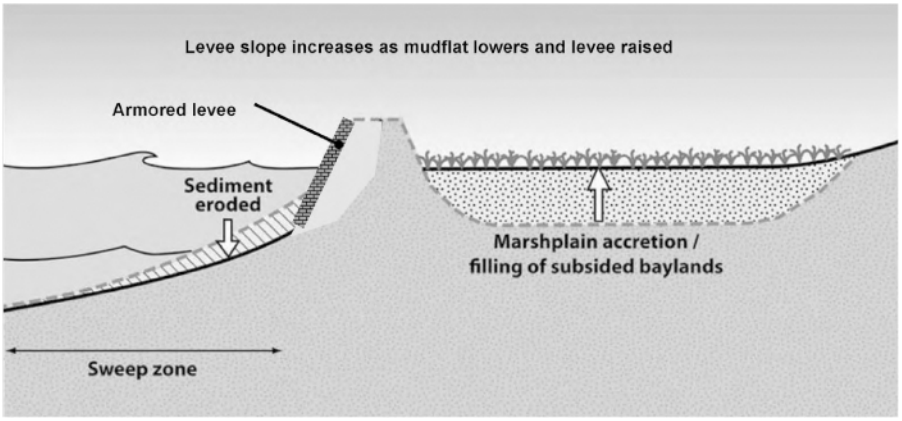
Gradual Steepening

Steepen shoreline against sea level rise by (1) redirecting fresh water outflow from East Bay Dischargers pipeline to treatment marshes, creating brackish marshes that allow rapid organic and mineral accretion; and (2) reuse of sediment from San Leandro Marina and flood channels to create marsh berms that can easily be heightened by "capping" as sea level rise progresses. Pros: better accretion plus sediment would keep pace with sea level rise, with shoreline steepening rather than migrating inland; directing stormwater to marshes, rather than into the Bay, would reduce creek elevations upstream, increase channel capacity and reduce maintenance costs. Cons: doesn't mitigate possible land and related costs.

Diffused Armoring

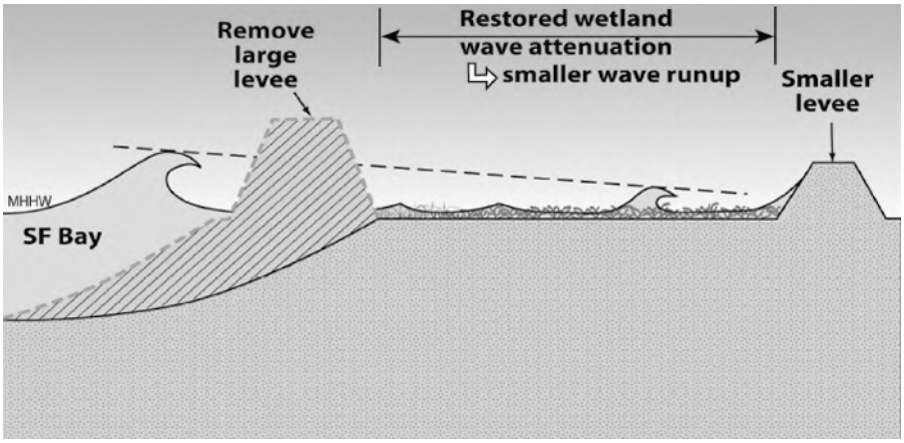
Applicable where space is not available, where upland uses—landfills, waste treatment plants—lie close to the shoreline, and where actions outboard of the levees are needed to mitigate wave action and shoreline retreat inland; utilizes alternatives to rock armor, such as sand, shell, or gravel sediments and coarse offshore berms. Pros: accommodates rising sea levels by adding sediment, enhances ecological objectives for tidal wetlands, and can provide added recreational benefits.

Hold the Line Strategy



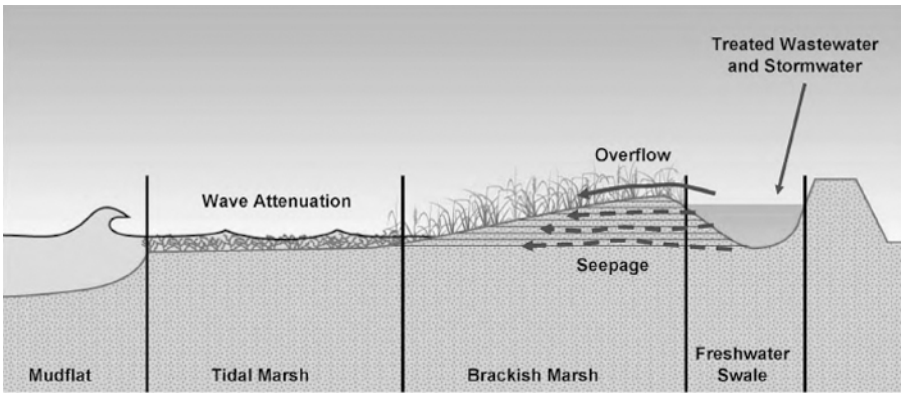
Source: HASPA Sea Level Rise Study, PWA Ref. #1955.00

Levee Realignment Strategy



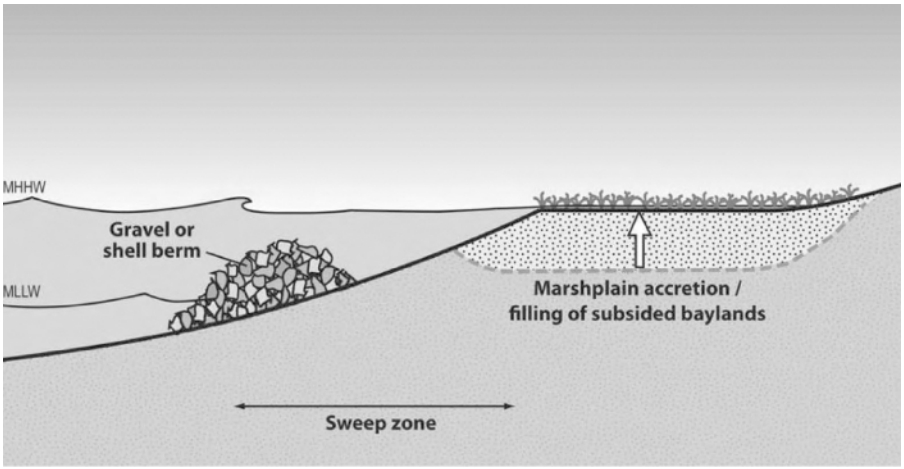
Source: HASPA Sea Level Rise Study, PWA Ref. #1955.00

Gradual Steepening Strategy (Seepage through Vegetated Berm)



Source: HASPA Sea Level Rise Study, PWA Ref. #1955.00

Diffused Armoring



Source: HASPA Sea Level Rise Study, PWA Ref. #1955.00

Cost Estimates

The table below shows cost estimates for the Hold the Line, Realignment and Gradual Steepening strategies, to meet an assumed 1.4 meter (approximately 55-inch) sea-level rise by the year 2100. Key elements of each strategy are described, and order of magnitude estimates are provided to allow cost comparison of alternatives. Estimates represent an approximation of total project costs appropriate for the conceptual level of design, for purposes of comparison only. Land acquisition and easement costs are not included. Costs are in 2010 dollars, based on comparable past work done by ESA PWA.

Estimated Cost Range *($ millions)*

Hold the Line	
Outboard levee upgrade	$103M–$137M
Inboard levee upgrade	$158M–$210M
Landfill armoring	$38M–$51M
Upgrade water management	$5M–$7M
Total	**$304M–$405M**
Realignment	
No outboard levee upgrade	$0
Inboard levee upgrade	$178M–$238M
No water management required	$0
Landfill armoring	$38M–$51M
Total	**$216M–$289M**
Gradual Steepening	
New inboard levee	$132M–$177M
Freshwater swale/Vegetated berm	$66M–$89M
No water management required	$0
Landfill armoring	$38M–$51M
Diffused armoring of landfill	$7M–$10M
Total	**$243M–$327M**

Finally, ESA PWA is in the process of preparing an analysis for the Bay Institute that will, among its objectives, examine tidal and fluvial flood control benefits from specific wetlands restoration projects around the Bay. These will include economic benefits, including estimates of avoided costs from a restored wetland versus an engineered approach (levees or berms, flood channel dredging, etc.). Consultants expect the report to be completed by mid-2011.

Other Documents and Studies Relating to Wetlands

Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and its Shoreline

San Francisco Bay Conservation and Development Commission, April 2009

Global warming is expected to result in sea level rises in San Francisco Bay of 16 inches (40 cm) by mid-century and 55 inches by the end of the century. The economic value of Bay Area shoreline development (buildings and their contents) at risk from a 55-inch rise in sea level is estimated at $62 billion—nearly double the estimated value of development vulnerable to sea level rise along California's Pacific Ocean shoreline. An estimated 270,000 people in the Bay Area will be at risk from flooding, nearly double the number currently at risk. By mid-century 180,000 acres will be vulnerable to flooding; by the end of the century 213,000 acres will be vulnerable. The area that will be vulnerable to inundation with a 16-inch rise corresponds to today's 100-year floodplain.

The Bay Conservation and Development Commission's vulnerability assessment focused on three planning areas: the shoreline environment, the Bay ecosystem, and governance. The report specifically cites vulnerability in residential developments, commercial and industrial areas, transportation infrastructure, other infrastructure, and waterfront parks.

Regarding wetlands and the Bay itself, the Bay Conservation and Development Commission (BCDC) finds that sea level rise will substantially affect the Bay's ecosystem by inundating or eroding wetlands and transitional habitats, altering species composition, changing fresh water inflow, and impairing water quality. The fact of a highly developed shoreline combined with reduced freshwater inflow will constrain the ability of marshes to migrate upland—by reducing sediment and occupying open space to which marshes would otherwise migrate.

Resource managers must address issues that include identifying opportunities for tidal wetlands and tidal flats to migrate landward, managing and maintaining adequate volumes of sediment for marsh sedimentation, developing and planning natural flood protection, and maintaining sufficient upland buffer areas around tidal wetlands. Habitats, like beaches, should be a high priority for restoration and conservation.

Strategies should anticipate future desire to protect the shoreline from flooding using static or structural shoreline protection. Resilient shoreline protection, incorporating both engineering and ecosystem elements, should be used to develop a balanced long-term solution. Planning at the regional level can reduce adverse impacts.

BCDC notes its limited jurisdiction to address these planning issues. Local governments have broad authority over land use, and therefore need information about Bay-related impacts of climate change that is region-specific and site-specific, including a regional model that projects 50–100 years into the future or the expected life of the project.

Adapting to climate change on the Bay's shoreline will be critical to the region's economic stability, safety and public health. Adaptation planning must be a flexible and iterative process. Shoreline planning will be increasingly challenging as the line between uplands and Baylands becomes more dynamic.

BCDC goes on to recommend a series of measures relating to adaptation strategies, including developing a vulnerability analysis, changing the language in its Bay Plan, focusing on the development of a long-term strategy to address sea level rise, and developing an integrated regional approach with other agencies through the Joint

Policy Committee (JPC). The study specifically recommends that Bay Plan findings and policies on tidal marshes and tidal flats be amended to ensure that buffer zones are incorporated into restoration projects, where feasible, and sediment issues related to sustaining tidal marshes are addressed.

The Impacts of Sea Level Rise on the California Coast California Climate Change Center, May 2009

This paper assesses the statewide impact of a 1.0-meter to 1.4-meter sea level rise on the entire California coastline, including San Francisco Bay. It was initiated by BCDC and prepared by staff at the Pacific Institute for the California Ocean Protection Council—a group of state and regional funding agencies that includes the California Energy Commission (CEC), California Environmental Protection Agency (Cal/EPA), California Department of Transportation (CalTrans), and the regional Metropolitan Transportation Commission (MTC). It includes information and analysis developed by Philip Williams and Associates (PWA).

Work was done through the California Climate Change Center, part of CEC's Public Interest Energy Research (PIER) program. The Center, established in 2003, is a virtual organization with core research activities at Scripps Institute of Oceanography and the University of California, Berkeley. Its broad mission is to document climate change research relevant to the state.

Methodology

The paper begins with an estimate that a 1.4-meter sea level rise during the next century would put 480,000 California residents at risk of a 100-year flood event over 30 years (a period corresponding to a mortgage for purposes of assessing risk for FEMA-guaranteed flood insurance). A "100-year flood event" is defined as a major event that has a 1% chance of occurring in any year, and therefore, mathematically, a 1 in 4 chance of occurring over the life of a 30-year mortgage.

In such an event, estimated statewide property damage along the Pacific Coast and within San Francisco Bay was estimated at $100 billion. Seawalls, levees and other

flood control defenses to protect the highest-value vulnerable areas statewide would total about $14 billion in upfront costs (in 2000 dollars), with $1.4 billion annually for OM. The capital cost of protection within the Bay Area was estimated to be $5.11 billion. OM costs were not included.

In an earlier 1990 report, the Pacific Institute estimated $48 billion in property damage along the San Francisco Bay coastline from a 1.0-meter sea level rise, with seawall/levee costs projected at $1 billion up front and $100 million annually for OM. That report was completed prior to significant residential and industrial bayfront development in Alameda, Santa Clara and San Mateo Counties.

For this paper, staff had access to NASA and NOAA satellite mapping, as well as hydrodynamic modeling of the Bay prepared by the U.S. Geological Survey. Modeling used FEMA baseline flood elevations and hourly water levels at the Presidio during 2000–2009 to extrapolate likely scenarios for moderate to high sea level rises. Satellite mapping, along with 2000 Census block data, helped define relative vulnerabilities.

Population Vulnerable to 100-Year Flood Event Along San Francisco Bay, by County

County	Current Risk	Risk with Sea-Level Rise of 0.5m	1.0m	1.4m	% Increase (with 1.4m Rise)
Alameda	12,000	22,000	43,000	66,000	+470%
Contra Costa	840	1,600	3,400	5,800	+590%
Marin	25,000	29,000	34,000	39,000	+55%
Napa	760	830	970	1,500	+99%
San Francisco	190	600	1,600	3,800	+1900%
San Mateo	80,000	88,000	99,000	110,000	+34%
Santa Clara	13,000	17,000	24,000	31,000	+140%
Solano	3,700	5,500	8,800	12,000	+230%
Sonoma	250	300	420	540	+110%
Total	**140,000**	**160,000**	**220,000**	**270,000**	**+98%**

Counties with borders on the Pacific Coast and San Francisco Bay (e.g., San Mateo) were separated based on the shoreline affected. Numbers may not add up due to rounding.

For counties fronting both the Bay and the Pacific Coast, it is assumed that 80% of those at risk are on the Bay side.

Significantly, the paper assesses the potential dollar value of property loss due to a 1.4-meter sea level rise in San Francisco Bay, projecting cost by county:

San Mateo	$23 billion
Alameda	$15 billion
Marin	$8.5 billion
Santa Clara	$7.8 billion
San Francisco	$4.0 billion
Solano	$1.9 billion
Contra Costa	$0.98 billion
Napa	$0.41 billion
Sonoma	$0.28 billion
Total	**$61.87 billion**

The paper also considers roads and railways potentially affected by flooding due to sea level rise, some of which cross existing wetland areas or areas planned for restoration. It also identifies sites monitored by the U.S. Environmental Protection Agency on San Francisco Bay. It finds 134 such sites (Superfund sites, hazardous waste generators, facilities with permits or under requirements to report discharge of toxic air or water pollutants, brownfield properties, etc.) currently at risk from flooding. A 1.4-meter sea level rise would increase that number by 250%, to 332, with the potential to affect wetland areas.

Wetlands

The paper identifies wetlands using satellite mapping data from the National Wetlands Inventory and defines coastal wetlands as being located within 100 feet of the Mean Higher High Water Line.

Assigning economic value to wetlands is an imprecise science. It is typically done by one of three methods: *direct*, in which stakeholders and/or the public at large are formally surveyed to ask what they would be willing to pay to restore and maintain wetlands or what compensation they would expect for elimination of wetlands; *indirect*, where economic models use indicators of market demand (such as miles traveled to visit a wetland area for recreation or relative property values adjacent to that area); or *proxy*, which assesses the replacement costs of wetland benefits in

related goods and services (additional water filtration or flood control equipment and structures, for example).

California Coastal Conservancy estimates from 2008 cited in the paper place the cost of restoring various tidal marshes on San Francisco Bay in a range of $5,000 per acre to $200,000 per acre, depending on size, degree of restoration needed and subsequent management involved. The South Bay Salt Ponds restoration project is estimated to cost about $67,000 per acre. Researchers add the qualifier that this assessment is based on a direct valuation in which the public was surveyed regarding its willingness to pay for restoration (see page 12).

Statewide total value of California's 350,000 acres (550 square miles) of coastal wetlands is estimated at anywhere from $1.8 billion to $70 billion, based on the restoration value range given above. Wetlands are located in nearly every California county, but the majority are along San Francisco Bay and in the Sacramento/San Joaquin Delta. Total wetlands area estimated for the nine Bay Area counties is 256,460 acres, covering 417 square miles. Only a portion of that acreage, however, is San Francisco Bay shoreline.

San Francisco Bay Area Coastal Wetland Area, by County

County	Area (sq. mi.)	Area (acres)	% of State Total
Alameda	70	45,000	13%
Contra Costa	36	23,000	6.5%
Marin	45	29,000	8.3%
Napa	20	13,000	3.6%
San Francisco	1.2	760	0.2%
San Mateo	34	22,000	6.2%
Santa Clara	25	16,000	4.5%
Solano	130	86,000	24%
Sonoma	56	36,000	10%
Total	**417.2**	**256,460**	**76.3%**

Note: Numbers may not add up due to independent rounding.

Extrapolating costs for protection structures in the 1990 study, this paper estimates the cost of a new levee (10–20 feet high with a 3:1 waterside slope) at $1,500 per linear foot in 2000 dollars. Raising an existing levee in anticipation of a sea level rise would run about $530 per linear foot. Subsequent operations and maintenance is assumed to add another 10% to total capital cost and construction.

Statewide, the paper concludes that 270 miles of raised levees, 450 miles of new levees, and 350 miles of new seawall will be needed for flood protection in coming decades, at an estimated cost of $14 billion. For the nine Bay Area counties, costs are as follows.

Estimated Length/Capital Cost of Defenses Against 1.4-Meter Sea Level Rise, by County

County	**Raised Levee** (miles)	**New Levee** (miles)	**Seawall** (miles)	**Total** (miles)	**Capital Cost** ($ millions)
Alameda	45	49	16	110	950
Contra Costa	26	29	8	63	520
Marin	43	77	7.7	127.7	930
Napa	2.8	62	–	64.8	490
San Francisco	–	10	21	31	680
San Mateo	35	29	9.2	73.2	580
Solano	2.7	63	8.0	73.7	720
Sonoma	30	15	1.3	46.3	240
Total	**184.5**	**334**	**71.2**	**589.7**	**$5.11 billion**

In addition, researchers estimate that wetlands require approximately 150 square miles of accommodation space, or land into which they must migrate to survive a sea level rise of 1.4 meters. *[Note: "Gradual Steepening" strategy could partially mitigate this.]* Of this amount, 83 square miles (55%) would make viable wetland habitat; 23 square miles (15%) is land that is viable for wetland migration but at some loss of value, including parks, orchards, and agricultural land. The remaining 30% of the available accommodation space is unsuitable for wetland migration because it is built up, covered with roads, buildings, and pavement.

Recommended Practices and Policies

- Climate change must be integrated into design of all coastal structures.
- The federal government and the insurance industry should develop and implement a methodology integrating climate change into insurance policies and strategies.
- Federal flood insurance maps should include information on future flood risks due to sea level rise.
- Wetlands and potential migratory bird flyways should be protected.
- Future development should be limited in areas that are at risk from rising seas.
- Local planning processes need to involve communities most vulnerable to harm when developing appropriate preparation and adaptation strategies.
- Consider phased abandonment of low- and medium-density areas at high risk.
- Protect vital societal resources, such as harbors or airports, especially those that are “coastal-dependent.”
- Cost-benefit analyses should explicitly evaluate the social and environmental costs of building coastal protection structures.
- Coastal emergencies are inevitable. Coastal communities should improve disaster response and recovery.
- Coastal managers should consider adopting the principles of “No Adverse Impact” when designing and permitting flood protection, beach nourishment, and other coastal protection projects.

Finally, the paper calls for additional research and analysis in several areas, including:

- Local governments or regional planning agencies should conduct detailed studies of potential local impacts and responses to sea-level rise.
- Existing levees and other flood defenses should be surveyed, assessed, and cataloged.
- Improved methods are needed to assess valuation of natural ecosystems at risk, beyond those currently used in traditional economic analyses.

2009 California Climate Adaptation Strategy
California Natural Resources Agency

This strategy outlines possible measures that can be implemented within and across state agencies to promote resiliency in the face of sea level rise. The California Natural Resources Agency has taken the lead in developing this adaptation strategy, working with the state's Climate Action Team, with recommendations designed to inform and guide state decision makers as they begin to devise climate-related policies.

In sections relating directly or indirectly to wetlands, the strategy recommends that agencies consider project alternatives that avoid significant new development in areas that cannot be adequately protected from flooding. However, vulnerable shoreline areas containing existing development that have regionally significant economic, cultural or social value may have to be protected, and in-fill development in these areas may be accommodated.

Restoration Costs Summary

The following table summarizes regional wetlands estimated restoration costs derived from five of the reports mentioned above. The numbers vary from study to study, based on variables such as timelines, the specific scope and geography of the projects being analyzed, whether or not operations and maintenance costs or other contingencies are included, and the fact that in some cases estimated costs are associated with a range of options. The most comprehensive figure, in geography and time, is the $1.43 billion estimate from Save the Bay.

Regional Wetlands Restoration Estimated Costs

Source	Scope	Projects	Time	Cost
Greening the Bay: Financing Wetland Restoration in San Francisco Bay Save the Bay, 2007	Bay Area Region	30	50 yrs.	$1.43 billion
Funding Needs for Ready to Go or In Progress Tidal Wetland Projects in San Francisco Bay San Francisco Bay Joint Venture, September 2010	Bay Area: Projects Slated or Underway	23	5 yrs.	$127.4 million
South Bay Salt Pond Restoration Project: Updated Preliminary Cost Estimate September 2006	South Bay: Three Salt Ponds	—	50 yrs.	$650–657 million
South Bay Salt Pond Restoration Project: Phase 1 Funding and Construction Status September 2010	South Bay: Three Salt Ponds, Phase 1	7	50 yrs.	$38.2 million (funded/pending)
Preliminary Study of the Effect if Sea Level Rise on the Resources of the Hayward Shoreline March 2010	Hayward Shoreline	—	100 yrs.	$243–405 million

Restoration Financing Options

Full Bay Area wetlands restoration will almost certainly require some form of regionally-based financing. The key question is what vehicle will be most feasible and effective.

Parcel tax

Of the various public funding mechanisms identified in the above reports, observers see a parcel tax as the most promising option, applied on either a county-by-county or (preferably) a regional basis.

A 2007 study produced by Fred Silva for California Forward, *Learning from Others: Governance and Finance Lessons from Three Complex Ecosystem Restoration Programs*, found that in addition to unified leadership, the most important factor for the success of large-scale ecosystem restoration projects is access to a continuing funding source. The most successful example is the Columbia River Basin Authority, which imposes an electricity rate surcharge, thereby generating a sustained revenue source that goes beyond one-time bonds to cover both capital and OM requirements. As a locally-generated resource, a parcel tax could constitute a continuous and sustained flow of revenue.

The San Francisco Bay Restoration Authority engaged Fairbank, Maslin, Mullin, Metz & Associates, a public opinion research and strategy firm, to conduct a regional voter survey in August 2010 to assess support for funding Bay restoration. The consultants surveyed 1,202 voters in the nine county Bay Area considered likely to vote in November 2012. That survey found that the funding option with the highest support was a parcel tax. This was also the only funding mechanism that garnered close to the required two-thirds required for voter approval. The survey found the maximum tax likely to attract support at the two-thirds threshold is $20 per parcel. Support for a .25% sales tax did not approach two-thirds approval. The political viability of a parcel tax in the $10–20 range, as compared to a sales tax, was reaffirmed by focus groups conducted by the Restoration Authority in the South Bay in May 2011.

Analysis by the Economic Institute suggests that a parcel tax would likely receive a higher credit rating than a sales tax because there is more predictability in the amount that would be collected, and there is a high confidence level that the tax would be paid because it would be based on the property tax rolls.

To derive an estimate of resources that could be generated by bonding against parcel tax revenues, the following assumptions would apply:

- Revenue bond structure
- Aa/AA tax-exempt scale
- Fully funded debt service reserve fund
- Level debt service payments

Based on a total of 1,741,000 taxable parcels, the Economic Institute estimates that a parcel tax could generate:

$20 per parcel (flat)	$34 million
$20 per parcel (tiered)	$52 million

$15 per parcel (flat)	$26 million
$15 per parcel (tiered)	$39 million

Allowing for operations and maintenance and the cost of issuance, and a conservative position from rating agencies, the amount available for bonding would be lower than the amounts shown above.

This would generate the following bonding revenue and obligations:

Maximum annual debt service of $20 million 25 year final maturity Bond proceeds of $288 million

Maximum annual debt service of $30 million 25 year final maturity Bond proceeds of 432 million

Maximum annual debt service of $40 million 25 year final maturity Bond proceeds of $577 million

Pursuit of this option would require an assessment of the possible application of Proposition 26, passed in November 2010, which restricts the ability of local governments to levy fees in lieu of taxes.

Beneficial Transfer Fees

Beneficial transfer fees are voluntarily imposed fees on a parcel or unit of real estate that are triggered upon the sale or other specified transfers of the property. These financing mechanisms have grown increasingly popular over the past 10–15 years. Typically ranging from .25% to 1% of the assessed value of the property at the time of sale, transfer fees have proven to be a stable source of long-term income for everything from high-rise co-ops in Manhattan to resort communities in the Sierra Nevada mountains to suburban subdivisions throughout the West, with more than thirty projects documented in a wide range of states, jurisdictions and settings.

A California example is the Martis Camp development in Truckee, a 653-unit project, where a 1% transfer fee is being applied to the acquisition, restoration of open space in a scenic and environmentally sensitive valley adjacent to the development. In the 412-unit Cornerstone community in Ouray and Montrose counties in Colorado, a 0.5%–2.5% fee is being applied to nearby open space preservation and maintenance and to wildlife management. At the Maribou development in Steamboat Springs, Colorado, a 0.5% transfer fee is being applied to wildlife management and the maintenance and improvement of fisheries.

Other established uses for transfer fees include maintenance and upkeep of building structures in the co-op context; programs and benefits in a master-planned community administered by a homeowners association; environmental conservation and stewardship programs overseen and administered by an independent 501(c)(3) board of directors; or the provision of affordable housing via a non-profit or governmental body. The deed restriction establishing the fee specifies the entity to which it is payable and the purposes for which it is to be devoted. A distinct aspect of a transfer-fee financing mechanism is that the rate of revenue keeps pace

with the surrounding community/economy, given that it is a percentage of the presently assessed value of the property.

Typically, the fee is established prior to subdivision of the underlying property holding, and the transfer fee obligation is conveyed to each subsequently created parcel or unit. The obligation is recorded along with the deed of trust, and the governance provisions regarding assessment and expenditure of the transfer fee revenues are spelled out in the condition, covenant, and restriction documents for the property. The obligation "runs with the land," so it binds subsequent purchasers for the defined term of the fee (typically 60–99 years) and is spelled out in the underlying documentation.

Variables relevant to calculating projected fee revenues include:

- Number of units subject to the fee
- Term of years for the fee
- Average sales price for a typical unit subject to the fee
- Projected turnover rate for the property (how frequently sold or transferred, often assumed to be every 7 years)
- Projected rate of appreciation for the property
- Compounded inflation rate

A transfer fee applicable to development in the vicinity of the Bay could potentially be applied to benefit the Restoration Authority. The scale of benefit would vary with the size of the development(s), the value of the properties being conveyed, and the changes in property values over time. For example, in a hypothetical community of 1,500 units with an average sales price of $400,000, a percentage fee value of .5% or 1% applied over 25 or 50 years, and a compound inflation rate of 5–7%, the following revenues could potentially be generated.

Potential Transfer Fee Revenues-
Community of 1,500 units with an Average Sales Price of $400,000

Turnover Period	Percentage of Value for Fee	Number of Years of Fee Applied	Compounded Inflation Rate	Total Revenues from Transfer Fee
7 years	.5%	25 years	5%	$20,018,757
7 years	.5%	25 years	7%	$26,668,159
7 years	.5%	50 years	5%	$89,284,855
7 years	.5%	50 years	7%	$173,788,113
7 years	1%	25 years	5%	$40,037,513
7 years	1%	25 years	7%	$53,336,318
7 years	1%	50 years	5%	$178,569,711
7 years	1%	50 years	7%	$347,576,225

Such fees could potentially supplement other resources in meeting the region's restoration needs. While having the advantage of not depending on government sources such as parcel taxes or federal appropriations, this option has the limitation that it would not be available as a resource against which bonds could be issued.

Carbon Sequestration

Carbon sequestration, a priority strategy for addressing climate change, may offer the Restoration Authority another opportunity. Tidal wetlands have a sequestration benefit that is comparable to forests. This is particularly the case for brackish as opposed to saline wetlands. Use of sequestration as a financing vehicle would require a scientific protocol and accounting system that would be applied by the California Climate Registry. What would be required from that point is a voluntary carbon trading market (for individuals and companies wishing to purchase carbon credits) or a mandatory carbon market created and managed by the California Air Resources Board (CARB) under AB 32. That mandatory market ("Cap and Trade") will be established in 2011 and operational by 2012. Carbon trading could generate $1–2 million per year for wetlands restoration.

State, Federal and Private Sources

State funding has come primarily through natural resource bonds, which remain the most promising state source for wetlands restoration finance. California generates these bond measures approximately every four years, usually at the level of several billion dollars. While a bond measure in 2012 is unlikely due to the economy and California's debt and budget situation, there will undoubtedly be bond measures in the future in which the San Francisco Bay Restoration Authority can participate. The Restoration Authority should therefore be an early participant in the negotiations over future measures and the allocation of the funds generated.

Given the magnitude of the state's budget deficit and the expectation that state funds will be highly constrained for at least the next several years, dependence on the state's General Fund for a sustained flow of resources is problematic and carries with it a high level of risk. The state's fiscal situation may also impact its ability to float new bonds over time.

Revenues from oil leased on state lands, administered by the State Lands Commission, are another possible funding source. Total annual revenue from these leases to the state is in the range of $300–400 million (rising and falling with the price of gasoline) and has in past years been used to support public objectives, including capital outlays for higher education and housing. While there is a clear nexus between wetlands and tidelands oil, all oil lease revenues are currently being diverted to the General Fund. Reliance on this as a source of sustained financial support is therefore also problematic.

To date, funding for salt pond restoration has come from a mix of state and federal resources, augmented by resources from local foundations for the South Bay Salt Ponds. A number of potential state, federal and private funding sources for wetlands restoration are listed on pages 27–30.

At the federal level, most funding for wetlands restoration has come through the Army Corps of Engineers, at a rate of $10–12 million per year for projects such as Hamilton Field, with similar amounts expected for the Napa River. Once a project

receives funding, the stream is normally continued, making this a relatively stable funding source. Other federal funds have come through NOAA Restoration Committee grants. Moderate amounts have also come through the U.S. Fish and Wildlife Service.

Rep. Jackie Speier has introduced the San Francisco Bay Improvement Act of 2010 (H.R. 5061) to authorize $100 million annually over ten years for the U.S. Environmental Protection Agency to fund efforts to restore and improve the environmental health of San Francisco Bay, including projects, programs and studies relating to wetland and estuary restoration and protection and adaptation to climate change. In the current budgetary environment, however, the bill's prospects are uncertain.

Conclusion

A number of funding sources are identified in the body of this white paper. Its assessment focuses primarily on funds that could be generated from within the region and does not attempt to explore detailed strategies for obtaining funds from state and federal sources. However, a number of state and federal sources with the potential to significantly contribute to wetlands restoration are identified in the body of the paper.

As noted above, at the local level there is broad agreement among knowledgeable observers that a region-wide parcel tax offers the best option for sustained funding that would also cover OM costs; county-by-county or sub-regional revenue measures may be politically easier to achieve in the near term but have the drawback of being less than complete in scope. One promising approach could be a state statute to authorize a regional vote to levy a region-wide tax to support wetlands restoration. While needing only a majority vote in the legislature, two-thirds voter approval would be required in the region.

The Restoration Authority could also look to the state for front-end capital through state resource bonds. Supplementary revenues may be available through beneficial (private) transfer fees that do not depend on public resources.

In addition to their ecological value, wetlands have been shown to be an effective buffer against shoreline erosion caused by storms and tidal action—an impact that

will grow as water level rises. The costs of a failure to maximize wetlands restoration in the region are potentially substantial and are exacerbated by anticipated sea level rise. Properties at risk include commercial and industrial facilities, research parks, residences, roads, railways, airports, and other key infrastructure such as electrical transmission lines, gas pipelines and water treatment plants. Many of these structures are in or adjacent to wetlands.

The value of structures and other property vulnerable to flooding in the South Bay totals several billion dollars. The total potential property loss in the region due to a 1.4 meter rise in water levels in the Bay has been estimated at $67.1 billion, primarily concentrated in San Mateo, Alameda, Santa Clara and Marin Counties. Income losses to businesses in floodplain areas and emergency costs will further increase the costs of inaction. Some 270,000 Bay Area residents could be directly impacted, again concentrated in San Mateo, Alameda, Santa Clara and Marin Counties.

The funding of wetlands restoration in the Bay Area—whether from state, federal or local resources—has significant economic implications and should be considered an important regional priority.

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Appendix A

Funding Needs for Ready to Go or In Progress Tidal Wetland Projects in San Francisco Bay

September 2010

Project Type: R=Restoration, E=Enhancement, M=Monitoring, P=Planning
Please note: More project information is available from the San Francisco Bay Joint Venture. Contact Sandra Scoggin at sscoggin@sfbayjv.org

Tidal Marsh Restoration Projects within San Francisco Bay

Aramburu Island Enhancement Project – Richardson Bay, Marin County
Aramburu Island is a 17-acre island, owned by Marin County and managed as part of the Richardson Bay Audubon Sanctuary. The Aramburu Island Enhancement/Restoration project will improve habitat for resident and migratory birds, as well as harbor seals and many native plants.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	17	$469,000			Audubon California; Richardson Bay Audubon Center & Sanctuary

Bahia, Marin County
The Bahia property was acquired in 2003 by the Marin Audubon Society (MAS). Restoration and enhancement has been completed. Funding is needed for monitoring.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
M	1,417		$200,000		California Department of Fish and Game; Marin Audubon Society

Breuner Property Restoration and Public Access Project, Contra Costa County
and enhancement of up to 30 acres of tidal wetlands, up to 45 acres of seasonal wetland, 2 acres of riparian habitat along Rheem Creek and up to 25 acres of coastal prairie and upland buffer in the 113-acre portion of the property. Implementation expected in 2013.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	102	$7,000,000			East Bay Regional Park District; State Coastal Conservancy

Candlestick Point – Yosemite Slough Wetland Restoration, San Francisco County
Proposed project will include restoration of 12 acres of historic bay fill to functioning tidal marsh, creation of two isolated bird nesting islands and nursery areas for fish and benthic organisms, transitional and upland areas to buffer sensitive habitats, and trails and interpretive center.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	31	$3,400,000	$125,000		California State Parks Foundation

Chelsea Wetlands, Contra Costa County
Tidal wetland restoration. Project will benefit migratory shorebirds and waterfowl, and support of species such as the salt marsh harvest mouse, the burrowing owl, white-tailed kite and northern harriers. Funding needed would complete the 2nd phase of restoration and flood relief.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	12	$551,250			City of Hercules

Cullinan Ranch, Solano County
This is a two-phased tidal restoration project with the goal of restoring diked baylands to historic tidal marsh conditions. Implementation of this project has been delayed because of the need to increase protection for Highway 37. The site is currently providing interim seasonal wetland habitat of low quality. *Have received approximately $1.69 Million in stimulus funding that could be in jeopardy if the remainder of funding needed is not secured.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	2,975	$2,000,000	$450,000		Ducks Unlimited; U.S. Fish and Wildlife Service – San Pablo Bay National Wildlife Refuge

Dutch Slough, Contra Costa County
The Dutch Slough Tidal Marsh Restoration Project will restore tidal marsh and associated wetland and terrestrial habitats on 1,166 acres near Oakley in eastern Contra Costa County. Implementation will be carried out in three phases. Funding needs estimate is for phase 1.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitor-ing**	**OM**	**Project Lead(s)**
R	2,332	$5,000,000			California Department of Water Resources; State Coastal Conservancy

Hamilton – Bel Marin Keys Wetlands Restoration, Marin County
The Hamilton-Bel Marin Wetlands Restoration Project restores over 2,500 acres of wetlands, provides a beneficial reuse of 24 million cubic yards of dredged materials, converts a former military base into a treasured public resource. *Corps wants a cost share of 35% on BMK – State wants 25% and is trying to get it changed in DC.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	3,580	$38,550,000			State Coastal Conservancy; U.S. Army Corps of Engineers

Invasive Spartina Control Efforts in San Francisco Bay, San Mateo County

Coordinated effort to eradicate four species of the exotic, invasive cordgrass from SF Bay Estuary. Exotic Spartina had become established in the SF Bay's marshes and tidal flats, taking over 1,600 acres of the bay's tidal flats, and threatening a total of 69,000 acres. *5 million is estimate for 5 years of funding for entire project. Treatment funding is in place through 2011, but $1 M is needed to fill a gap for management through 2011. If this funding could be secured, it would be easier for the State Coastal Conservancy to fill in the other funding gaps

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitor-ing**	**OM**	**Project Lead(s)**
E	4,000	$5,000,000		$1,000,000	Invasive Spartina Project; State Coastal Conservancy; U.S. Fish and Wildlife Service

Middle and Inner Bair Islands, San Mateo County

Approximately 932 acres of former commercial salt ponds will be restored to tidal wetlands. Outer, Inner and Middle Bair Islands cover 3,000 acres. Middle and Inner Bair Islands will be restored as a second phase of restoration.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	932	$8,000,000			Ducks Unlimited; Save The Bay; U.S. Fish and Wildlife Service; U.S. Fish and Wildlife Service – Don Edwards National Wildlife Refuge

Napa Plant Site, Napa County

The Napa Plant Site is now part of the Napa River Unit of the California Department of Fish and Game's Napa-Sonoma Marshes State Wildlife Area. The main portion of the Plant Site will be restored to tidal marsh. Construction is being completed. Funding needed for monitoring.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
M	2,500		$500,000		California Department of Fish and Game

Napa-Sonoma Marshes Wildlife Area, Napa County

Also known as the Napa River Salt Marsh Restoration Project includes restoration or enhancement of nearly 10,000 acres of formerly commercial salt ponds in three phases, to a mix of tidal marsh and managed ponds. Phases I and II are complete. Funding estimate is for Phase III, which will restore the final 1,900 acres. All funding is expected from the US Army Corps of Engineers. Funding, however, is not yet committed

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	1,900	$27,483,000	$3,211,377		California Department of Fish and Game; State Coastal Conservancy; U.S. Army Corps of Engineers; Wildlife Conservation Board

New Chicago Marsh Restoration, Santa Clara County
The project goal is to restore estuarine intertidal habitat. Improved hydrology will benefit wildlife diversity, reduce mosquitoes, and improve water quality.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	340	$100,000			Ducks Unlimited; U.S. Fish and Wildlife Service – Don Edwards National Wildlife Refuge

Petaluma Wetlands -Marin Audubon, Marin County
Purchased 182 acres, restored 100 acres. Planning and restoration to tidal marsh completed. Additional funds needed for planting and monitoring.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E, M	284	$250,000			Marin Audubon Society

Rush Ranch, Solano County
Rush Ranch Open Space Preserve is a 2,070 acre ranch located along the northern edge of the Suisun Marsh in Solano County. The property consists of 1,050 acres of tidal wetlands, 940-acres of grassland and a 70-acre diked marsh. Funding needed is for a variety of projects.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
P	800	$498,000			Solano Land Trust; State Coastal Conservancy

Sears Point Restoration Project, Sonoma County
The Sears Point Preliminary Restoration Plan includes restoration of 970 acres of tidal marsh, enhancement of over 400 acres of seasonal freshwater wetlands, enhancement of 15.5 acres of CA red-legged frog habitat by constructing breeding ponds, restoring riparian habitat and managing grazing, enhancement of over 900 acres of upland grasslands, vernal pools, and riparian drainages through cattle management and exclusionary fencing, and trails

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E, R	2,473	$15,000,000			Sonoma Land Trust

Shollenberger Park Wetland Enhancement, Sonoma County
Proposed actions include vegetation management, and the replacement of water control structures to improve hydrology in the seasonal freshwater wetlands and to prevent the undesirable transfer of fresh water from the existing drainage into the dredge spoil ponds.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	73	$30,000			Ducks Unlimited

Skaggs Island, Sonoma County
Project involves transfer of Naval Reserve site from US Navy to USFWS for tidal wetland restoration and inclusion in San Pablo Bay NWR. Issues involve demolition and remediation of 60-acre campus structure and restoration to tidal marsh and the requirement of the property owner to protect the adjacent Haire Ranch from flooding.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	6,620	$3,000,000			Save The Bay; U.S. Fish and Wildlife Service; U.S. Fish and Wildlife Service – San Pablo Bay National Wildlife Refuge

Sonoma Creek – Tidal Marsh Enhancement to Improve Habitat and Water Quality, Sonoma County
Audubon California and the San Pablo Bay National Wildlife Refuge plan to enhance 400 acres of degraded tidal marsh habitat at the mouth of Sonoma Creek in the wetlands of northern San Pablo Bay. Restoration goals are 5-fold and represent an innovative strategy to simultaneously address water quality, mosquito production, habitat enhancement, cost-savings, and public outreach and education.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	400	$1,800,000	$140,000		Audubon California; U.S. Fish and Wildlife Service – San Pablo Bay National Wildlife Refuge

South Bay Salt Ponds: Alviso -Pond A16, Santa Clara County
The goal is to incorporate water control structures, internal levees, and islands within the pond to diversify and improve management capabilities for resident waterbirds and threatened Snowy Plover. *Pending appropriation request of $2 million. $2 million funding needs estimate is in addition to the current request. Developing cost estimates that will be available in 3 months.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	243	$2,000,000			U.S. Fish and Wildlife Service, State Coastal Conservancy, Ducks Unlimited

South Bay Salt Ponds: Eden Landing Ponds E12 and 13, Alameda County
Eden Landing Ponds E12 and E13 would be reconfigured to create shallow-water foraging habitat for migratory shorebirds, with a range of salinities, and a limited number of islands for nesting bird habitat. Processes underway to acquire $5 Million from the State and additional funding from The Alameda County Water Conservation and Flood Control District. No additional funding needed if these agreements are finalized.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	230				California Department of Fish and Game, U.S. Fish and Wildlife Service, State Coastal Conservancy

Viansa, Sonoma County
The proposed enhancement and restoration project will improve habitat conditions through vegetation control, improvements to water management capabilities, increased number of habitat types, and increases in total acreage.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	94	$100,000			Ducks Unlimited

Wingo East, Napa County
The project actions will increase wetland habitat within East Wingo by providing additional flooding capability and creating ponded habitat important for migratory waterfowl.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
E	248	$1,500,000			Ducks Unlimited

Total Acres and Funding Needed for Tidal Marsh Restoration Projects within San Francisco Bay

	Acres	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	
	31,603	**$121,731,250**	**$4,626,377**	**$1,000,000**	

Coastal Wetland Restoration Projects

Giacomini Wetlands, Marin County
The National Park Service has restored natural hydrologic and ecological processes and functions to a significant portion of the Giacomini Ranch and Olema Marsh. Additional funds are being sought for further restoration actions, management, and monitoring.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
M	610		$600,000		National Parks Service

Redwood Creek Restoration at Muir Beach (Big Lagoon), Marin County
The project is a landscape-level restoration extending over 46 coastal acres owned by both MPS and the San Francisco Zen Center. the project entails relocating about 2,000 linear feet of the channel to its historic and more stable location; wetland, lagoon and dune restoration; and modifications to the visitor parking lot to reduce its effects on channel dynamics.

		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	46	$14,000,000			National Parks Service

Total Acres and Funding Needed for Coastal Wetland Restoration Projects

	Acres	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	
	6,563	$14,000,000	$600,000	$0	

Russian River Watershed Restoration Projects

Laguna de Santa Rosa Middle Reach Restoration Project – Phase 1, Sonoma County Riparian restoration along nearly 2 miles of the Laguna de Santa Rosa, plus oak woodland restoration and seasonal wetland management to improve prospects for endangered plants.					
		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	47	$100,000			Laguna de Santa Rosa Foundation

The Laguna Wetlands Preserve Riparian and Oak Savannah Restoration, Sonoma County The Laguna Foundation planted 11.5 acres of riparian and oak savannah on the property in 2008. Five acres are still in need of similar restoration. Activities will include invasive species control, planting and maintenance.					
		Estimated Funding Needed for Next 3–5 Years			
Project Type	**Acres**	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	**Project Lead(s)**
R	5	$77,000			Laguna de Santa Rosa Foundation

Total Acres and Funding Needed for Russian River Watershed Restoration Projects					
	Acres	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	
	6,563	**$14,000,000**	**$600,000**	**$0**	

Total Acres and Funding Needed for Major Restoration Projects Throughout the San Francisco Bay Area					
	Acres	**Construction/ On the Ground Implementation**	**Monitoring**	**OM**	
	32,311	**$135,908.250**	**$5,226,377**	**$1,000.000**	

Appendix B

South Bay Salt Pond Restoration Project
Phase 1 Funding and Construction Status

Note: Restoration funds are approved of imminently anticipated. Funds in italics are not yet confirmed, but processes are underway to acquire.

PROJECT	HABITAT RESTORATION	PUBLIC ACCESS	CONST. SCHED.
SF2 ($9.2M)	**FWS ($6.8M) Menlo Park Mitigation ($0.5M)**	**FWS ($0.8M FY '09) CalTrans Mitigation ($1.1M)**	**COMPLETE**
A6 ($1.72M)	**ARRA-NOAA ($1.6M) NAWCA ($0.12M)**	**N/A**	**2010**
A8 ($2.7M)	**Santa Clara Valley Water District ($1M) CA Water Resources Control Board ($1M) ARRA-NOAA ($.7M)**	**N/A**	**2010**
A16/17 (~$10.6M)	*FWS (Est. $6.0M over 2 years FY '10 & FY '11) State Coastal Conservancy (Est. $4.0M)*	*State Coastal Conservancy (Est. $0.6M)*	*2011-2013*
MOFFETT BAY TRAIL ($0.1M)	**N/A**	**State Coastal Conservancy ($0.1M)**	**COMPLETE**
E8A/9/8X ($6.9M)	**FWS WETLANDS CONS. GRANT ($1.0M) NFWF LEOPARD SHARK PENALTIES ($0.6M) State Coastal Conservancy ($1.5M) Alameda County Flood Control District ($0.8M) ARRA-NOAA ($3M)**	**N/A**	**2010-2011**
E12/13 (~$7.0M)	*CA Wildlife Conservancy Board ($5.0M)*	*State Coastal Conservancy or CA Wildlife Conservation Board (Est. $2.0M)*	*2011-2013*
SCIENCE	**Resources Legacy Fund ($1M), State Coastal Conservancy ($1.5M) USEPA/San Francisco Estuary Project ($480,000), USGS ($1M), FWS ($130,000)**		

The Bay Area Council Economic Institute is a public-private partnership of business, labor, government and higher education that works to support the economic vitality and competitiveness of California and the Bay Area. Its work builds on the twenty-year record of fact-based economic analysis and policy leadership of the Bay Area Economic Forum, which merged with the Bay Area Council in January 2008. The Association of Bay Area Governments is a founder and key institutional partner. The Economic Institute also supports and manages the Bay Area Science and Innovation Consortium (BASIC), a partnership of Northern California's leading scientific research institutions and laboratories. Through its economic and policy research and partnerships, the Economic Institute addresses major issues impacting the competitiveness, economic development and quality of life of the region and the state, including infrastructure, globalization, science and technology, and governance. Its Board of Trustees, which oversees the development of its products and initiatives, is composed of leaders representing business, labor, government, higher education, science and technology, and philanthropy.

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The Association of Bay Area Governments (ABAG) is the official comprehensive planning agency for the San Francisco Bay Area region. ABAG's mission is to strengthen cooperation and coordination among local governments. ABAG addresses social, environmental, and economic issues that transcend local borders, such as land use, growth management, housing, and economic competitiveness. All nine counties and 101 cities within the Bay Area are voluntary members of ABAG, representing nearly all of the region's population.

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