

## COASTAL CONSERVANCY

Staff Recommendation

July 16, 2007

### **SAN FRANCISCO BAY HYDRODYNAMIC AND SEDIMENT TRANSPORT MODELING**

File No. 07-049

Project Manager: Abe Doherty

**RECOMMENDED ACTION:** Authorization to disburse up to \$293,000 to the Regents of University of California and \$565,000 to Stanford University for the development of a San Francisco Bay hydrodynamic and sediment transport model and a modeling framework for San Francisco Bay.

**LOCATION:** San Francisco Bay

**PROGRAM CATEGORY:** San Francisco Bay Area Conservancy; Integrated Coastal and Marine Resources Protection

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#### **EXHIBITS**

Exhibit 1: [Project Location](#)

Exhibit 2: [South Bay Salt Ponds Map](#)

Exhibit 3: [Letters of Support](#)

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#### **RESOLUTION AND FINDINGS:**

Staff recommends that the State Coastal Conservancy adopt the following resolution pursuant to Sections 31160-31165 and 31220 of the Public Resources Code:

“The State Coastal Conservancy hereby authorizes the disbursement of up to two hundred ninety-three thousand dollars (\$293,000) to the Regents of the University of California and five hundred sixty-five thousand dollars (\$565,000) to the Board of Trustees of Leland Stanford Junior University (“Stanford University”) for the development of a San Francisco Bay hydrodynamic and sediment transport model and a modeling framework for San Francisco Bay. This authorization is subject to the condition that prior to the disbursement of any of these funds, the grantees shall each submit for the review and approval of the Executive Officer of the Conservancy a work program, budget and schedule, and the names and qualifications of any subcontractors that it intends to employ.”

Staff further recommends that the Conservancy adopt the following findings:

“Based on the accompanying staff report and attached exhibits, the State Coastal Conservancy hereby finds that:

1. The proposed project is consistent with Public Resources Code Sections 31160-31165 regarding the Conservancy’s mandate to address the resource goals of the San Francisco Bay Area and with Section 31220 regarding the Conservancy’s mandate to undertake coastal watershed and coastal and marine habitat water quality;
2. The proposed project is consistent with the Project Selection Criteria and Guidelines adopted by the Conservancy on January 4, 2001; and
3. Stanford University is a nonprofit organization existing under the provisions of section 501(c)(3) of the United States Internal Revenue Code, whose purposes are consistent with Division 21 of the Public Resources Code.”

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**PROJECT SUMMARY:**

The proposed grants of \$293,000 to the Regents of the University of California for work to be done by the University of California, Berkeley (“U.C. Berkeley”) and \$565,000 to the Board of Trustees of Leland Stanford Junior University (“Stanford University”) will enable these institutions to develop a San Francisco Bay hydrodynamic and sediment transport model and a modeling framework for San Francisco Bay. The benefits of this modeling effort are as follows.

- Reduced risk to San Francisco Bay resources from well-intentioned restoration actions. The Coastal Conservancy is currently working with a broad range of other public and nonprofit entities to plan or implement restoration of 35,000 acres of publicly owned baylands in various locations in San Francisco Bay to improve habitat for fish and wildlife, flood control capacity, and water quality. The proposed hydrodynamic and sediment model is crucial to evaluate various scenarios for restoration design and the potential effects of these restoration actions.
- Reduced costs of restoration project management by informing and improving future decisions.
- Improved understanding of the continually evolving San Francisco Bay and its inter-relationship with the near-shore Pacific Ocean.
- Improved management of San Francisco Bay’s bottom and shoreline. The San Francisco Bay Conservation and Development Commission’s (BCDC) Strategic Plan, adopted on October 20, 2005, includes an objective to manage the extraction of mineral resources from the bay using the most up-to-date scientific information. BCDC’s Strategic Plan specifically identifies research on sediment dynamics in the bay as a priority task to assist with this objective.
- Improved ability to understand and respond to global climate change including sea level rise. The model will include upland areas that may be inundated in the future with sea level rise. The project will simulate changes in mean sea level rise to evaluate changes in inundation, salinity and rates of sediment accretion and deposition.

The proposed funds will support the work of three principal investigators (Mark Stacey at U.C. Berkeley, Jeff Koseff and Oliver Fringer at Stanford University) and graduate research assistants working with them over a period of approximately three years. The project will build on the work of these investigators and the results of a collaborative process to develop an integrated modeling framework for San Francisco Bay. Agencies and research institutions that are participating in the development of a modeling framework for San Francisco Bay include:

- National Oceanic and Atmospheric Administration
- U.S. Geological Survey
- U.S. Army Corps of Engineers
- California State Coastal Conservancy
- San Francisco Bay Conservation and Development Commission
- California Department of Water Resources
- San Francisco Bay Regional Water Quality Control Board
- California State University Center for Integrative Coastal Observation, Research and Education
- Central Coast Ocean Observing System
- U.C. Santa Cruz
- U.C. Berkeley
- U.C. Davis – Bodega Marine Lab
- U.C. Los Angeles
- San Francisco State University – Romberg Tiburon Center
- Stanford University
- San Francisco Estuary Institute
- Monterey Bay Aquarium Research Institute
- Jet Propulsion Laboratory
- Santa Clara Valley Water District

This project will support workshops involving agencies and research institutions on the development of inter-disciplinary models of San Francisco Bay. One of the key elements of these workshops will be the identification and evaluation of modeling approaches to address priority management needs and uncertainties, such as contaminant mobilization and transformation, estuarine ecosystem dynamics, geomorphology and habitat development.

The project will result in the development of an open source, flexible, three-dimensional hydrodynamic and sediment transport SUNTANS model (Stanford Unstructured Nonhydrostatic Terrain-Following Adaptive Navier-Stokes Simulator, Fringer et al., 2005, <http://suntans.stanford.edu>). The model will be used to predict how restoration actions in San Francisco Bay will interact with the existing estuarine system, including changes in local tidal dynamics, salinity and suspended sediment concentrations. The SUNTANS model is designed to allow for highly resolved studies in and around particular restoration sites without compromising complete bay coverage (through variable grid spacing).

While the initial modeling efforts will focus on the tidal and wind-forced dynamics, and their influence on transport of salinity and suspended sediments, this modeling approach provides a necessary foundation on which other, inter-disciplinary modeling efforts can be built. For example, modeling the mobilization of metals and their transformation into bioavailable forms

relies heavily on an understanding of how sediment moves through the system due to the strong association of these contaminants with sediments. Ecologically, primary productivity in the estuary is sensitive to the penetration of light into the water column, so understanding and predicting how the turbidity (suspended sediment concentration) will change following restoration activity is a necessary first step. In each case, the aim is to provide the physical “infrastructure” on which interdisciplinary models can be layered through an overall San Francisco Bay modeling framework.

For the development of the SUNTANS hydrodynamic model, the project first will pursue an analysis of sediment transport in the region south of the Dumbarton Narrows (the Far South Bay) and the influence of annual variability in sediment supply. This activity would consist of both numerical development and continued analysis of data sets collected in conjunction with the South San Francisco Bay Salt Pond Restoration Project. The data sets address the detailed dynamics of Coyote Creek adjacent to early breaches in the project (the Island Ponds) and evaluate flows and transport through a breach in detail. The data analysis would be focused on developing an understanding of the basic physical processes that dominate sediment transport and establishing a reliable calibration and verification data set for the numerical activity at the scale of interest. Next, the project will pursue modeling and analysis of a second site of similar scale to the Far South Bay modeling effort. The specific choice of a site would be based on what data are available for calibration and verification purposes, most likely a San Pablo Bay restoration site. Finally, in both of these modeling efforts, the project will evaluate the performance of the model in Central Bay using existing measurements of currents, salinity, temperature and suspended sediment (Fram et al., 2006). This final effort is motivated by the interest in using the modeling approach to examine the effects of restoration at the scale of the entire estuary; the Central Bay data sets provide a rigorous test of the model’s ability to extend to those spatial scales. To summarize these activities:

- Transport analysis and modeling south of the Dumbarton Narrows, including annual variability;
- Transport modeling at a second restoration site to be determined (likely to be in San Pablo Bay);
- Evaluation of model performance in Central Bay near the Golden Gate.

The project will also support planning for responding to sea level rise by simulating changes in mean sea level and evaluating the resulting changes in inundation, salinity and rates of sediment accretion and deposition. The geographic grid for the model will include low-lying areas adjacent to the bay that may be inundated with sea level rise. This broader geographic area will support the use of the model by other researchers interested in future scenarios with sea level rise.

The grant to Stanford University will support the work that researchers at the Ward W. and Priscilla B. Woods Institute for the Environment at Stanford University have done to develop the SUNTANS model which will be refined and applied to San Francisco Bay. The resulting SUNTANS product would be available for use and improvement by other researchers in support of an increasing array of management questions. The grant to U.C. Berkeley will support on-going research of San Francisco Bay that includes model development, observations and analysis to research the underlying dynamics of San Francisco Bay and the associated ecosystem. The researchers at both universities will work collaboratively on the tasks, with Stanford University

doing the development of the model and application to North San Francisco Bay and U.C. Berkeley doing most of the work on application to South San Francisco Bay and evaluation of the model's performance in Central San Francisco Bay.

### **Project Background**

Changes, some planned and some unplanned, are ahead for San Francisco Bay. To understand the implications of the changes we make to the system and to help guide those changes, we must have predictive tools, both models and a modeling framework, to guide us. Historically, marshlands were ubiquitous around the San Francisco Bay estuary, with large portions of South San Francisco Bay, San Pablo Bay and Suisun Bay fringed by tidal marsh habitat. Over the past century, these marshes have been "reclaimed" for development, including commercial salt ponds.

Recently, restoration of diked baylands to recover ecosystem function is being pursued at an accelerating pace. Over the past five years, approximately \$300 million has been spent by federal, state and local public agencies and private partners on the acquisition, planning and restoration of San Francisco Bay wetlands. It is anticipated that another \$400 million will be spent on wetland restoration in the Bay Area over the next five years.

The largest single restoration project is the South San Francisco Bay Salt Pond Restoration Project, which involves more than 15,000 acres of salt ponds acquired by the state and federal governments (Exhibit 2). Other restoration projects throughout the estuary include Bair Island near Redwood City, and several projects around the perimeter of San Pablo Bay including the Napa Salt Ponds, Cullinan Ranch and Hamilton Field/Bel Marin Keys. In each case, the success of the restoration project, as well as the condition of existing estuarine ecosystems, will be shaped by the interaction between the new wetlands and the physical and biological processes of the bay.

While the goal of restoring native habitats and associated ecosystem function carries great benefits, restoration of tidal marsh habitat on this scale is not without its risks. These risks include effects both within the projects and external effects of the projects on other, existing habitats. Within the project areas, negative outcomes may include an incomplete recovery of marsh habitat (due to, say, insufficient sediment supply or a lack of vegetation recruitment) or poor quality habitat, which could be due to the detailed spatial structures of the restored habitat and its connection with adjoining habitats, the mobilization of contaminants at the site or other perturbations to the habitat that reduce its ecosystem function.

The uncertainty that surrounds the prospects for restoration success is compounded by uncertainties in the driving natural and anthropogenic processes, particularly at the decadal timescales of interest. Climate change (and variability) is likely to alter oceanic conditions, both through sea level rise and changes in the temperature and biota associated with oceanic waters. Further, the hydrology of the watersheds surrounding the estuary is likely to adjust in response to climate change, including the amount and timing of freshwater flows and the associated sediment supply. In an urban setting like the San Francisco Bay Area, sediment supply will also be altered due to shifts in land use over the decadal timescale of interest. Finally, policies that govern how humans interact with the restored habitats will be dynamic, and create additional uncertainty for the success of the projects.

Each of the restoration projects noted above has engaged in analysis of its effects, but there is not

a modeling framework or sufficiently robust open source hydrodynamic and sediment transport model to predict those effects on an ongoing basis as the projects evolve.

On January 19, 2007 a monitoring and modeling workshop regarding San Francisco Bay was conducted by the Coastal Ocean Currents Monitoring Program, NOAA, and the South Bay Salt Pond (SBSP) Restoration Project. The workshop was well-attended by a wide array of coastal and San Francisco Bay researchers and managers (see list of participants on page 3). The proceedings are being prepared. Priority actions identified at that meeting were:

- Develop a three-dimensional hydrodynamic and sediment transport model of the bay, beginning with high resolution in limited geographic areas (Far South Bay and North Bay) and expanding over time.
- Develop an ensemble of models as needed to address the broad array of management questions regarding San Francisco Bay.
- Institute periodic collection of bay-wide bathymetry data (~ five to ten year intervals) as a base from which all modeling can proceed.
- Maintain and systematically enhance collection of sediment flux data bay-wide, beginning at Dumbarton Narrows.
- Expand ecological monitoring in the bay.

This project would accomplish the first of these priority actions and begin accomplishment of the second.

**PROJECT FINANCING:**

Coastal Conservancy	\$858,000
Stanford University (inc. \$30,000 computational cluster)	\$128,500
U.C. Berkeley	<u>\$56,500</u>
<b>Total Project Cost</b>	<b>\$1,043,000</b>

It is anticipated that the Conservancy’s funding for these grants will come from appropriations to the Conservancy from the Water Security, Clean Drinking Water, Coastal Beach Protection Fund of 2002 (Proposition 50) which are available for the purpose of protecting coastal watersheds (including, but not limited to, acquisition, protection and restoration of land and water resources and associated planning, permitting and administrative costs). These funds were allocated for coastal watershed protection purposes of the San Francisco Bay Conservancy Program pursuant to Chapter 4.5 (commencing with Section 31160) of Division 21 of the Public Resources Code and under Division 21 of the Public Resources Code generally. Use of Proposition 50 funds for the modeling project is consistent with these purposes, since it will contribute to and improve the design of habitat restoration and enhancement projects in the watersheds that drain to San Francisco Bay and the coastline of the Bay Area counties.

Proposition 50 also requires that any watershed protection activities financed with Proposition 50 funds must be consistent with “the applicable adopted local watershed management plan and the applicable regional water quality control plan adopted by the regional water quality control board” (Water Code Section 79507). This modeling project is consistent with the Water Quality Control Plan for the San Francisco Bay Basin (“Basin Plan”), as revised by the San Francisco Bay Regional Water Quality Control Board (“Regional Board”) on December 22, 2006. Section 2.2.3 of the

Basin Plan declares that “The protection, preservation, and restoration of the remaining marsh communities are essential for maintaining the ecological integrity of the Estuary.” As described by a letter from the Executive Officer of the Regional Board in Exhibit 3, the project will assist the Regional Board in implementation of the Basin Plan, by improving the design of restoration projects and providing information on the transport of sediment within the bay.

On May 18, 2005, the Conservancy reserved five million dollars of existing bond and other funds for ocean conservation projects and programs that are given high priority by the Ocean Protection Council and are consistent with the Conservancy’s project selection criteria. At its meeting on June 14, the Ocean Protection Council determined that this project is a high priority for ocean conservation and directed its Secretary to take actions necessary for its implementation. Approval of this recommendation by the Coastal Conservancy would fulfill a significant portion of the Conservancy’s commitment to ocean conservation projects.

**CONSISTENCY WITH CONSERVANCY’S ENABLING LEGISLATION:**

This project would be undertaken pursuant to Chapter 4.5 of the Conservancy’s enabling legislation, Public Resources Code Sections 31160-31165, to address resource goals in the San Francisco Bay Area and pursuant to Chapter 5.5, Public Resources Code Section 31220, to improve and protect coastal and marine water quality and habitats . The project area includes all of the nine counties which make up the jurisdiction of the San Francisco Bay Area Conservancy Program, as described in Section 31162 of the Conservancy’s enabling legislation. Section 31161 declares that San Francisco Bay is the central feature in an interconnected open-space system of watersheds, natural habitats, waterways and scenic areas.

Under Section 31162(b), the Conservancy may undertake projects and award grants to achieve the goal of protecting, restoring and enhancing natural habitats and connecting corridors, watersheds, scenic areas, and other open-space resources of regional importance. This project helps to achieve this goal by improving the design of habitat restoration and enhancement projects in San Francisco Bay.

Consistent with Section 31163(c), the modeling project is a priority since it serves a regional constituency, can be implemented in a timely way, provides opportunities for benefits that could be lost if the project is not quickly implemented and includes matching funds from other sources, as described in the “Consistency with Conservancy’s Project Selection Criteria and Guidelines” section of this staff recommendation.

Under Section 31220, the Conservancy may undertake coastal watershed and coastal and marine habitat water quality, sediment management, and living marine resources protection and restoration projects, or award grants for those projects. Consistent with section 31220(b), the proposed project will protect and restore fish and wildlife habitat within coastal and marine waters and coastal watersheds; reduce threats to coastal and marine fish and wildlife; contribute to the reestablishment of natural erosion and sediment cycles; provide for monitoring of marine habitats and wildlife in order to facilitate the protection and enhancement of resources within the coastal zone; and provide for projects and activities consistent with the California Ocean Protection Act, Division 26.5 (commencing with section 35550) of the Public Resources Code.

**CONSISTENCY WITH CONSERVANCY'S  
STRATEGIC PLAN GOAL(S) & OBJECTIVE(S):**

Consistent with **Goal 10, Objective B** of the Conservancy's Strategic Plan, the proposed project will help the Conservancy and others develop plans for protection, restoration and enhancement of natural habitats in the San Francisco Bay Area.

**CONSISTENCY WITH CONSERVANCY'S  
PROJECT SELECTION CRITERIA & GUIDELINES:**

The proposed project is consistent with the Conservancy's Project Selection Criteria and Guidelines adopted January 24, 2001, in the following respects:

**Required Criteria**

1. **Promotion of the Conservancy's statutory programs and purposes:** See the "Consistency with Conservancy's Enabling Legislation" section above.
2. **Consistency with purposes of the funding source:** See the "Project Financing" section above.
3. **Support of the public:** This project is supported by Senator Diane Feinstein, the Bay Conservation and Development Commission, the San Francisco Bay Regional Water Quality Control Board, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the Santa Clara Valley Water District, the non-profit organization San Francisco Estuary Institute, and the San Francisco Bay Joint Venture, which is a collaboration of approximately 25 non-profit organizations, public agencies and businesses that are working on the protection and restoration of habitats in the Bay Area.
4. **Location:** This project is located in the nine Bay Area counties, entirely within the San Francisco Bay Area, consistent with Section 31162 of the Public Resources Code.
5. **Need:** This project would not occur without the funding from the Conservancy.
6. **Greater-than-local interest:** In creating the San Francisco Bay Area Conservancy Program, the legislature identified San Francisco Bay as the central feature in an interconnected open-space system of watersheds, natural habitats, scenic areas, agricultural lands and regional trails of statewide importance. In Public Resources Code Section 31162(b), the legislature identified one of the goals of the San Francisco Bay Area Conservancy as protecting, restoring and enhancing natural habitats and connecting corridors, watersheds, scenic areas, and other open-space resources of regional importance. This project will help guide the design of restoration and enhancement projects the San Francisco Bay Area. Many of these projects are being designed to restore and enhance habitats for rare, threatened and endangered species, such as the clapper rail and the salt marsh harvest mouse. The California Ocean Protection Council has determined that the project is a high priority for ocean conservation.

**Additional Criteria**

7. **Urgency:** It is estimated that approximately \$400 million will be invested in projects to restore and enhance intertidal habitats in San Francisco Bay over the next five years. It is

urgent to complete this project to improve the likelihood of these projects meeting the goals and targets for restoration, and to minimize risks of flooding, negatively impacting habitats of endangered and threatened species and mobilizing contaminants. The project will also help with planning for responses to sea level rise, an urgent issue that has the potential for profound consequences.

8. **Resolution of more than one issue:** This project will improve the design of restoration projects that have multiple purposes, including habitat restoration and minimizing flood risks. The project also contributes towards understanding how global warming will effect San Francisco Bay and will provide important information to support regulatory decisions by agencies such as BCDC and the Regional Board.
9. **Leverage:** See the “Project Financing” section above.
10. **Readiness:** U.C. Berkeley and Stanford University researchers are eager to begin this project and plan on completing it within 3 years.
11. **Realization of prior Conservancy goals:** This project will assist the Conservancy with the adaptive management and design of many intertidal restoration projects that the Conservancy has funded in the Bay Area, including the South Bay Salt Ponds and Hamilton/Bel Marin Keys.
12. **Cooperation:** One of the tasks that will be accomplished with this project is the development of a modeling framework in collaboration with many resource managers and researchers. Refer to page 3 for a list of the entities participating in this effort.

**CONSISTENCY WITH SAN FRANCISCO BAY PLAN :**

The proposed project is considered project planning and is exempt from permit requirements from the Bay Conservation and Development Commission, under the San Francisco Bay Plan (“Bay Plan”). The project is supported by many policies of the Bay Plan, including Policy 5 of the Subtidal Areas section: “The Commission should continue to support and encourage expansion of scientific information on the Bay’s subtidal areas, including:...(b) the relationship between the Bay’s physical regime and biological populations; (c) sediment dynamics, including sand transport, and wind and wave effects on sediment movement; ...and (e) where and how restoration should occur”.

**CONSISTENCY WITH LOCAL WATERSHED MANAGEMENT PLAN/  
STATE WATER QUALITY CONTROL PLAN:**

This modeling project is consistent with the Water Quality Control Plan for the San Francisco Bay Basin (“Basin Plan”), as revised by the San Francisco Bay Regional Water Quality Control Board (“Regional Board”) on December 22, 2006. Section 2.2.3 of the Basin Plan declares that “The protection, preservation, and restoration of the remaining marsh communities are essential for maintaining the ecological integrity of the Estuary.” As described by a letter from the Executive Officer of the Regional Board in Exhibit 3, the project will assist the Regional Board in implementation of the Basin Plan, by improving the design of restoration projects and providing information on the transport of sediment within the bay.

**COMPLIANCE WITH CEQA:**

The proposed project is statutorily exempt from review under the California Environmental Quality Act pursuant to 14 California Code of Regulations Section 15262, in that it would involve only planning studies and feasibility analyses for possible future action not yet adopted by the Conservancy. Implementation of this modeling project does not legally bind the Conservancy to future implementation of protection, restoration or enhancement projects whose design may be guided by the recommendations of the modeling project. The project is also categorically exempt under Section 15306, which exempts basic data collection and resource evaluation activities leading to an action which the Conservancy has not yet approved, adopted, or funded. Upon approval, Conservancy staff will file a Notice of Exemption for this project.