RMP Sediment Workgroup Meeting

May 1, 2018
9:30 AM – 4:15 PM

LOCATION
San Francisco Estuary Institute
4911 Central Ave, Richmond, CA

REMOTE ACCESS
Audio by Phone: (415) 594-5500, Access Code 943-326-397#
Slides: https://join.me/sfei-conf-cw1

AGENDA

1.	**Introductions and Goals for Today's Meeting** The goals for today are to: ● Review the management questions for this workgroup ● Recommend which special study proposals should be funded in 2019 and provide advice to enhance those proposals	9:30 Philip Trowbridge (SFEI)
2.	**Information: Management Questions and Process to Develop Proposals for 2019 Special Studies** The Sediment Workgroup held its first meeting on January 31, 2018. Outcomes from the meeting were a set of revised management questions, further definition of the scope of the Workgroup, and a list of ideas for potential special studies in 2019. On March 14, RMP staff circulated a list of 20 special study ideas for Workgroup members to rank. Eight of the studies were subsequently selected for full proposals based on their ranking, their need for funding, or their importance in the RMP Multi-Year Plan. Today, the Workgroup will review these proposals and prioritize them for RMP funding in 2019. More information on the process for RMP funding decisions is provided in the RMP Charter and Multi-Year Plan. Meeting materials: See pages 1-6 ● Sediment Workgroup Mission and Management Questions ● Overall Management Questions for the RMP ● Summary Tables of Proposals *(continued next page)*	9:40 Philip Trowbridge (SFEI)

	Desired outcome: ● Common understanding of the mission and Management Questions of the Sediment Workgroup ● Common understanding of process to develop the proposals.	
3.	**Information: Presentation of Proposed Studies related to Strategy Development** Two of the proposed special studies are needed to establish a strategy for answering the management questions for the Workgroup. These two proposals will be presented together because they are interrelated. Meeting materials: See pages 7-18 ● Proposal for Conceptual Model and Sensitivity Analysis (SFEI) ● Proposals for Sediment Monitoring Strategy Development, Phase II (SFEI) Desired outcome: ● Opportunity for clarifying questions about proposed studies. ● Direction from the Workgroup on strategy development and how to plan for funding outside of the RMP.	10:00 Scott Dusterhoff (SFEI)
	Short Break	11:00
4.	**Information: Presentation of Proposed Studies related to Sediment Fluxes** Three of the proposed special studies would perform monitoring or modeling to better understand sediment fluxes into or out of the Bay or subembayments. Short presentations on each proposal will be given followed by discussion. Meeting materials: See pages 19-51 ● Proposal for Golden Gate Sediment Flux Modeling (Anchor QEA) ● Proposal for Update of Erosion and Deposition in San Francisco Bay (USGS) ● Proposals for Sediment Load Monitoring on the Napa River and Sonoma Creek (USGS) Desired outcome: Opportunity for clarifying questions about proposed studies.	11:15 Michael MacWilliams (Anchor QEA) Bruce Jaffe (USGS) Scott Wright (USGS)
	Lunch (provided)	12:30

5.	**Information: Update on Measuring Sediment Fluxes at the Dumbarton Bridge** The RMP provided funding to USGS to improve instrumentation at the Dumbarton Bridge to verify a proposed flocculation correction to sediment flux measurements. USGS will provide a short update from Year 1 of the study. Year 2 funding has been secured from another source so the Workgroup does not need to allocate additional funds to the project. Meeting materials: None Desired outcome: Informed committee	1:00 Daniel Livsey (USGS)
6.	**Information: Presentation of Proposed Studies related to Beneficial Reuse** Two of the proposed studies relate to beneficial reuse of sediment for wetland restoration. A third study related to improving estimates of bulk density of sediment is broadly applicable to all aspects of sediment monitoring and modeling. Short presentations on each proposal will be given followed by discussion. Meeting materials: See pages 52-65 ● Proposal for Workshop on Beneficial Reuse Screening Levels (SFEI) ● Proposal for Strategic Placement Study Decision-Making Process and Success Criteria (SFEI) ● Proposal for Sediment Bulk Density Study (SFEI) Desired outcome: Opportunity for clarifying questions about proposed studies.	1:15 Beth Christian (Water Board) Jeremy Lowe (SFEI)
7.	**Discussion of Proposals** The workgroup will consider the studies as a group, ask questions of the Principal Investigators, and begin the process of prioritization. Materials: None Desired outcomes: Discussion of individual proposals, how they implement the mission of the Sediment Workgroup, and how they fit together.	2:15 Philip Trowbridge (SFEI)

8.	**Closed Session** **Decision: Recommendations for 2019 Special Studies Funding** RMP Special Studies are identified and funded through a three-step process. Workgroups recommend studies for funding to the Technical Review Committee (TRC). The TRC weighs input from all the workgroups and then recommends a slate of studies to the Steering Committee. The Steering Committee makes the final funding decision. For this agenda item, the Workgroup is expected to decide on a prioritized list of which studies to recommend to the TRC. To avoid an actual or perceived conflict of interest, the Principal Investigators for proposed special studies are expected to leave the room during this agenda item. Meeting Materials: ● RMP Charter (describes process for funding decisions) ● RMP Multi-Year Plan (outlines Steering Committee priorities) Desired Outcome: Recommendations from the Sediment Workgroup to the TRC regarding which special studies should be funded in 2019 and their order of priority.	3:15 Bridgette DeShields (TRC Chair)
9.	**Report Out of Recommendations to Principal Investigators**	4:00 Bridgette DeShields (TRC Chair)
10.	**Adjourn**	4:15

Mission and Management Questions for the RMP Sediment Workgroup

Proposed Mission Statement

To provide technical oversight and stakeholder guidance on RMP studies addressing questions about sediment delivery, sediment transport, dredging, and beneficial reuse of sediment.

Management Questions

MQ1: What are acceptable levels of chemicals in ~~dredged material~~ **sediment** for placement in the Bay, baylands, or restoration projects?

MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of ~~dredged material~~ **sediment**?

MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to **and within** the Bay and subembayments?

MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?

MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?

Changes made to the questions at the January 31, 2018 workgroup meeting are shown in ~~strikethrough~~ for deletions, **bold** for additions.

These questions are nested within the core management questions of the RMP. These core management questions provide the context for evaluating changes over time and forecasting future conditions for any or the parameters of interest.

Management Questions from the 2015 BCDC Science of Sediment Workshop Summary Report Cross-reference to the RMP Sediment Priority Questions

Topic	Q I.D.	Questions	Cross-reference to RMP Sediment Priority Questions
Watershed, Tributaries, and Flood Control	W1	How can we design channels to help convey sediment to marshes/baylands rather than into the Bay?	MQ 4
	W2	What do we estimate to be the change in sediment supply/erosion of our watersheds into the future (using modeling)?	MQ 3
	W3	Where can we reuse dredged sediment from channels—nearby, locally, and cheaply?	MQ 4
	W4	How do we resolve the conflict between policies encouraging the trapping of sediment upstream and those allowing it to flow through? -Are there opportunities here for decision science tools? -Can we identify the hurdles? -Could we use multi-criteria decision analyses tools to address sediment management alternatives?	MQ 4 (last question only)
	W5	How do we better link our flood plains with our marsh plains?	MQ 3 MQ 4
Marshes and Mudflats	M1	How can we verify or test (i.e., through pilot study) the modeling results of in-Bay placement naturally redistributing to marsh plain, leading to more efficient "beneficial reuse"?	MQ 3 MQ 4
	M2	How and where do/should we assist vertical accretion of marsh/mudflats? (a) Viability of thin layer deposition of dredged sediment in marshes; (b) reconnecting flood control channels to marshes; (C) effectiveness/timing/ location of sediment placement (source replenishment) on mudflats for redistribution onto marshes; (d) criteria to prioritize locations for marsh conservation or restoration	MQ 3 MQ 4
	M3	What is the predicted "new normal" for suspended sediment concentrations (a critical driver for predicting marsh accretion rates), and how does it vary spatially around the Bay.	MQ 3

Topic	Q I.D.	Questions	Cross-reference to RMP Sediment Priority Questions
	M4	How can we design an integrated monitoring program (i.e. water levels, accretion rates, sediment supply) of both natural and restored marshes to aid in future restoration designs? Can we use the data-driven transfer of lessons learned from existing restoration projects to aid in improving designs for newly planned restoration efforts?	MQ 3 MQ 4
Beaches and Non-wetland Shoreline	B1	Are there particular shoreline areas that are most at risk from erosion and sea level rise (SLR)?	
	B2	Are there new/candidate sites for shoreline restoration where natural processes can be used, as opposed to retrofitting existing armored shorelines (i.e. using horizontal levees)	MQ 4
	B3	Where should managed retreat be applied/implemented? What are the cost/benefits?	
	B4	Where is armoring or infrastructure no longer needed and can be removed to restore sediment supply/ transport?	
Open Bay and Subtidal Areas	S1	Does placement of dredged sediment at in-Bay disposal sites help with shores and wetlands?	MQ 3 MQ 4
	S2	Can we develop sediment budgets for embayments, tributaries, and the flux between the Golden Gate (GG) and outer coast?	MQ 3
	S3	What is the sand budget of the Bay? (Including watersheds, shorelines, beaches & GG) What is the source and transport of sand moving on and off of Bay beaches?	MQ 3
	S4	How would deeper water (due to sea level rise) affect sediment deposition dynamics of mudflats and shallow subtidal shoals?	MQ 3

RMP Management Questions

Level 1
(Core) Management Questions

Level 2
Questions

1 Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
- 1 Which chemicals have potential for impacts?
- 2 What is the potential for impacts due to contamination?
- 3 What are appropriate guidelines?
- 4 What contaminants are responsible for impacts?

2 What are the concentrations and masses of contaminants in the Estuary and its segments?
- 1 Are there particular regions of concern?

3 What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- 1 Which sources, pathways, etc. contribute most to impacts?
- 2 Opportunities for management intervention for important pathways?
- 3 Effects of management actions on loads and processes?

4 Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
- 1 Effects of management actions on concentrations and mass?
- 2 Effects of management actions on potential for adverse impacts?

5 What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?
- 1 Impacts forecast under various management scenarios?
- 2 Which contaminants predicted to increase?

General Goal of the RMP:
Collect data and communicate information about water quality in San Francisco Bay in support of management decisions

Summary of Study Ideas Sediment Workgroup and 2019 Proposals

Prioritized Study Ideas from Workgroup Survey (ranked by responses to survey)

Priority	*Study Name*	*Proposal?*	*Budget*	*Comments*
Top Third	Develop Recommendations for Updated Beneficial Reuse Thresholds	Y	$26,500	
	Phase II of Strategic Placement Study	Y	$40,000	
	Overall Conceptual Model Development and Sensitivity Analysis	Y	$78,000	
	Mallard Island Suspended and Bedload Monitoring	**N**		Funding not needed for 2019
	Dumbarton Bridge Sediment Flux Monitoring	**N**		Alternative funds identified
	Bathymetric Change Analysis Study	Y	$154,000	Can be phased over 2 years
Middle Third	Golden Gate Sediment Flux Modeling	Y	$45,000	
	Trends in SSC and bedload at stream gages			
	Key Tributary Suspended and Bedload Monitoring	Y	$102,700	Monitors 2 sites; could scale to 1 site.
	South Bay Sediment Mass Balance			
	Bay Sediment Erodibility Study			
	San Pablo Bay Sediment Mass Balance			
	Sediment Bulk Density Study	Y	$30,000	
Bottom Third	Suisun Bay Sediment Mass Balance			
	Monitoring Design for Sediment Storage and Removal from Flood Control Channels			
	Watershed Sediment Management Workshop and White Paper			
	Monitoring Design for Inundation and Accretion in Wetlands			
	Numerical Modeling Strategy Assessment			
	Bed Sediment Grain Size and Cohesion Study			
	Conceptual Model for Sediment Fate and Transport in Tidal Channels			

Other Projects in the RMP Multi-Year Plan for the Sediment Workgroup

	Healthy Watersheds Resilient Baylands Monitoring Strategy	Y	$50,000	
	Sediment Strategy Support	**N**		Other proposals cover strategy devel.
	DMMO Database Support	**N**		Will propose in Data Services budget

Late Ideas (ideas that came in too late for the survey)

	Mud Flat Mapping Study			
	Sediment Provenance Study			
	Data Collection to Fill Bathymetric Datagaps			

TOTAL	**$526,200**
Planning Budget for Sediment Workgroup	**$245,000**

RMP Sediment Workgroup Special Study Proposals by Management Question

		Project Type				
Management Questions	Relevant 2019 Proposals	Strategy	Monitoring	Modeling	Synthesis	Workshop
MQ1: What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?	Develop Recommendations for Updated Beneficial Reuse Thresholds					X
	Some proposals in the Exposure and Effects Workgroup are also relevant.					
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?	Phase II of Strategic Placement Study *(also listed under MQ4)*					X
MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	Conceptual Model and Sensitivity Analysis for Sediment Mass Balance in San Francisco Bay and its Subembayments	X				
	Bathymetric Change Analysis Study				X	
	Golden Gate Sediment Flux Modeling			X		
	Key Tributary Suspended and Bedload Monitoring		X			
	Sediment Bulk Density Study				X	
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?	Phase II of Strategic Placement Study *(also listed under MQ2)*					X
	Healthy Watersheds Resilient Baylands Monitoring Strategy	X				
MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?	*No proposals but S&T monitoring by USGS addresses this question.*		X			

RMP Special Study Proposal: Conceptual Model and Sensitivity Analysis for Sediment Mass Balance in San Francisco Bay and its Subembayments

Summary: A sediment conceptual model and sensitivity analysis (CM/SA) is an important communication tool for describing key sediment transport and depositional processes that when coupled with a sensitivity analysis can describe key uncertainties to support recommendations about data collection and modeling needs. Sediment conceptual models have been developed for San Francisco Bay in the past but have not been linked to key management and policy questions at a suitable range of spatial and temporal scales, have not been completed for coarse and fine sediment concurrently and separately, and have not provided information using multiple units of interest (mass, volume, and concentration). Managers have expressed interest in an updated set of sediment conceptual models that would provide context for planning marsh restoration, evaluating marsh and mudflat resilience to sea level rise, planning dredging, evaluating pollutants and primary productivity, and regionally monitoring and managing sediment. This project aims to fulfill that need by developing quantitative conceptual models for sediment at the subembayment scale and testing these for the relative importance of data weaknesses using a sensitivity analysis.

Estimated Cost: $78,000

Oversight Group: RMP Sediment Workgroup

Proposed by: Lester McKee, Phil Trowbridge, Scott Dusterhoff, Jeremy Lowe, and Letitia Grenier (SFEI)

Proposed Deliverables and Timeline

Deliverable	Due Date
Kick off phone call meeting	October 2018
Draft framework to share with local experts	February 2019
Draft report for Workgroup	May 2019
Final report	August 2019

Background

A sediment conceptual model and sensitivity analysis (CM/SA) for an estuary is an important first step when developing a management program with the aim of maintaining or enhancing a system of interest for beneficial uses for now and future generations. If linked to key management questions and developed at appropriate spatial and time scales, conceptual models can be used cost effectively to make broad and far reaching policy decisions and build frameworks for management, monitoring and modeling decisions. They differ from dynamic simulation models in their simplicity and low cost and that they use simple concepts that stakeholders can understand and discuss without the need for a detailed scientific understanding of the underlying physics of sediment processes in an estuary. When coupled with a sensitivity analysis that tests the impacts of uncertainties on the relative importance of each of the main sources, losses and transport terms, conceptual models can also be used to support decisions about further data collection and modeling priorities within an adaptive management framework.

To develop a conceptual model for a system of interest, the fluxes, sources and sinks from different processes that give rise to gains and losses of sediment within a defined area of interest (e.g. an estuary, small embayment, tidal channel, or wetland) are identified and qualified to develop an enhanced understanding of the system. Conceptual models for estuaries can be developed for any scale of interest or developed in a nested fashion to cover a variety of spatial and temporal scales. Previous conceptual models have been developed at a whole Bay system scale historically (Ogden Beeman and Associates and Krone, 1992) and more recently for total sediment (Schoellhamer et al., 2005) and for sand only (Perry et al., 2015). Although both considered uncertainties conceptually, neither performed a formal analysis the effects of errors and data uncertainties on interpretations. In addition, there has been considerable data development since these conceptual model sediment budget were completed including recent estimates of suspended and bed load sediment supply from local tributaries and flood control sediment removal (not available to Schoellhamer et al., 2005 and not available for bed load or FCC removal to Perry et al., 2015), recent flux modeling and monitoring at the Golden Gate Bridge (not available to either study), and bathymetric data for the central Bay (not available to Schoellhamer et al., 2005).

Recently, a sediment synthesis was completed for San Francisco Bay that included updated information on supply of sediment to the Bay that for the first time considered grain size and sediment removal, considered fluxes at two cross sections in the Bay (the Dumbarton and Benicia Bridges), and formally reported estimates of errors (Schoellhamer et al., 2018). However, estimates of bed erosion (see accompanying proposal: Jaffe, Bathymetric Change Analysis Study), flux at the Golden Gate bridge (Downing-Kunz et al., 2018; and see accompanying proposal: MacWilliams - Golden Gate Sediment Flux Modeling), dredge records, sand mining volumes, and standing mass in the water column were not discussed and only mass units were presented. However, units matter a lot since those who manage sediment by dredging are mostly interested in volume whereas those interested in contaminant transport might prefer

mass and those interested in primary productivity (light penetration) may be most interested in concentration.

The proposed CM/SA for sediment mass balance in San Francisco Bay will build upon these previous efforts to address these data gaps and weaknesses. It will be developed at the scale of subembayments (not done before), for both coarse and fine sediment for the current climatic regime and report in both mass and volume units taking into account errors associated with assumptions about sediment bulk density (see accompanying proposal: Lowe: Sediment Bulk Density Study), sediment particle density, and water density. Where data allow, conceptual models will also be developed for smaller spatial scales such as Bay margin channels to learn about how sediment transport and deposition work at the edge of the Bay. Once data are compiled, the budget terms and associated errors will be analysed by maximising and minimising the budget terms to determine the importance of each term in relation to the balance of sediment for the area of interest and interpretations drawn from the budget. In addition, we will also consider at least conceptually how the Bay sediment system might change as sea level rises and the rainfall and runoff regime changes in the future. We may also be in a position to discuss the interaction between subtidal bathymetry change and mudflat change and how that relationship might change as water depth increases.

Study Objectives and Applicable RMP Management Questions

Such a conceptual model (or nested conceptual models) and sensitivity analysis will provide stakeholders with a common understanding of important sediment processes in the Bay now and in the future and will help coordinate and focus limited funding resources on important data gaps. A lot of effort has already been made to understand a general set of research questions and data gaps related to Bay sediment. A sediment conceptual model is now needed to understand the relative importance of the different information needs in the context of key management questions. This study is designed to set up a framework for supporting and prioritizing data collection and modeling to address of the sediment related management questions.

Management Question	Study Objective	Example Information Application
MQ1: What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?		
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?		
MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	1. Reach consensus on a conceptual model for sediment sources, sinks, and transport in San Francisco Bay and its subembayments. 2. Understand the relative value of adding new monitoring and modeling programs.	The Sediment WG can use the conceptual model to put project ideas into context. The Sediment WG can make objective decisions about priorities for monitoring and modeling. Recommendations will inform the Sediment Monitoring Strategy being developed for the Healthy Watersheds Resilient Baylands Project.
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?		
MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?		

Approach

Task 1. Conceptual Model Development

Develop a conceptual model of sediment transport and depositional processes within San Francisco Bay at the subembayment scale (with nested detail at smaller scales where available and for illustrative purposes). The basic model will consist of a series of boxes and arrows with differing shapes, colors and sizes representing fluxes, sources and sinks, and magnitude.

Task 2. Literature Review and Data Compilation

Review relevant literature and local monitoring data to quantify masses, volumes, fluxes, sources, and sinks of sediment for each subembayment. Uncertainties associated with these estimates and key system components and processes will also be compiled. Although some of the information has been recently compiled in the RMP sediment synthesis, information on flux at the Golden Gate, bed elevation change, dredging and sand mining records, and standing sediment stock as not been recently compiled and information of volume, mass, and concentration for coarse and fine sediment need to be gathered and synthesized for all the terms in the conceptual model.

Task 3. Sensitivity Analysis

Complete a sensitivity analysis (a numerical evaluation of errors and uncertainties) to determine current data and information weaknesses and prepare a justification of future monitoring and or modeling tasks. This will be done by creating a spreadsheet based mass balance for each subembayment and then minimizing and maximizing each of the terms in the budget in relation to the estimated or known errors or conceptual biases to evaluate the relative importance of the accuracy of each of the terms. This assessment will quantitatively show which of the sediment sources will be most important to conduct further monitoring or modeling. For example, we will be able to determine if the errors associated with flux and the Golden Gate is a more important weakness than improvement in the estimate of bed elevation change or bulk density.

Task 4. Reporting

Draft a short report of the results using a series simple diagrams and tables (likely an appendix) with consistent well defined nomenclature using appropriate units and clearly articulated assumptions in relation to units conversions. Present results to the stakeholder and advisory team, address review comments and complete report for publication and distribution.

Budget

The following budget represents estimated costs for this proposed special study.

Expense	Estimated Cost
Task 1: Conceptual Model Development	$15,100
Task 2: Literature Review and Data Compilation	$18,600
Task 3: Sensitivity Analysis	$10,000
Task 4: Reporting	$34,300
Subcontracts	$0
Direct Costs	$0
Grand Total	**$78,000**

Budget Justification

Labor Costs

The majority of the work will be completed by an environmental analyst (280) and an environmental scientist (170 hrs) with oversight from Lester McKee (88 hrs) and conceptual model development and review assistance from Phil Trowbridge (10 hours), Jeremy Lowe (18 hours), Scott Dusterhoff (18 hours), and Letitia Grenier (18 hours). Some budget has also been set aside for graphic support (20 hours).
The total labor cost for this level of effort is $78,000.

Direct costs for the meeting to present the draft results including lunches and travel for technical advisors is assumed to be covered by the RMP Workgroup Meeting budget.

Reporting

The final report will be prepared for publication on the RMP website after appropriate review by the Sediment Workgroup and the TRC and addressing reviewer comments. A draft of the report will be prepared by May 2019. The final report will be published by August 2019.

References

Downing-Kunz, M., Schoellhamer, D., and Work, P., 2017. Water and Suspended-Sediment Flux Measurements at the Golden Gate, 2016-2017. Report prepared by the United States Geological Survey, California Water Science Center, Placer Hall, 6000 J Street, Sacramento, CA 95819 in partnership with the Regional Monitoring Program for Water Quality in San Francisco Bay. SFEI Contribution Number: 856.

Ogden Beeman and Associates and Ray B. Krone and Associates, 1992. Sediment budget study for San Francisco Bay: Final Report prepared for the San Francisco

District, U.S. Army Corps of Engineers.

Perry, H., Lyndon, A., Soumoy, P., and Goeden, B., 2015. San Francisco Bay sediment: Challenges and opportunities. Poster presented to the 12th Biennial State of the San Francisco Estuary Conference - Sept. 17-18, 2015, Oakland Marriott City Center, Oakland, CA.

Schoellhamer, D.H, Lionberger, M.A., Jaffe, B.E., Ganju, N.K., Wright, S.A., and Shellenbarger, G.G., 2005. Bay Sediment Budget: Sediment Accounting 101. In San Francisco Estuary Institute (SFEI), 2005. “The Pulse of the Estuary: Monitoring and Managing Water Quality in the San Francisco Estuary”. SFEI Contribution 411. San Francisco Estuary Institute, Oakland, CA. pp 58-63.

Schoellhamer, D., McKee, L., Pearce, S., Kauhanen, P., Salomon, M., Dusterhoff, S., Grenier, L., Marineau, M., and Trowbridge, P., 2018. Sediment Supply to San Francisco Bay, Water Years 1995 through 2016: Data, trends, and monitoring recommendations to support decisions about water quality, tidal wetlands, and resilience to sea level rise. San Francisco Estuary Institute, Richmond, CA. SFEI Contribution Number 842.

RMP Special Study Proposal: Sediment Monitoring Strategy for San Francisco Bay - Phase II

Summary: In fall 2016, the RMP provided $50,000 toward a EPA-funded project titled *Healthy Watersheds Resilient Baylands* (HWRB). The RMP funds are for the development of a sediment monitoring strategy for addressing key data gaps related to the transport of sediment to and within the Bay. Since developing the scope of work for the HWRB project, there has been a growing focus on sediment monitoring in the Bay that has led to a reevaluation of the necessary components of the sediment monitoring strategy development effort. Specifically, there needs to be close coordination with the newly-formed RMP Sediment Workgroup and other regional efforts focused on Bay sediment monitoring and a stand-alone sediment monitoring strategy that is available for use by the RMP and other partner organizations sooner than the completion of the HWRB project. There should also be a presentation of the sediment monitoring strategy to the RMP Sediment Workgroup and key stakeholders. This funding request is for budget to support these additional project components.

Estimated Cost: $50,000

Oversight Group: RMP Sediment Workgroup

Proposed by: Scott Dusterhoff, Letitia Grenier, and Jeremy Lowe (SFEI)

Proposed Deliverables and Timeline

Deliverable	Due Date
Draft Regional Sediment Monitoring Strategy Framework	February 2019
Expert Review of the Draft Framework	March 2019
WG Meeting to Present the Draft Sediment Monitoring Strategy	May 2019
Final Sediment Monitoring Strategy	August 2019
Presentation of Strategy to RMP Sediment Workgroup	September 2019

Background

In fall 2016, SFEI and several partner agencies were awarded an EPA San Francisco Bay Water Quality Improvement Fund grant for a project titled *Healthy Watersheds Resilient Baylands* (HWRB). This project includes the development of a regional sediment strategy that will contain a sediment monitoring strategy for addressing key data gaps related to the transport of sediment to and within the Bay. In 2017, the RMP provided $50,000 in matching funds to help support the development of the sediment monitoring strategy, which is planned to be a chapter in the regional sediment strategy report that will be released by early 2020.

Since developing the scope of work for the HWRB project, there has been a growing focus on sediment monitoring in the Bay that has led to a reevaluation of the necessary components of the sediment monitoring strategy development effort. For example, the RMP recently formed a Sediment Workgroup that will need the strategy soon to help guide monitoring and modeling priorities for the coming decade and will need to be closely involved in the strategy development. In addition, there are now several other regional efforts addressing sediment monitoring strategies (e.g., Wetlands Regional Monitoring Program, Bay Restoration Authority, BCDC Sediment Strategy) that the project team will need to coordinate with as part of strategy development.

This funding request is for budget to support additional coordination time with key partners,, a stand-alone monitoring strategy report that will be available by the next RMP Sediment Workgroup meeting, and presentations of the strategy upon completion to promote its adoption by as many agencies as possible.

This request for a second phase of funding for the sediment monitoring strategy in 2019 is in the RMP's Multi-Year Plan.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential in setting long-term priorities for monitoring and modeling sediment delivery to and transport/deposition within San Francisco Bay. The objectives of the project and how the information will be used are shown in Table 1 relative to the management questions of the RMP Sediment Workgroup.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
1) What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?		
2) Are there effects on fish, benthic species, and submerged habitats from dredging or placement of sediment?		
3) What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	Develop a sediment monitoring strategy that helps fill data gaps related to the sources, particle sizes, and amounts of sediment delivered to and transported within the Bay	The RMP Sediment Workgroup will use the monitoring strategy to prioritize investments in new monitoring and modeling activities
4) How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?		
5) What are the concentrations of suspended sediment in the Estuary and its segments?		

Approach

The Healthy Watersheds Resilient Baylands Project was originally proposed in 2016. However, since that time, interest in sediment monitoring and management has increased. The number of interested parties has grown. The scope of the regional sediment monitoring strategy has also increased along with the need for it be prepared earlier. Therefore, the following tasks are needed to meet expectations of stakeholders:

- Increased coordination among stakeholders
- Time to expand the scope and accelerate the schedule of the monitoring strategy.
- A second Workgroup meeting in fall 2019 to present the final monitoring strategy.

These tasks are described in more detail below.

1. **Coordination with regional partners and the RMP Sediment Workgroup**
   Currently, there are limited funds in the project budget for coordination with regional partners involved in regional sediment monitoring strategy development and the RMP Sediment Workgroup. The additional funds requested will be used in part to fund meeting with SFEP staff managing the Wetlands Regional Monitoring Program, BCDC staff leading the development of regional monitoring recommendations as part of an overall sediment strategy, staff at the Restoration Authority involved with developing monitoring activities associated with restoration projects, as well as other key regional partners like the Regional Board whose input on the sediment monitoring strategy is essential. The funds will also support coordination between the RMP Sediment Workgroup and the Healthy Watersheds Resilient Baylands Project.

2. **Expanded sediment monitoring strategy document, available earlier**
   Currently, there are project funds available for the sediment monitoring strategy to be a short chapter in the full regional sediment strategy synthesis report, which is scheduled to be released in early 2020. However, the RMP Sediment Workgroup needs guidance on priorities for monitoring and modeling for the next meeting in May 2019. Therefore, the additional funds requested will be used in part to fund the development of a more detailed, stand-alone sediment monitoring strategy document. An initial step in the process will be to develop a draft framework that will be reviewed by technical experts in early spring 2019 to ensure that it is on the right track. A complete draft will be available for review by the RMP Sediment Workgroup and other key regional partners at the May 2019 Workgroup meeting. This draft will help guide the Workgroup decisions for funding in 2020. The final strategy document will be completed by September 2019. As a result of this investment, the Sediment Workgroup will have a draft strategy for planning one year earlier than previously planned.

3. **Second Workgroup meeting for monitoring strategy presentation**
   There are currently no project funds available to present the final sediment monitoring strategy to the RMP Sediment Workgroup and key regional partners.

Yet, communication of the strategy will be critical for its implementation because the RMP funding will not be sufficient to cover all recommended monitoring activities. The additional funds requested will be used for a Workgroup meeting at SFEI where the project team will present the sediment monitoring strategy and answer questions. The presentation will occur after the release of the final monitoring strategy, likely in September or October 2019.

Budget

The following budget represents estimated costs for this proposed special study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Cost
Task 1: Coordination	$5,000
Task 2: Stand-Alone Strategy Document	$35,000
Task 3: Second WG Meeting	$8,000
Subcontracts	$0
Direct Costs	$2,000
Grand Total	**$50,000**

Budget Justification

The majority of the time will be for Letitia Grenier, Scott Dusterhoff, and Katie McKnight to have meetings with key partners, coordinate the workshop, compile the detailed sediment monitoring strategy document, and coordinate the final presentation. Senior scientists serving as advisors for the Health Watersheds-Resilient Baylands project will also be involved to ensure consistency with the larger project. There is also a direct costs budget to pay for review and meeting attendance by technical experts.

Reporting

The final report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee. It will be published by SFEI as a Healthy Watersheds Resilient Baylands-RMP joint-funded report.

References

NA

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415.230.0862
ANCHOR QEA

Regional Monitoring Program Special Study Proposal
Golden Gate Sediment Flux Modeling

April 17, 2018

To: Philip Trowbridge, PE, Program Manager, Regional Monitoring Program for Water Quality in San Francisco Bay

From: Michael L. MacWilliams, PhD, PE, Anchor QEA, LLC

Re: Golden Gate Sediment Flux Modeling

Proposal Summary	The U.S. Geological Survey (USGS) measured sediment fluxes through the Golden Gate during complete tidal cycles in March and June 2016 and February 2017. The sediment flux measurements in February 2017 showed a greater sediment flux into San Francisco Bay on flood tide than the flux out on the preceding ebb tide. USGS hypothesized that this result occurred because the measurements were made on the falling limb of the hydrograph and that during peak outflows the sediment flux out was greater than the flux in. This study proposes to simulate the sediment flux across the February 2017 high flow period, validate the model-predicted sediment flux using the one tidal cycle of flux observations collected by USGS, and then compute the total predicted sediment flux through the Golden Gate over a 3-month period. The primary motivation is to understand why the measured sediment flux back into the Bay during the observation period was greater than the flux out, and whether this is related to being on the tail end of the sediment pulse. The model simulations can also be used to assist in developing surrogate measurements of sediment flux at the Golden Gate that are critical for understanding the overall sediment mass balance in San Francisco Bay. The predicted sediment flux at the Golden Gate will be compared to observed parameters such as suspended sediment concentration (SSC) at Alcatraz or Sacramento-San Joaquin Delta (Delta) outflow to develop these relationships. Predicted sediment fluxes between each subembayment will also be calculated from this simulation to inform calculation of sediment fluxes within the Bay.
Relevant Management Questions	**MQ3:** What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments? **MQ5:** What are the concentrations of suspended sediment in the Estuary and its segments? One of the single greatest uncertainties related to developing a sediment budget for San Francisco Bay is the uncertainty related to the sediment flux at the Golden Gate. The application of an existing hydrodynamic and sediment transport model to simulate the period of data collection will add value to the existing data set from February 2017 by helping to understand sediment fluxes immediately prior to the sampling event during peak flows and allow for an assessment of why the measured flux back into the Bay during the observation period was greater than flux out (MQ3). The model predictions will also be compared to observed SSC throughout the Bay (MQ5).
Estimated Cost	$45,000
Proposed by	Michael L. MacWilliams, PhD, PE, and Aaron Bever, PhD, Anchor QEA, LLC

1. Background

This project will apply an existing 3-D hydrodynamic, salinity, and sediment transport model of San Francisco Bay to predict sediment fluxes at the Golden Gate and between each subembayment of the Estuary. This project leverages an existing model that has already been extensively calibrated and validated for SSC throughout the Estuary and the Delta and will build on existing work currently being conducted to simulate sediment concentrations in Suisun Bay and the Delta during 2017. As a result, this project provides a cost-efficient way to add significant value to the data set collected by USGS in February 2017, provides a way to investigate the hypothesis that the net sediment flux into the Bay through the Golden Gate was positive because the measurements were made on the falling limb of the hydrograph and that during peak flows the flux out was greater than the flux in, and provides additional information that can be used to develop surrogate flux estimates.

1.1 Sediment Modeling Background

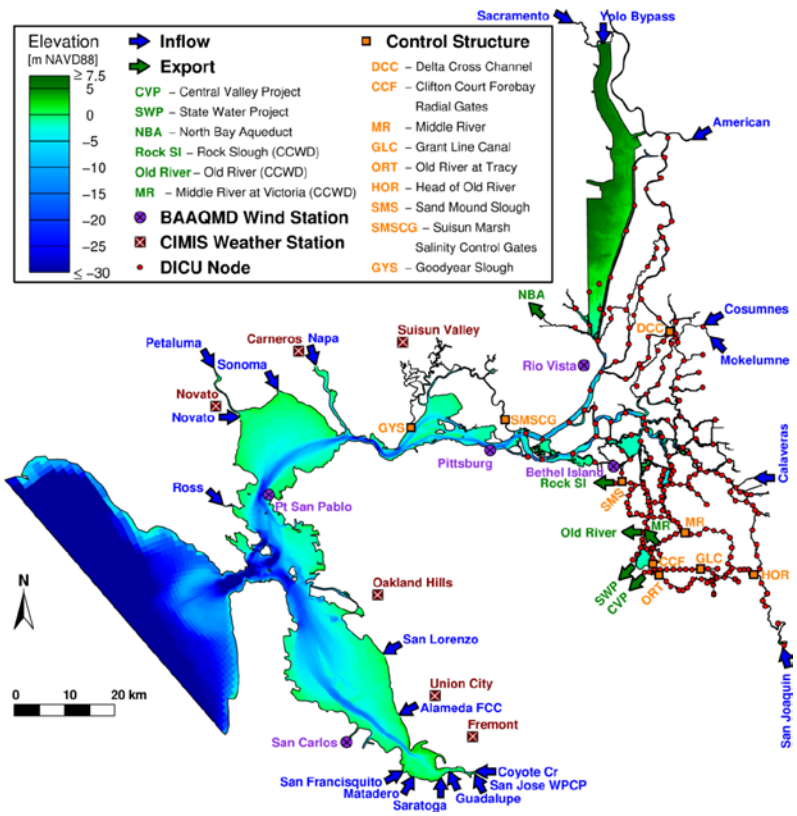
The UnTRIM Bay-Delta model (MacWilliams et al. 2007, 2008, 2009, 2015) will be applied together with the SWAN (SWAN Team 2009a) wave model and the SediMorph sediment transport and seabed morphology model (BAW 2005), as a fully-coupled hydrodynamic-wave-sediment transport model. This coupled modeling system has been used previously to predict sediment transport throughout the Bay-Delta system, as part of two projects for the U.S. Army Corps of Engineers (USACE) to investigate how sea level rise and a reduced sediment supply to the Delta impacted the sediment routing through the Bay-Delta system and the sediment deposition within Suisun and San Pablo Bays (MacWilliams et al. 2012; Bever and MacWilliams 2014). The coupled models were also used to investigate the effects of breaching Prospect Island on regional turbidity and sediment dynamics in the north Delta and Cache Slough region (Delta Modeling Associates 2014). Other applications of the sediment transport model include simulations of dredged material dispersal in Northern San Francisco Bay (MacWilliams et al. 2012) and South San Francisco Bay (Bever and MacWilliams 2014; Bever et al. 2014) to determine the fate of dredged material and investigate whether open water placements can potentially be used to augment mudflat and marsh sedimentation. Bever and MacWilliams (2013) applied the coupled modeling system to investigate wave shoaling and sediment fluxes between the channel and shoals in San Pablo Bay. The model has also been used to investigate sediment fluxes at Dumbarton Bridge (Delta Modeling Associates 2013), following a similar approach to that proposed in this study.

The UnTRIM San Francisco Bay-Delta model (UnTRIM Bay-Delta model) is a 3-D hydrodynamic model of San Francisco Bay and the Delta developed using the UnTRIM hydrodynamic model (MacWilliams et al. 2007, 2008, 2009, 2015). The UnTRIM Bay-Delta model extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta (Figure 1), and takes advantage of the grid flexibility allowed in an unstructured mesh by gradually varying grid cell sizes, beginning with large grid cells in the Pacific Ocean and gradually transitioning to finer grid resolution in the smaller

channels of the Delta. This approach offers significant advantages both in terms of numerical efficiency and accuracy and allows for local grid refinement for detailed analysis of local hydrodynamics, while still incorporating the overall hydrodynamics of the larger estuary in a single model.

The SWAN model (SWAN Team 2009a) is a widely used model for predicting wind wave properties in coastal areas (e.g., Funakoshi et al. 2008). SWAN "represents the effects of spatial propagation, refraction, shoaling, generation, dissipation and nonlinear wave-wave interactions" (SWAN Team 2009b) on wind waves. Therefore, SWAN can estimate the wind waves in coastal regions with variable bathymetry and ambient currents. SWAN can also accommodate spatial variability in bottom friction parameters and wind velocity. In the coupled modeling system, the SWAN model runs on the same unstructured grid as UnTRIM, providing high resolution in areas where it is needed.

Figure 1
Model domain and boundary conditions for the UnTRIM Bay-Delta model

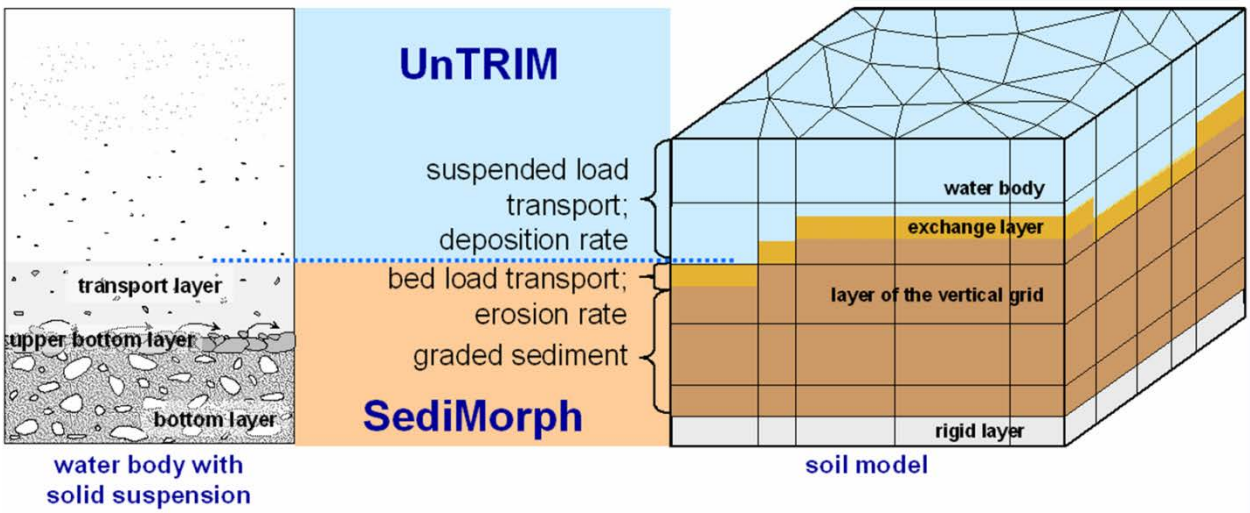


The primary purpose of the SediMorph module is to compute the sedimentological processes at the alluvial bed of a free-surface flow, including the following (Weilbeer 2005):

- The roughness of the bed resulting from grain and form roughness (ripples and/or dunes)
- The bottom shear stress as a result of roughness, flow, and waves
- Bed load transport rates (fractioned)
- Erosion and deposition rates (fractioned)
- Bed evolution
- Sediment distribution within the bed exchange layer

SediMorph is designed to use the same horizontal computational mesh as the UnTRIM hydrodynamic model. In the vertical, the SediMorph module allows for evolution of the bed elevation above a pre-defined rigid layer in each cell. Above the rigid layer, SediMorph includes at least one exchange layer in which sediments are mixed and exchange processes such as erosion and deposition occur. Figure 2 shows the horizontal and vertical grid structure of the UnTRIM and SediMorph models and provides a schematic representation of the location of the sediment transport processes within the model grid structures.

Figure 2
Horizontal and vertical grid structure of the UnTRIM and SediMorph models (right); schematic (left) and process list (middle) show the location of the sediment transport processes within the model grid structures (Source: BAW)



Sediment transport simulations using the UnTRIM San Francisco Bay-Delta Model include multiple sediment classes, an initial sediment bed based on over 1,300 observed seabed grain size distributions within the Bay and the Delta, sediment input from 10 Bay-Delta tributaries, and wave- and current-driven sediment resuspension and transport.

In this coupled modeling system, UnTRIM calculates the flow, water level, salinity, sediment advection, sediment settling, and sediment mixing. SWAN calculates the temporally and spatially varying waves needed for accurate predictions of sediment resuspension in the presence of wind waves. SediMorph calculates the erosion and deposition of sediment and the seabed morphologic change, and keeps track of the sedimentological properties within the seabed. The model bathymetry in each grid cell is adjusted each time step to account for erosion and deposition.

The calibration and validation of salinity, flow, and water level in the UnTRIM Bay-Delta model has been well-documented (e.g., MacWilliams et al. 2007, 2008, 2009, 2015). The model accurately predicts the salinity, flow, and water level throughout the San Francisco Bay and the Delta under a wide range of conditions. The SWAN wave results have been calibrated and validated to observed wave properties in San Pablo and Suisun Bays and at four locations south of Dumbarton Bridge. The sediment transport within the coupled modeling system has been calibrated using SSC time series at five stations within San Francisco Bay (red squares on Figure 3), eight stations within the Sacramento-San Joaquin Delta (orange triangles on Figure 3), and using vertical SSC profiles along a transect along the axis of San Francisco Bay from the far South Bay to Rio Vista (yellow circles on Figure 3). Figure 4 shows an example of the observed and predicted SSC at Rio Vista spanning a 7-month period during water year 2011. This shows that the model accurately predicts both the magnitude and seasonal patterns of SSC in the Sacramento River indicating the model is accurately predicting the outflow of sediment from the Delta during high flows. Figure 5 shows a comparison of observed and predicted SSC along the axis of San Francisco Bay on June 14, 2011, and demonstrates that the model is capturing the primary features in the vertical and longitudinal SSC. The model has also been validated through comparison of observed and predicted deposition within a breached salt pond during the period following the initial breach (Bever and MacWilliams 2014). The sediment validations demonstrate that the coupled hydrodynamic-wind wave-sediment model is accurately capturing the processes that resuspend, deposit, and advect sediment throughout the Bay-Delta system, and would therefore be suitable for evaluating sediment fluxes both at the Golden Gate and between each subembayment of the Bay. By simulating suspended sediment processes directly, the physical feedbacks between changing forcing and their influence on local and regional sediment dynamics can all be explicitly evaluated.

Figure 3
The locations of SSC data within the San Francisco Bay (red squares), within the Delta (orange triangles), and for the transect vertical profiles (yellow circles)

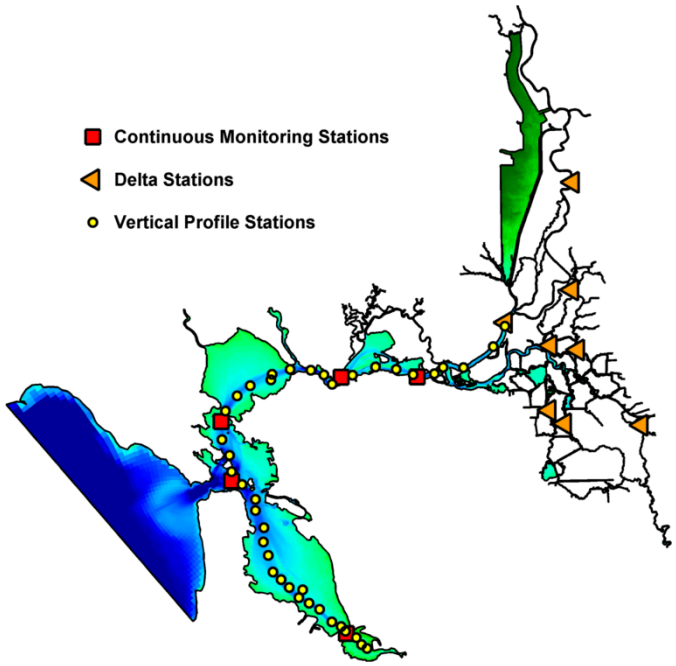


Figure 4
Observed and predicted cross-section average SSC at the Sacramento River at Rio Vista (RIO)

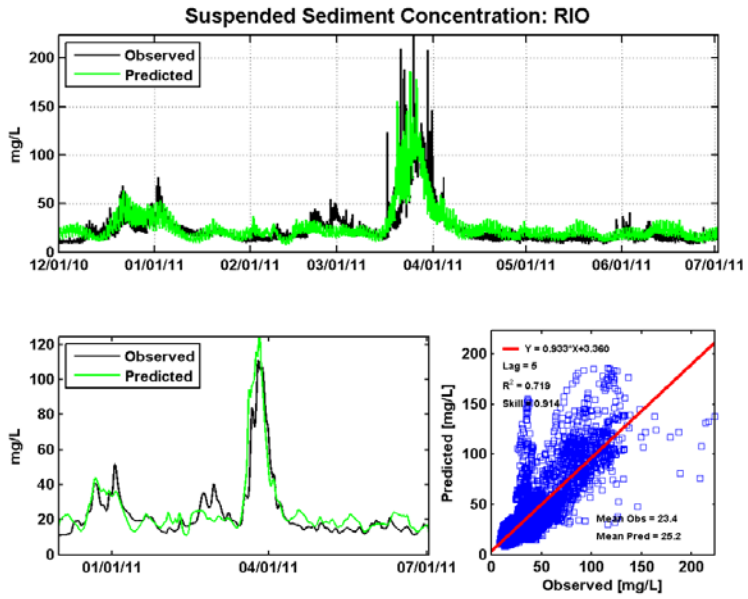
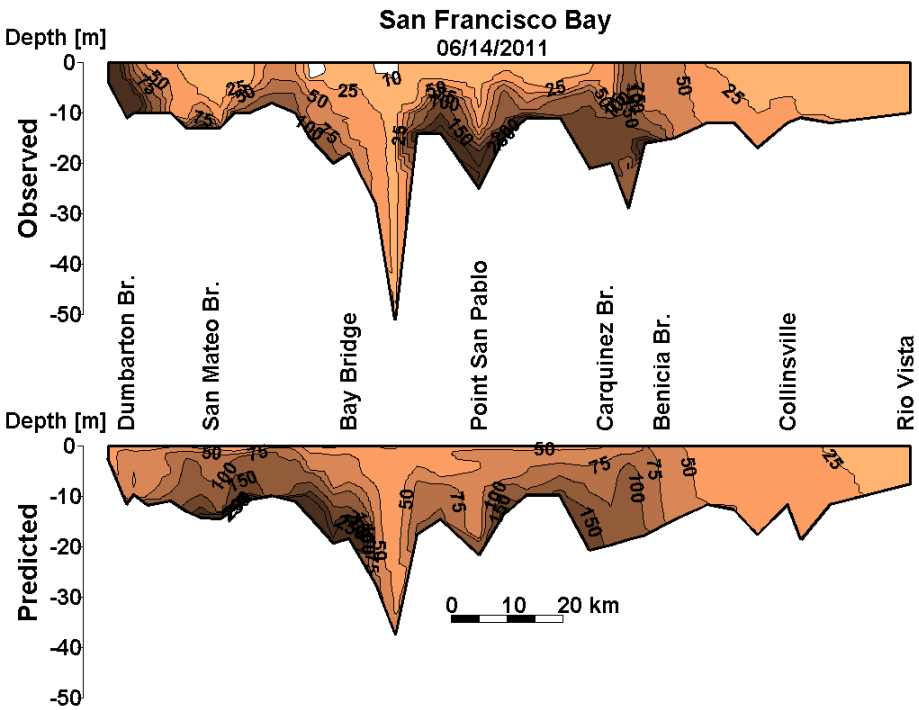


Figure 5
Observed and predicted SSC along a transect from the far South Bay to Rio Vista on June 14, 2011



1.2 Sediment Flux at Dumbarton Bridge

The UnTRIM Bay-Delta model was previously used to provide a detailed evaluation of sediment flux at Dumbarton Bridge based on data estimates and model predictions (Delta Modeling Associates 2013). Model results of water flow and sediment flux at Dumbarton Bridge were compared to USGS estimates. While the modeled and observed water flow agreed well on a tidal time scale, the directions of net observed and predicted water flow were different (Figure 6). The model predicted a net water flow toward the north out of the far South Bay (8.99 cubic meters per second [m^3/s]), while the USGS estimates have a southward net water flow (-46.9 m^3/s). When the model-predicted net flows in the channel (red line) are compared to the observed flows (black line), they match closely and indicate a net flow into the far South Bay (Figure 7). The boat-based sampling spanned only the channel and did not include the shoals (Figure 8). This analysis suggests that the discrepancy in the water net flow direction occurred because the observed flow does not include the northward net flow which occurs on the relatively shallow shoals, and that when the flows on the shoals are included, the net water flow is north (Figure 7, green line).

Figure 6
USGS estimated (Observed) and model predicted (Predicted) water discharge past Dumbarton Bridge from December 2010 through July 2011. The upper panel shows the instantaneous values while the lower left panel shows the tidal average. Negative discharge is southward into the far South Bay.

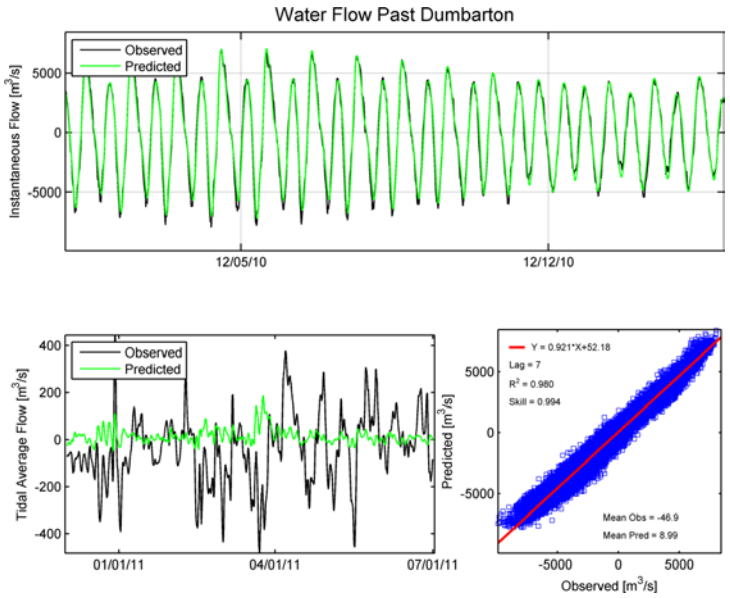


Figure 7
USGS estimated (Observed) and model predicted cumulative water discharge within the entire cross section (green) and in just the channel (red) past Dumbarton Bridge for December 2010 through July 2011. Negative flow is southward into the far South Bay.

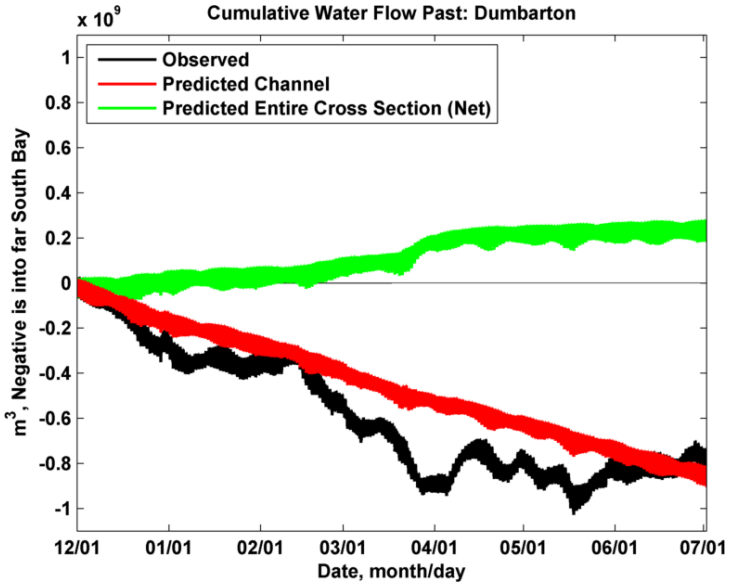
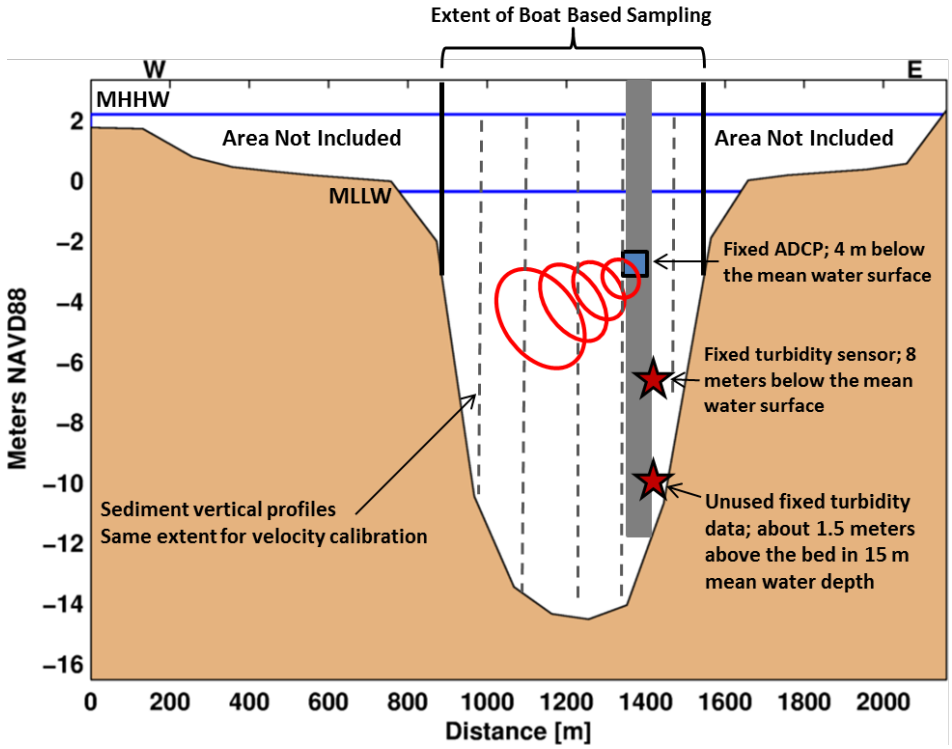


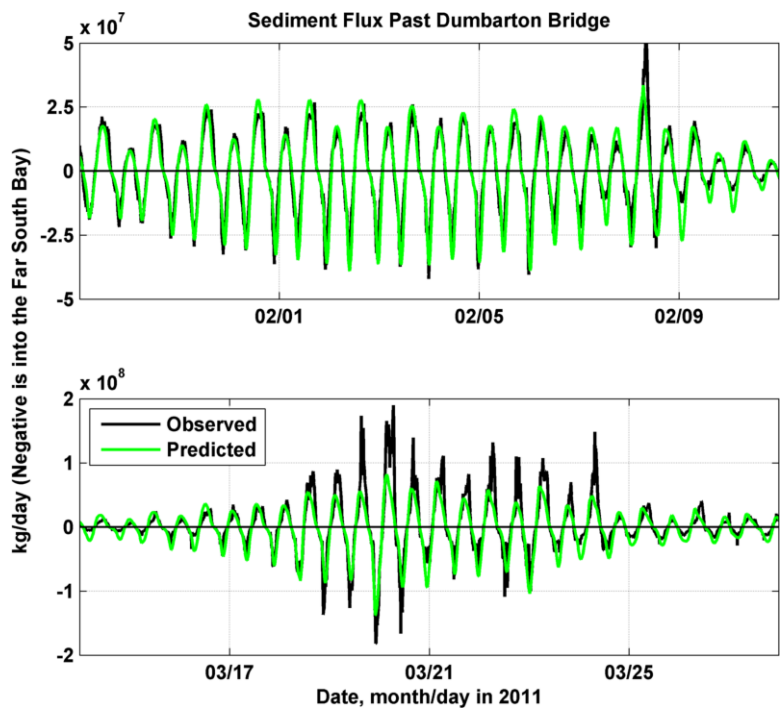
Figure 8
The cross section underneath Dumbarton Bridge highlighting the deeper main channel and shallower shoals. The water surface shows the mean higher high water (MHHW) and mean lower low water (MLLW) levels at Dumbarton Bridge. The thick grey line represents the bridge piling with the ADCP (blue square) and turbidity (red stars) sensors (vertical and horizontal locations are approximate). The dashed grey lines show the approximate locations of the vertical profiles used to correlate the point SSC to cross-section averaged concentration. The approximate extent of the boat-based sampling for determining the cross-section quantities is also shown.



The modeled and observed sediment fluxes also agreed well on a tidal time scale (Figure 9), yet had different net flux directions, with the net flux from the model toward the south and from the USGS estimates toward the north. A detailed comparison of multiple sediment flux estimates calculated using the available SSC data suggested that the USGS estimated sediment flux may overestimate the northward sediment flux (Delta Modeling Associates 2013). The analysis suggested that this northward overestimate may occur because only the SSC from the upper turbidity sensor on Dumbarton Bridge was used to determine the cross-sectional SSC. Sediment flux estimates calculated using the upper sensor result in a much more northward sediment flux compared to calculating the flux using the lower sensor or the average of the two sensors. The model results demonstrated that the sediment concentration near the bed was not in phase with the sediment concentration higher in the water column (which was also confirmed using the data), and thus the

observed sediment flux direction was highly sensitive to which sensor was used to calculate the flux. Because of this analysis, USGS conducted additional data collection to improve the estimate of sediment flux at Dumbarton Bridge. This demonstrates the utility of applying a 3-D hydrodynamic and sediment transport model to understand and investigate the data used to estimate observed sediment fluxes.

Figure 9
Observed and predicted instantaneous sediment flux past Dumbarton Bridge for two time periods. These time periods are shaded in Figure 6 for reference.



1.3 Sediment Flux at the Golden Gate

USGS measured sediment fluxes through the Golden Gate during complete tidal cycles in March and June 2016 and February 2017. Observed sediment fluxes are calculated by multiplying the measured discharge across the cross-section by the sediment concentration across the section (Figure 10). Discrete measurements of sediment concentrations were estimated from backscatter and velocity transects were measured using a boat-mounted ADCP for approximately 32 transects on February 27, 2017 (Figure 11). However, the sediment flux measurements in February 2017 showed a greater sediment flux into San Francisco Bay on flood tide than the flux out on the preceding ebb tide (Figure 12). USGS hypothesized that this result occurred because the measurements were made on the falling limb of the hydrograph and that during peak flows the flux out was greater than the flux in. The model will be used to investigate this hypothesis. Previous comparisons of model simulations of sediment flux at Dumbarton Bridge (Delta Modeling Associates 2013) have demonstrated the utility of this approach, and ultimately resulted in improved sediment flux estimates from the observations.

Figure 10
Calculation of observed sediment flux from measurements (Source: USGS)

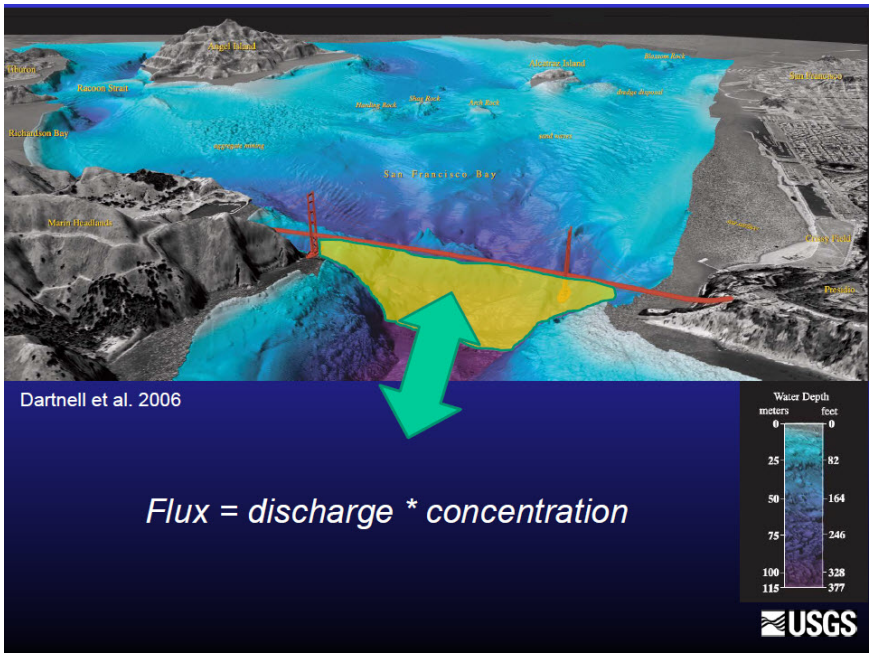


Figure 11
Example of measured acoustic backscatter (top) and velocity magnitude used to calculate observed sediment flux from measurements (Source: USGS)

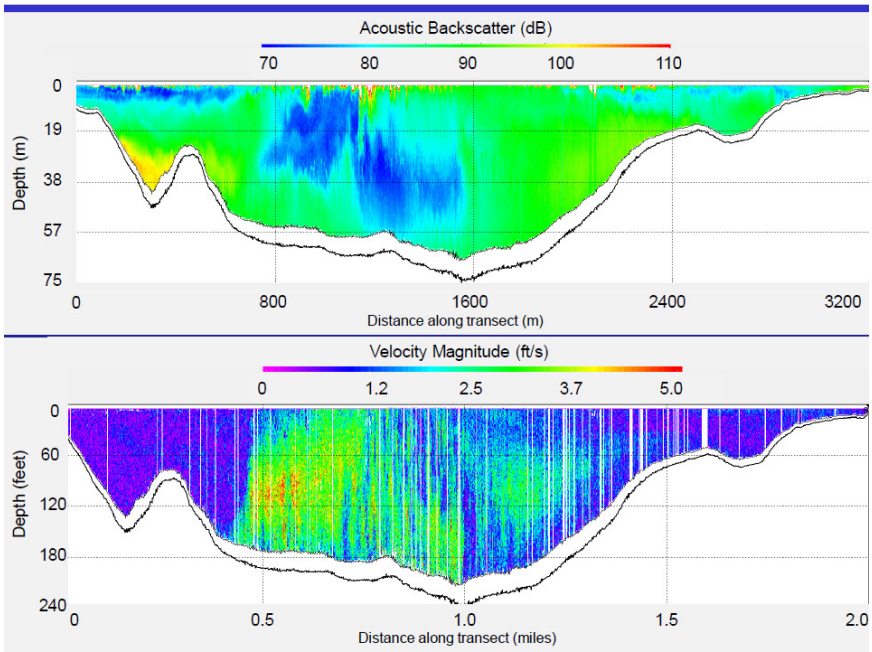
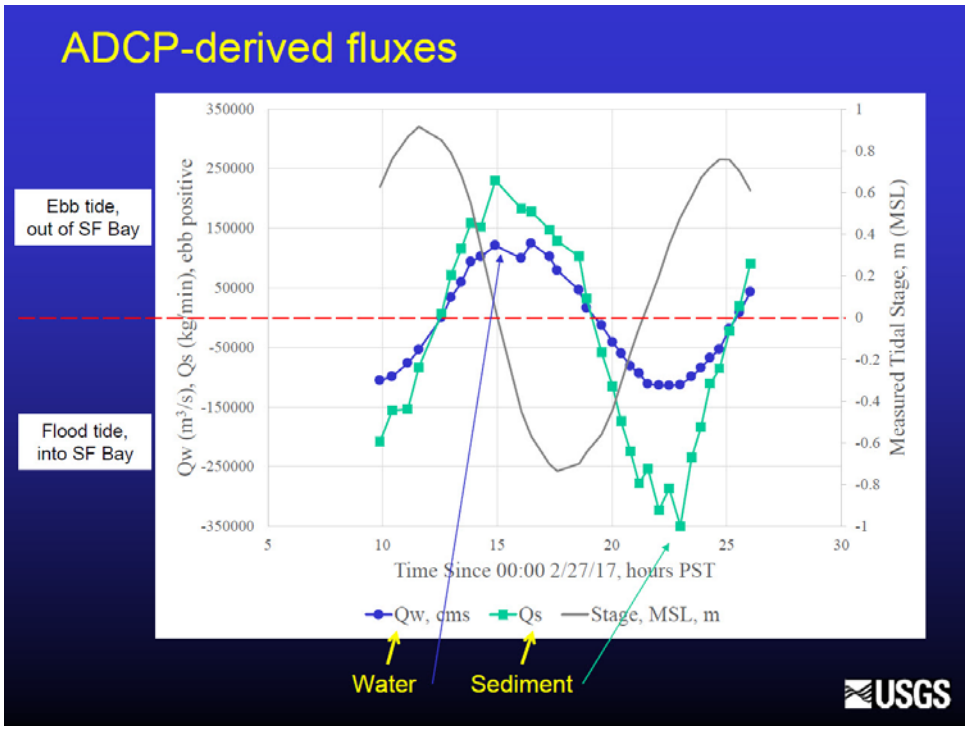


Figure 12
ADCP derived fluxes (water and sediment) at the Golden Gate on February 27, 2017 (Source: USGS)



II. Study Approach

The following section provides a detailed description of the work to be completed. Revisions or refinements to the scope of work can be made if requested.

Task 1: Simulation of Sediment Flux during January through March 2017

The UnTRIM Bay-Delta model will be used to simulate hydrodynamics, salinity, and sediment transport for the period from January 1, 2017, through March 31, 2017. This period spans the USGS sediment flux measurements at the Golden Gate made on February 27, 2017. This period is also particularly interesting because it spans two large outflow periods (Figure 13, top) and a period when the observed SSC at the Richmond San Rafael Bridge is higher than at Benicia (Figure 13, bottom).

The predicted sediment concentrations will be compared to observed SSC throughout the Estuary to validate model predictions of SSC. The sediment flux at the Golden Gate and between each of the subembayments of the Estuary will be calculated over the 3-month period. While the USGS sediment flux measurements span only a single day, the prediction of sediment fluxes during the 3-month high flow period in 2017 will allow for an increased understanding of how sediment fluxes vary on the rising and falling limbs of large outflow events.

During the data collection period on February 27, 2017, the model predictions of velocity and sediment concentration will be compared to the observed measurements of velocity and estimates of sediment concentration from backscatter (Figure 11). Previous comparisons between observed and predicted velocity transects have demonstrated that the model can accurately predict the complex velocity patterns near the Golden Gate (Figure 14). The model-predicted net flow, SSC, and net flux will be compared to the observations at each of the approximately 32 transects collected on February 27. This will allow for a detailed assessment of how differences between the predictions and observations affect the flux estimates for each discrete measurement transect.

Following the approach used at Dumbarton Bridge (Figure 9), the model-predicted sediment flux on each flood and ebb tide will be calculated for each day during the simulation period. These predictions will be used to investigate the hypothesis that the net sediment flux into the Bay through the Golden Gate during the sampling period was positive because the measurements were made on the falling limb of the hydrograph and that during peak flows the sediment flux out was greater than the flux in.

Because the model predictions of sediment flux at the Golden Gate will span a much longer period that the single day of data collection, the model predictions of sediment flux also be used to assist in developing surrogate measurements of sediment flux at the Golden that are critical for understanding the overall sediment mass balance in San Francisco Bay. The predicted sediment flux

at the Golden Gate will be compared to observed parameters such as SSC at Alcatraz or Delta outflow to help develop these relationships.

The results of these analyses will be included in a draft technical memorandum which will be provided to the Regional Monitoring Program sediment workgroup for review. Based on the comments received, the document will be revised, and a final memorandum will be submitted.

Task 1 Deliverables

- Draft technical memorandum describing sediment simulation period, model validation to continuous monitoring sensors, model comparisons to observed sediment flux on February 27, and model predictions of sediment fluxes between embayments during simulation period
- Final technical memorandum incorporating revisions based on comments from the Regional Monitoring Program sediment workgroup

Figure 13
Observed flow, salinity, and SSC during 2017 (Source: USGS)

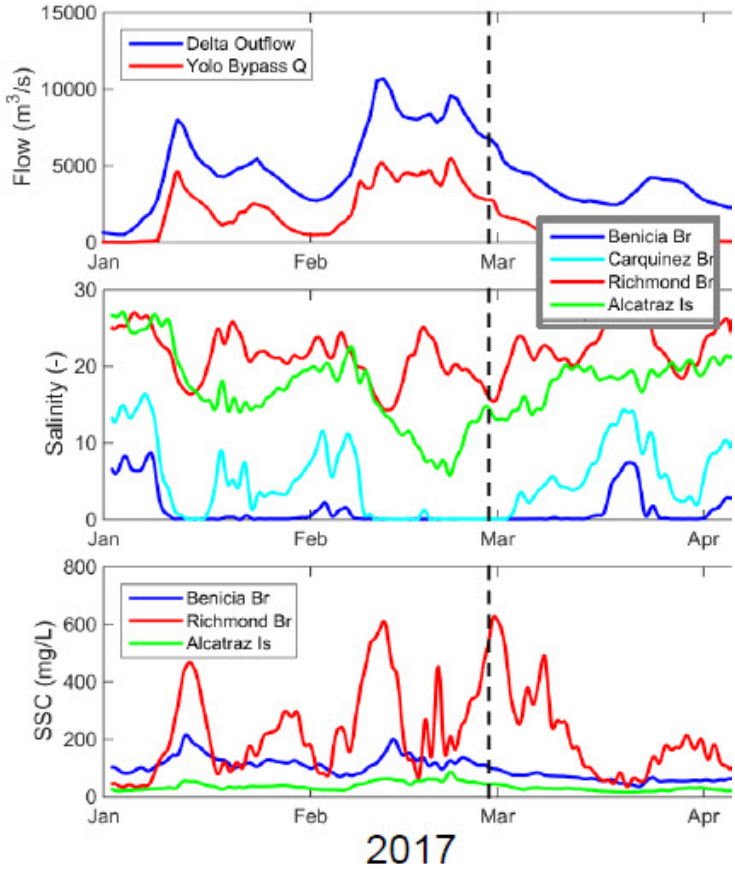
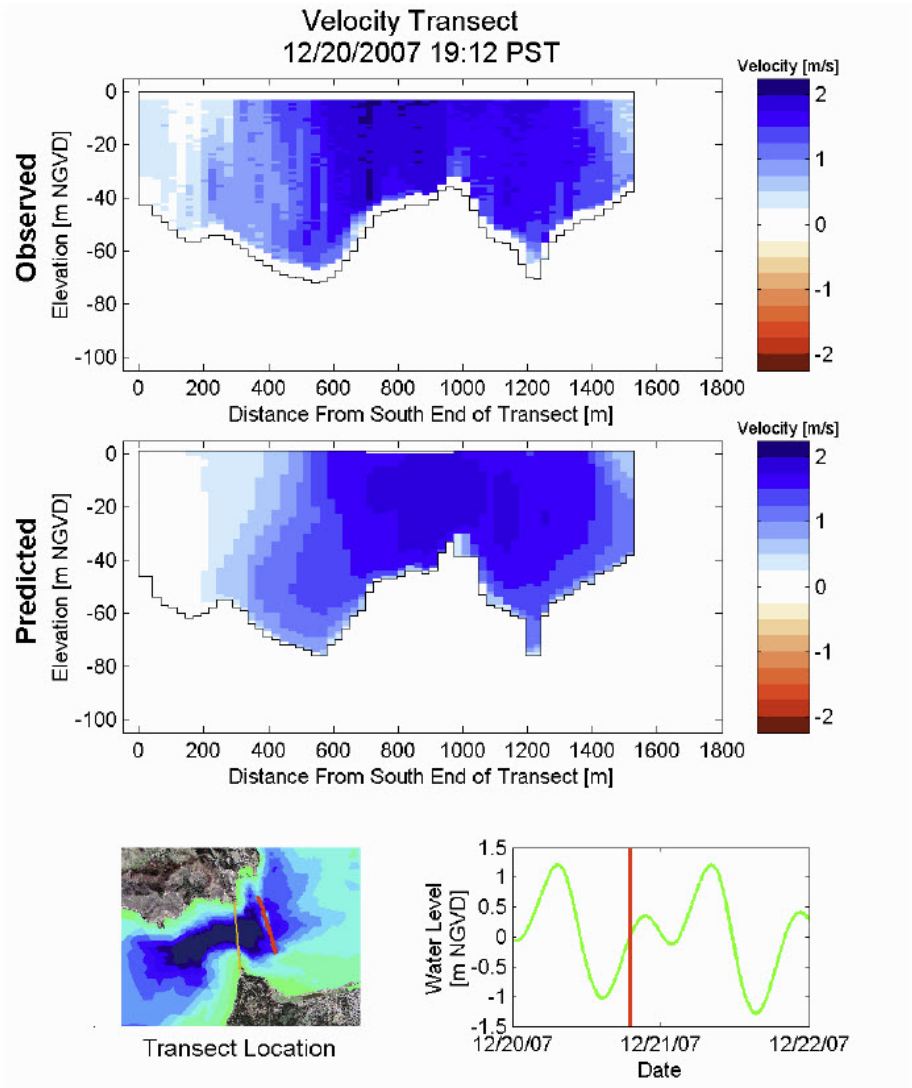


Figure 14
Observed (top) and predicted (middle) velocity transect on December 20, 2007, at 19:12 PST. The location of the transect (red line) is shown (lower left) relative to the position of the Golden Gate Bridge (orange line). Observed water level at Fort Point is shown with the red line indicating the start time of the transect (lower right).



4. Cost Estimate

A detailed project budget will be added after this scope of work is finalized. Based on the scope of work as described in the preceding sections, the estimated cost of this work is summarized in Table 1.

Table 1
Cost Estimate

Task Number	Description	Estimated Budget
1	Simulation of Sediment Flux from January through March 2017	$45,000
	Total	**$45,000**

5. Schedule

We anticipate that the draft technical memorandum will be completed within 4 months of notice to proceed. The final technical memorandum will be submitted within 1 month of receiving comments on the draft technical memorandum.

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RMP Special Study Proposal: Update of Erosion and Deposition in San Francisco Bay

Summary: In 2014 and 2015 the Ocean Protection Council (OPC) contracted for bathymetric surveys of large portions of San Francisco Bay. This data along with recent NOAA, USGS, and California State University Monterey Bay surveys can now be combined to create a revised bathymetric bathymetric Digital Elevation Model (DEM) of the whole of San Francisco Bay (South Bay, Central Bay, San Pablo Bay, and Suisun Bay). Analysis of these surveys and comparison with the USGS DEMs of earlier surveys will provide an update on the quantities and patterns of erosion and accretion in the Bay over the past 25 to 35 years. Such information can be used to assess how the Bay has responded to changes in sediment supply from the Delta and tributaries and provide managers with data for making decisions on a variety of issues including exposure of legacy contaminated sediment and strategies for beneficial dredge disposal.

Estimated Cost: $154,000

Oversight Group: RMP Technical Review Committee

Proposed by: Bruce Jaffe, USGS

Proposed Deliverables and Timeline

Deliverable	Due Date
Composite DEM of San Francisco Bay based on 2014-2015 OPC bathymetric surveys and other recent bathymetric data.	June 2020
Update on the quantities and patterns of erosion and accretion in the Bay over the past 25 to 35 years.	July 2020
Final report	July 2020 (draft) October 2020 (final)

Background

The USGS has spent just over a decade developing the historic bathymetric DEMs of San Francisco Bay from surveys conducted by NOAA's office of coast surveys beginning in the 1850s and ending in the 1990s. These DEMs have provided valuable insight to historic patterns of sediment deposition and erosion, pathways of sediment and sediment-bound contaminants within the Bay and subembayments, and sediment budgets.

We expect that erosion and deposition has changed recently in response to a decrease in sediment supply from the Delta (Wright et al., 2004) and the corresponding increase in the relative importance of sediment supply from local tributaries (McKee et al., 2013). There is no comprehensive, bay-wide, documentation of the recent (25 to 35 years) erosion and deposition.

The record of historical erosion and deposition has proven to be valuable for interpreting the spatial distribution and concentrations of contaminants in the Bay (Hornberger et al., 1999; Yee et al., 2011; Nilsen et al., 2014). This update can further aid in the interpretation of contaminants in the Bay and subembayments. Another application of this type of research was shown by Higgins et al. (2007), who produced a map of the age of near-surface sediments in San Pablo Bay that may be useful for understanding the distribution of legacy contaminants. The proposed updated DEM would allow construction of a bay-wide version of that map. The proposed work will also have a strong influence on helping to understand sediment processes at the more local scale of operational landscape units (OLUs), recently defined in the Bay to assist adaptation planning (SFEI 2018) . The new DEMs created from this project will help us to better understand the morphology of mudflats adjacent to key margin areas, and to better define risk in relation to water depth, fetch, and wave energy.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding sediment and sediment-bound contaminant pathways within San Francisco Bay and its subembayments. The objectives of the study and how the information will be used are shown in Table 1 relative to the management questions of the RMP Sediment Workgroup.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
MQ1: What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?		
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?		
MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	Update the distribution and quantities of erosion and deposition in the Bay and subembayments. Update mass balances for sediment in the Bay and subembayments. *Potential scope expansion: Assess the age of near-surface sediment.*	1) What are the present areas of erosion and accretion in San Francisco Bay? 2) How have human activities affected the erosion and accretion in the Bay? *What regions are erosional and may have older sediment with legacy contaminants near the sediment-water interface?*
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?		
MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?		

Approach

This research uses approaches developed by the USGS that documented erosion and accretion in San Francisco Bay from the mid-1800s to 1990s (Jaffe et al., 1998; Cappiella et al., 1999; Foxgrover et al., 2004; Jaffe and Foxgrover, 2006; Jaffe et al., 2007; Fregoso et al., 2008). Details of the development of data, phasing of research, and dissemination of study results are below.

1. Data Development

A. The 2014-15 OPC survey will be gridded using GIS surface modeling software to create a continuous bathymetric DEM. Gridding of the OPC surveys is time intensive because there are 93 surveys comprising a patchwork of surveys collected using either multibeam or interferometric sidescan sonar systems with varying spatial coverage. Some regions have continuous bathymetric coverage while others consist of striped trackline patterns with various spacing (Figure 1). Of the 93 surveys, 75 consist of swaths of bathymetry ranging from 18 to just over 100 meters wide. These swaths are collected along tracklines with spacings of 10 to just over 300 meters that will have to be interpolated across to create a continuous bathymetric surface DEM. The OPC data will support 1 m grid cells in regions with continuous coverage; larger grid cells may be necessary to accurately represent the bathymetry in regions where the bathymetry is only narrow swaths with larger gaps between adjacent tracklines.

B. Gaps in the OPC survey will be filled with the most recent bathymetric data from other sources, NOAA, USGS, CSUMB, and others, to allow a more complete comparison with earlier surveys (Figure 2). There are approximately 40 non-OPC surveys that will be used for gap filling.

C. All surveys will be resampled to a common resolution and mosaicked, with careful attention paid to edges, and possible discontinuities, between surveys.

D. After correcting to common vertical and horizontal datums, the bathymetric DEM of recent bathymetry will be differenced from existing 25 and 50 m resolution bathymetric DEMs of the 1970s-1990s to create a change DEM. This change DEM will be analyzed using GIS tools to document the quantities and patterns of erosion and accretion with South, Central, and San Pablo Bays during the past 25 to 35 years. These analyses will be conducted on both Bay segments and OLUs.

2. Phasing of Research

In the first year of the study we will refine methodology for creating an accurate modern DEM from bathymetric surveys with differing sounding densities and produce a DEM for Central Bay north of Tiburon, San Pablo Bay, and Suisun Bay. A DEM will be produced for the remainder of Central Bay and for South Bay in the second year of the study. The data release and final report will be prepared in the second year of the study as well.

3. Presentation of Results at Local Scientific Meeting
Results of this study will be presented at either the State of the Estuary or Bay-Delta Science Conference.

4. Report and Data Release
The final report will be published as a USGS Open-File Report. Contents will include the methodology for creation of the modern bathymetric DEM and analyses of the updated erosion and deposition. Analyses of erosion and accretion will be conducted on both Bay segments and OLUs. The modern bathymetric and change DEMs will be distributed as a USGS data release. Timeline for products is 18-24 months from start of the work. A draft of the report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee.

Budget

The following budget represents estimated costs for this proposed study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Cost
Year 1 Labor	$49,500
Year 1 Overhead	$27,500
Year 1 Total	**$77,000**
Year 2 Labor	$49,500
Year 2 Overhead	$27,500
Year 2 Total	**$77,000**
Grand Total	**$154,000**

Budget Justification

Labor Costs
Theresa Fregoso (11 months labor) will create a whole bay modern DEM from the 2014-2015 OPC surveys and other recent bathymetric data, conduct analyses of change DEM to quantify update erosion and accretion in the Bay and subembayments, compile data releases for modern and change DEMS, prepare final report. Amy Foxgrover (1/2 month labor) will assist Fregoso in the analyses.

$10,000 of funding for Bruce Jaffe's involvement with the project is being contributed by the USGS. Jaffe's primary contribution is to the final report.

Reporting

The final report will be published as an USGS Open-File Report. A draft of the report will

be reviewed by the RMP Sediment Workgroup and Technical Review Committee.

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Figure 1- Coverage of the Ocean Protection Council 2014-2015 bathymetric surveys. Inset shows regions with continuous (solid colors) and striped (colored lines with no data between lines) coverage.

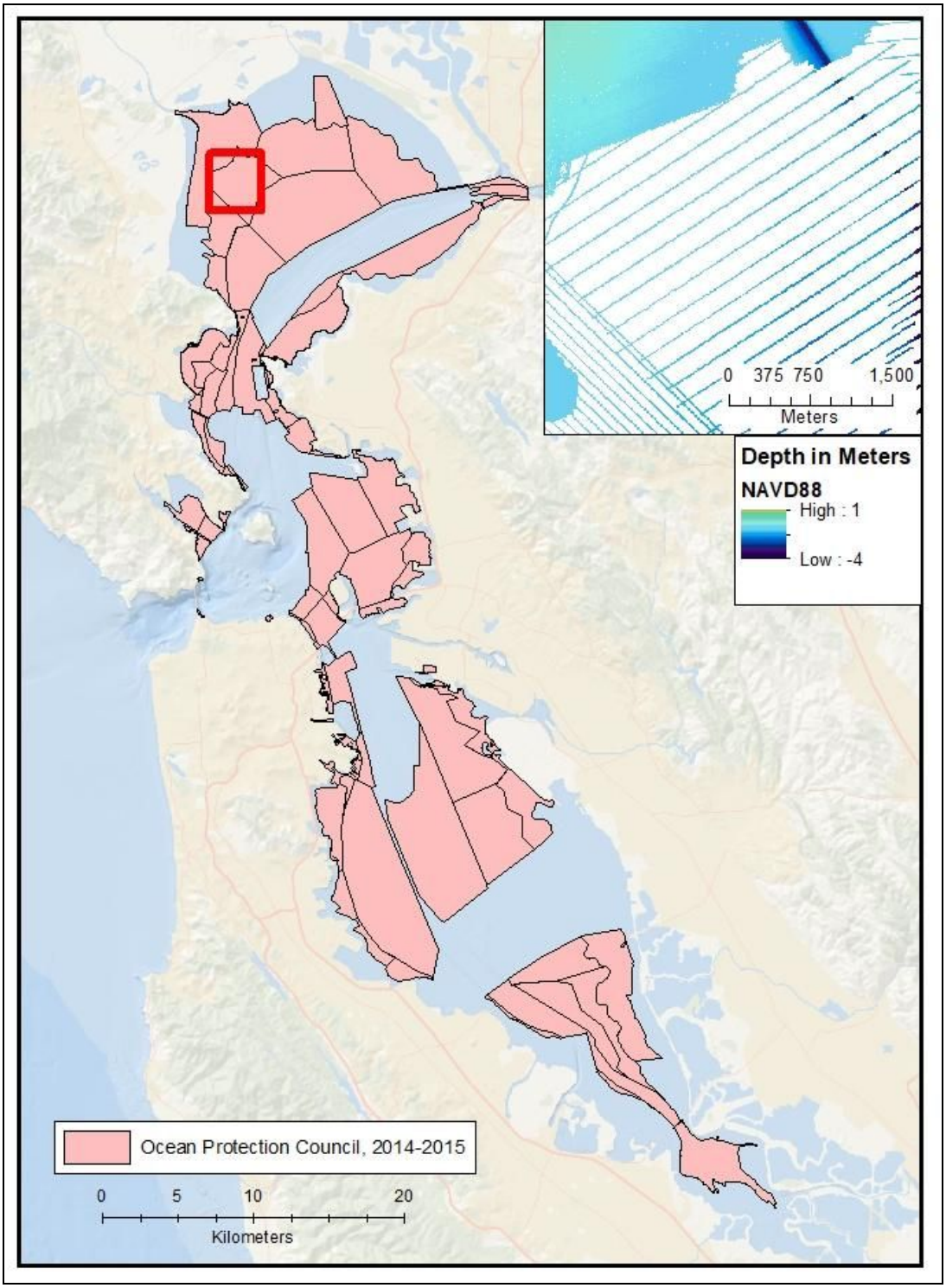
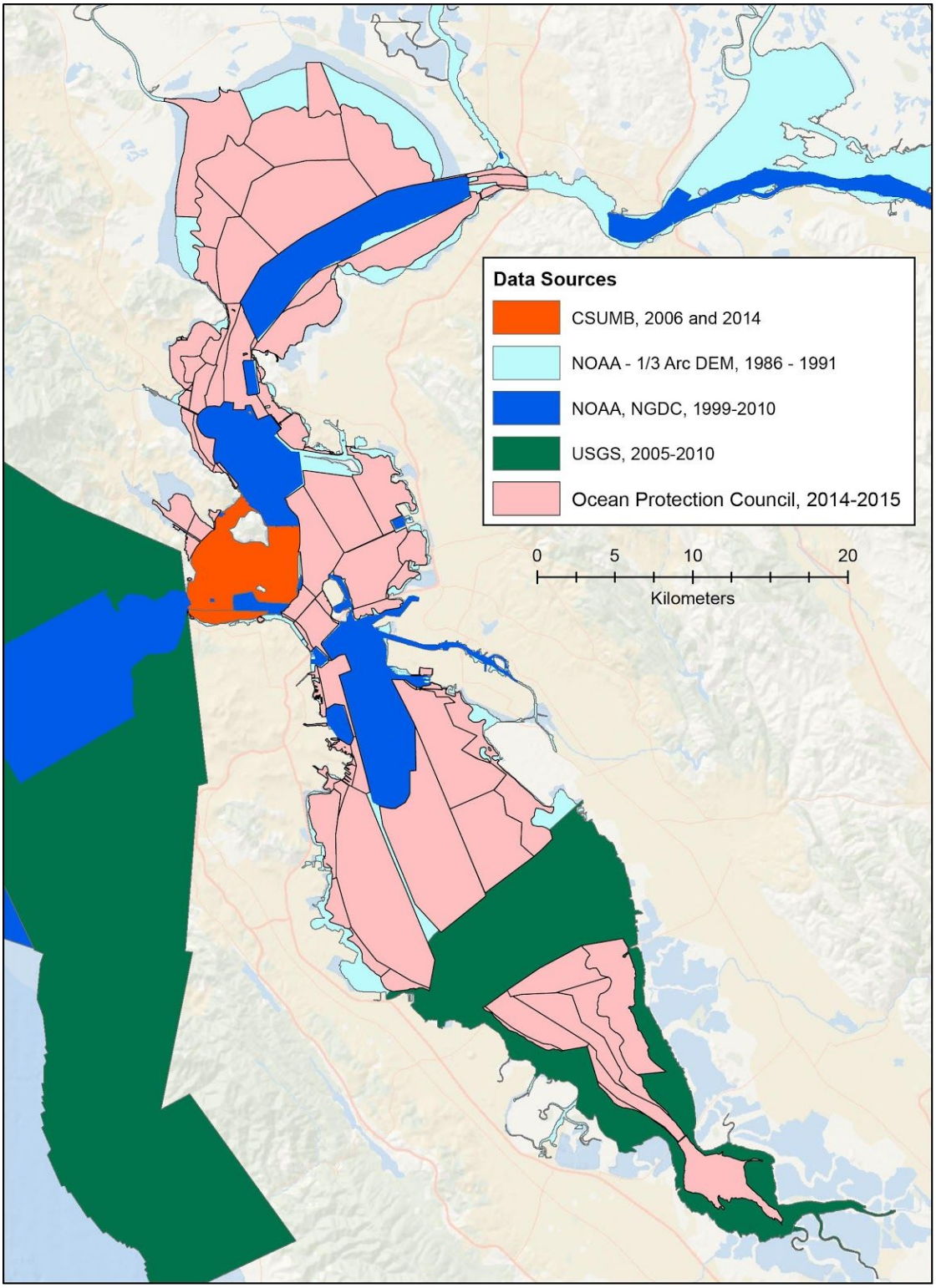


Figure 2- Coverage of Ocean Protection Council 2014-2015 and other recent surveys. The combination of surveys allows updated estimates of erosion and accretion in the majority of South, Central and San Pablo Bays and the main channel of Suisun Bay.



Proposal Title: Sediment Load Monitoring on the Napa River and Sonoma Creek

Summary: There is a need for sediment load data from tributaries to San Francisco Bay. The Napa River and Sonoma Creek have been identified as substantial sediment sources to the Bay for which little or no recent data exist. To address this data gap, the RMP funded USGS to initiate sediment monitoring (suspended and bedload) in water year 2018 at the Napa River Oak Knoll gage and the Sonoma Creek Agua Caliente gage. This proposal describes the scope of work and budget necessary to continue this monitoring for water year 2019.

Estimated Cost: $109,000 ($102,700 requested from RMP; $6,300 contributed by USGS)

Proposal to: RMP Sediment Workgroup

Proposed by: Scott Wright, USGS Sacramento, 916-278-3024, sawright@usgs.gov

Proposed Deliverables and Timeline

Deliverable	Due Date
Real-time provisional turbidity data	Ongoing
Sediment sample lab results	April 2020
Approved 15-minute turbidity and sediment concentration records published on NWISweb	April 2020
Presentation to RMP Sediment Workgroup	April 2020

Background

The sediment loads entering San Francisco Bay are important for a variety of reasons, including dredging, tidal wetland restoration, and aquatic ecology, among others. While the information on sediment loads from many of the tributary sources is up-to-date, for other areas such as the North Bay watersheds there is little or no recent data (McKee et al., 2013). As stated by Schoellhamer et al. (in review), there is a critical data gap regarding sediment loads into the North Bay: “North Bay: Sonoma Creek and Napa River in the North Bay are large watersheds with high sediment loads but the data for both systems were

collected in the 1960s and 1970s and are weakest for Napa. These watersheds need some sampling done to help verify or refute the historic rating curves. Presently the computations made from the historic data must be considered uncertain yet collectively, as described earlier, these two tributaries are estimated to supply, on average, 30% of the load from the collective Bay Area tributaries and during some years can supply >50% of the total small tributary load despite only comprising 12% of the total land area of small tributaries (8,045 km^2 or 3,106 mi^2). Bedload data are lacking completely for Sonoma Creek and are very limited for the Napa River. As discussed above, since bed loads that potentially come into the Bay from the Central Valley may be completely damped by management practices in the lower Delta, and given the out-weighted importance of coarse sediment supply for sand mining and some types of wetland and beach restoration efforts, the uncertainty associated with bed load information in the Napa and Sonoma Watersheds should be given strong consideration. Once collected, suspended sediment and bed loads data from these key watersheds would be a very important component of a larger data set to support the calibration of a dynamic simulation model, that once calibrated could be used to explore past and future regional scale sediment loading trends."

In water year 2018, with funding from RMP, USGS initiated sediment monitoring on the Napa River and Sonoma Creek, at the existing USGS flow gages at Oak Knoll Avenue (Napa) and Agua Caliente Road (Sonoma). Turbidity sensors were installed at both sites in January 2018 for monitoring suspended-sediment concentrations; these data are available at https://waterdata.usgs.gov/nwis/uv?site_no=11458000 and https://waterdata.usgs.gov/ca/nwis/uv?site_no=11458500. Automated pump samplers were also installed at both sites to facilitate unattended sampling during storm events. Cross-section integrated samples of suspended sediment and bedload were collected during runoff events from January 2018 to present. Figure 1 shows the flow and turbidity records, as well as the times of the suspended-sediment and bedload samples at the Napa gage for the recent storm in late March. The sediment samples are currently being processed in the USGS sediment lab in Sacramento. The sediment samples and turbidity record will be analyzed with the goal of producing a continuous record of suspended-sediment concentrations and loads.

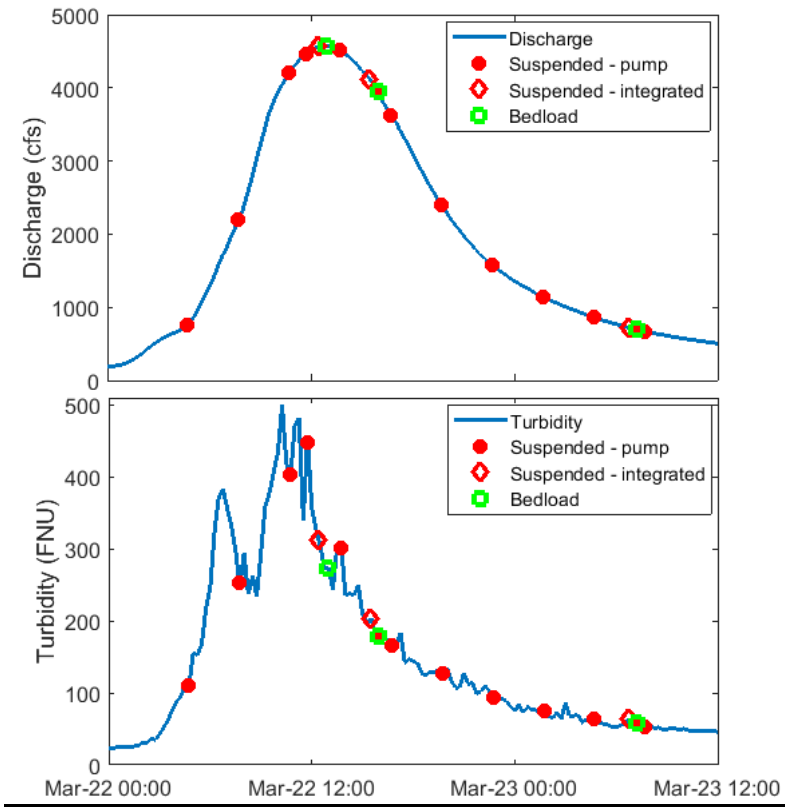


Figure 1

Study Objectives and Applicable RMP Management Questions

The objective of the proposed work is to address the data gap through continued monitoring of sediment loads at two sites on the Napa River and Sonoma Creek. Monitoring in water year 2018 will provide useful information to begin filling this data gap. However, it has been a relatively dry year in the watersheds and monitoring over a range of hydrologic conditions is necessary to verify or refute the historic rating curves and to develop estimates of long-term sediment loads to San Francisco Bay. For sediment loads, it is particularly important to collect data during wet years with high peak flows. Peak flow during WY 2018 on the Napa River (4,580 cfs, provisional) was the 12th lowest in the 62 years of peak flow record; for Sonoma Creek, the WY2018 peak flow (3,720 cfs, provisional) was the 11th lowest in the 43 years of peak flow record.

The proposed work directly addresses RMP Sediment Workgroup Management Question 3: “What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?”

Sediment load monitoring on the Napa River and Sonoma Creek provides information on the sources and loadings of sediment to the Bay. This work also aligns directly with RMP Sediment Workgroup Project Idea 7: “Key Tributary Suspended and Bedload Monitoring”, which describes the need for sediment load data on key tributaries to the Bay.

Approach

The proposed work will be a continuation of water year 2018 monitoring and will follow standard USGS protocols, as follows:

1. Suspended-sediment monitoring will use a combination of physical sample collection and *in situ* continuous monitoring of turbidity, following standard USGS methods (Wagner and others, 2006, Edwards and Glysson, 1999). Turbidity measurements will be made every 15-minutes using *in situ* sensors during the wet season (both streams go dry in the summer so turbidity cannot be measured). Physical samples will be collected using pump samplers deployed at the sites and cross-section integrated samples collected during site visits. The goal will be to collect approximately 30-40 samples at each site per year, which is the guideline for developing turbidity-SSC calibrations. Samples will be processed for suspended-sediment concentration (SSC) and particle size distributions (subset of samples) in the USGS sediment lab in Sacramento. A calibration will be developed between turbidity and SSC and used to develop a 15-minute time series of SSC, following the guidelines in Rasmussen and others (2006) and USGS Office of Surface Water Technical Memorandum 2016.07. The SSC and discharge time series will then be used to compute continuous sediment loads at each gage.

2. Bedload sediment samples will be collected following standard USGS methods (Edwards and Glysson, 1999). Approximately 5-10 samples will be collected per year, primarily during high flow conditions. Samples will be weighed and sieved in the USGS sediment lab in Sacramento following standard procedures (Guy, 1969). A rating curve will be developed between bedload transport rate and discharge, which will then be used to estimate a continuous record of bedload sediment flux (if the rating curve is adequate). In addition, a bedload calculation approach (Pitlick and others, 2009) will be evaluated at the sites as an alternative to discharge rating curves for computing bedload time series.

3. The records of suspended load and bedload will be analyzed and compared with water year 2018 data as well historical data at both gages. In particular, the relationships between discharge and sediment transport will be evaluated to determine if there has been a change over time, indicating a change in sediment supply from the watersheds and thus either validating or refuting the use of the historic rating curves for estimating current sediment supplies to SF Bay from these to important large North Bay watersheds.

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RMP Special Study Proposal: Workshop on Sediment Screening and Testing Guidelines for Beneficial Reuse of Dredged Sediments

Summary: The San Francisco Bay Regional Water Quality Control Board has guidelines for chemical testing requirements and evaluation of test results for the placement of dredge materials in beneficial reuse environments, such as wetland restoration (SFBWRCB. 2014). These guidelines sometimes prevent dredged sediments from the Bay and flood control channels from being beneficially reused despite the fact that there is an urgent need for sediment for wetland restoration around the Bay. The purpose of this study is to organize a workshop with technical experts and stakeholders to discuss whether the current approach to screening contaminants in dredged sediments is too protective, not protective enough, or just right. The deliverable will be a workshop summary that will distill the findings relative to the charge questions and recommendations to the Water Board regarding revisions to the Sediment Screening and Testing Guidelines.

Estimated Cost: $26,500

Oversight Group: Sediment Workgroup

Proposed by: Philip Trowbridge

Proposed Deliverables and Timeline

Deliverable	Due Date
Workshop	September 2019
Workshop Summary	December 2019 (draft) March 2020 (final)

Background

The San Francisco Bay Regional Water Quality Control Board (the “Water Board”) has guidelines for chemical testing requirements and evaluation of test results for the placement of dredge materials in beneficial reuse environments, such as wetland restoration (SFBWRCB. 2014). These guidelines sometimes prevent dredged sediments from the Bay and flood control channels from being beneficially reused despite the fact that there is an urgent need for sediment for wetland restoration around the Bay. The goals for wetland restoration around the Bay are to reduce impact to wildlife through habitat loss and restore 100,000 acres (Goals Project, 2015). A total of $0.5 billion from Measure AA will be invested to reach this goal. However, preliminary estimates show that there is not enough sediment for these projects, even if all the sediments delivered to the Bay are used. The deficit gets even larger when sea level rise is considered. Failure to reuse as much sediment as possible for restoring wetland area and helping to maintain marsh elevations presents its own risks to wildlife from habitat loss.

The purpose of this study is to organize a workshop with technical experts and stakeholders to discuss whether the current approach to screening contaminants in dredged sediments is too protective, not protective enough, or just right. It is not clear how much sediment is prevented from being reused because of these thresholds alone and whether changing the guidance will make a significant difference. However, updating the guidance is a low cost way to increase beneficial reuse. The impacts of revising the guidelines may be especially important at the local scale where sediment from flood control channels could be reused for marsh restoration nearby rather than being disposed in landfills.

Study Objectives and Applicable RMP Management Questions

The objectives of the project and how the information will be used are shown in Table 1 relative to the management questions for the Sediment Workgroup.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
MQ1: What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?	To organize a workshop with technical experts and stakeholders to discuss whether the current approach to screening contaminants in dredged sediments is too protective, not protective enough, or just right.	Revisions to the Sediment Screening and Testing Guidelines for Dredged Sediments by the Water Board
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?	NA	
MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	NA	
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?	NA	
MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?	NA	

Approach

Task 1. Assemble Technical Experts and Key Stakeholders

SFEI will identify and invite technical experts in ecotoxicology and other related disciplines to participate in the workshop. In particular, these experts will have experience with direct toxicity effects of contaminants on invertebrates, bioaccumulation to higher trophic levels, and beneficial reuse of dredged sediments. In addition, local stakeholders from the following organizations will be asked to participate:

- Resource Agencies: US Fish and Wildlife Service, National Marine Fisheries Service, California Department of Fish and Wildlife
- DMMO Agencies: USEPA, Water Board, BCDC, and USACE
- Flood Control Agencies: BAFPAA
- Dredgers: BPC, Port of San Francisco, Port of Oakland, and others
- NGOs: Baykeeper, Save the Bay

The meeting will be open to all interested participants. The list above just identifies the participants who are likely to have an interest the workshop.

Task 2. Prepare Background Materials for the Workshop

The facilitate discussion at the Workshop, SFEI will prepare summary materials on the current Sediment Screening and Testing Guidelines, typical beneficial use applications, and concentrations of contaminants in dredged sediments. DDT, PAHs, and cadmium are the contaminants that exceed the screening levels most frequently. Therefore, these contaminants will be top priorities for review but will not be limited to these chemicals. The RMP database, the DMMO database, and readily available information on sediment removed from flood control channels will be mined for information. The goal is to present the technical experts with ranges of concentrations typically present in dredged sediments and its physical characteristics.

Task 3. Organize and Facilitate Workshop Related to Sediment Screening and Testing Guidelines for Beneficial Reuse of Dredged Sediments

SFEI will provide meeting space, prepare an agenda, ensure that key participants will attend the workshop, and facilitate the discussion. The workshop will be held during the fall of 2019.

Proposed charge questions for the workshop will be:

- Are the current Sediment Screening and Testing Guidelines too protective, not protective enough, or just right?
- Are there other approaches besides those in the Guidelines that could be used to manage the risk from beneficial reuse of dredged sediment?
- What type of ambient monitoring should be conducted in beneficial reuse locations to verify that the Guidelines are having the desired effect?

- How should the Water Board balance the risks to wildlife from wetland habitat loss with the risks from exposure to contaminants in dredged sediments?

Task 4. Publish a Workshop Summary with Recommendations

SFEI will prepare a Workshop Summary. The summary will distill the findings relative to the charge questions and recommendations to the Water Board regarding revisions to the Sediment Screening and Testing Guidelines. The summary report will be reviewed by the workshop participants, Sediment WG, and TRC during the winter of 2019 before being finalized.

Budget

The following budget represents estimated costs for this proposed special study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Cost
Labor	$23,000
Subcontracts	$0
Direct Costs	$6,500
Grand Total	**$26,500**

Budget Justification

Labor Costs
The majority of the work will be completed by an Environmental Scientist (50 hours) with administrative and research assistance from an Environmental Analyst (40 hours) and Database Manager (20 hours). Oversight and assistance by Program Manager (20 hours) and Senior Scientist (20 hours). The total labor cost for this level of effort is $23,000.

Direct Costs
$6,000 has been budgeted for honoraria for technical experts in ecotoxicology and other subjects. $500 has been budgeted for food for the workshop.

Reporting

A summary report will be prepared by December 31, 2019 as a draft. The final report will be prepared by March 31, 2020. The draft report will be reviewed by the workshop participants, Sediment WG, and TRC.

References

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Ecosystem Habitat Goals Science Update 2015. Prepared by the San Francisco Bay Area Wetland Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

SFBWRCB. 2014. Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines, Draft Staff Report. Prepared by the San Francisco Bay Regional Water Quality Control Board staff, Oakland, CA. March 2014.

RMP Special Study Proposal: Strategic Placement Study Decision-Making Process and Success Criteria

Summary: The United States Army Corps of Engineers (USACE), San Francisco District directed a framework study of the feasibility of increasing marsh accretion rates with minimal ecological impacts through placement of dredged sediment in San Francisco Bay (Bay) (USACE 2017). This proposed Special Study will provide information essential to understanding the design and success of the proposed pilot studies and subsequent phases of the project. The purpose of the proposed working group meeting and stakeholder workshop is to facilitate the discussion of the experimental design and agreement on a decision-making process and success criteria to evaluate the pilot.

Estimated Cost: $40,000

Oversight Group: RMP Technical Review Committee

Proposed by: Craig Conner, Jeremy Lowe, Amy Richey

Proposed Deliverables and Timeline

Deliverable	Due Date
Materials for small working group meeting	October 2018
Small working group meeting	November 2018
Materials for stakeholder workshop	January 2019
Stakeholder workshop	February 2019
Report of outcomes of working group meeting and workshop	April 2019 (draft) June 2019 (final)

Background

The United States Army Corps of Engineers (USACE), San Francisco District directed a framework study of the feasibility of increasing marsh accretion rates with minimal ecological impacts through placement of dredged sediment in San Francisco Bay (Bay) (USACE 2017). This Framework Report identified and examined the potential impacts of methods that could be implemented to maintain ecosystem functions and enhance the Bay's resilience to climate change. Proposed methods for the placement of dredged sediment included various means in shallow water, in tidal channels, and directly onto the marsh, at several alternative locations. An approach was developed to address overarching study questions related to the effectiveness of the methods in augmenting

marsh accretion rates, their impacts on Bay ecology, and, the cost-effectiveness of the methods. The questions are:

1. Are strategic-placement techniques effective in maintaining mudflat and salt marsh systems?
    a. Are strategic-placement techniques effective in augmenting marsh accretion?
    b. Will augmenting marsh accretion rates help maintain mudflat and salt marsh systems?
2. Do the ecological benefits of maintaining mudflat and salt marsh systems using strategic-placement techniques outweigh the ecological impacts of these techniques?
    a. What are the ecological impacts of strategic-placement techniques?
    b. What are the ecological benefits of maintaining mudflat and salt marsh systems?
    c. What is the no-action ecological baseline, and how does this compare to the expected ecological effects of the strategic-placement scenarios?

A pilot study utilizing small volumes of shallow-water placement would allow the study of subtidal ecological impacts and could be followed by a demonstration project utilizing a larger volume to test the effectiveness of shallow-water placement. Funding for the pilot study is pending, and to make best use of time, early stakeholder input into the pilot study experimental design, including development of success criteria, will allow timely implementation of the pilot study when funds become available.

Study Objectives and Applicable RMP Management Questions

The framework calls for a collaborative decision-making process that includes the development of success criteria for both shallow-water placement and accretion on marshes to be discussed and agreed upon prior to the implementation of the pilot study. The purpose of the proposed meeting and workshop is to facilitate the discussion of the experimental design and agreement on a decision-making process and success criteria to evaluate the pilot. The outcome should include quantifiable metrics, an assessment of confidence in experimental results, and a clear identification of decision makers.

This proposed Special Study will provide information essential to understanding the design and success of the proposed pilot studies and subsequent phases of the project. The objectives of the Special Study and how the information will be used are shown in Table 1 relative to the management questions of the RMP Sediment Workgroup.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?	Develop experimental design and success criteria to determine effects on subtidal ecology.	Determination of whether to proceed with subsequent phases of the framework by using the success criteria developed for shallow-water placement.
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?	Develop experimental design and success criteria to determine efficacy of accretion on marshes.	Determination of whether to proceed with subsequent phases of the framework by using the success criteria for accretion on marshes.

Approach

1) **Small working group meeting**

A small working group meeting will be held to discuss the experimental design, and to agree upon a decision-making process and success criteria. The working group will be led by staff from the USACE, Stantec, and SFEI, who developed the Framework Report (USACE 2017). Invitees (ca. 10-15 people) for the small working group will include representatives from:

- USFWS
- CDFW
- NMFS
- BCDC
- EPA
- SFRWQCB
- SBSPRP
- Subject Experts as necessary

The proposed Beneficial Reuse workshop has many of the same stakeholders. If both proposals are funded, these meetings will be coordinated and perhaps combined, if this is more efficient.

The successful outcome of this meeting will be an agreement on the decision-making process and success criteria, which will then be presented at a larger stakeholder workshop described in Task 2.

Presentation materials (agenda, read-ahead materials, and powerpoint slides) will be

developed based on Chapter Seven of the Framework Report (USACE 2017).

2) Stakeholder workshop

A workshop will be held to inform stakeholders of the proposed experimental design and success criteria. The workshop will be led by staff from the USACE, Stantec, and SFEI. Invitees (ca. 20-30 people) will include members of the small working group, together with key stakeholders identified by the USACE.

The successful outcomes of this meeting will be an informed stakeholder group, and compilation of additional constructive comments about the experimental design, decision-making process, and success criteria.

Presentation materials (agenda, read-ahead materials, and powerpoint slides) will be developed based on the outcomes of the small working group meeting (Task 1).

3) Report

Results of the working group meeting and stakeholder workshop will be compiled into a short memo that clearly sets out the agreed-upon decision-making process and success criteria.

Budget

The following budget represents estimated costs for this proposed special study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Cost
Labor	$40,000
Grand Total	$40,000

<u>Budget Justification</u>

Labor Costs

TBD

The majority of the work will be completed by Jeremy Lowe (68 hours) and Amy Richey (72 hrs) with research and review assistance from Scott Dusterhoff (40 hours), Letitia Grenier (40 hours), and Jamil Ibrahim (24 hours). The total labor cost for this level of effort is $40,000.

Direct costs for the meeting to present the draft results including lunches and travel for technical advisors is assumed to be covered by the RMP Workgroup Meetings budget.

Reporting

The final report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee and published by SFEI as an RMP Technical Contribution.

References

USACE. 2017. Strategic Placement of Dredged Sediment to Naturally Accrete in Salt Marsh Systems Framework Report. Report prepared for the United States Army Corps of Engineers, San Francisco District, by Stantec and San Francisco Estuary Institute.

RMP Special Study Proposal: Sediment Bulk Density Study

Summary: The definition of sediment bulk density and the conversion between sediment bulk mass to bulk volume is an important step in many sediment calculations. It is used in dredging operations, sediment modeling studies, in the design of wetland restoration projects. The proposal is to create guidance on the definition of bulk density for use in San Francisco Bay projects, to provide typical values for different environments, and protocols for measuring and reporting bulk density in the future.

Estimated Cost: $30,000

Oversight Group: RMP Technical Review Committee

Proposed by: Jeremy Lowe, Lester McKee

Proposed Deliverables and Timeline

Deliverable	Due Date
2 small working group meetings/calls	Oct-February 2018
Draft framework to share with local experts	February 2019
Draft report for RMP Sediment Working Group review	May 2019
Final report	August 2019

Background

Monitoring programs measure sediment concentrations or sediment mass fluxes to and within the Bay yet many aspects of Bay beneficial use and management either record sediment removal as a volume or require information about sediment volume. Therefore, the definition of sediment bulk density and the conversion between sediment bulk mass to bulk volume is an important step in many sediment calculations. It links observations and modelling of sediment transport and morphology to dredging operations and wetland restoration projects. For sediment transport calculations the transport rate is usually expressed in terms of a mass. For morphological calculations, accretion or erosion usually expressed as a volume or depth per unit area. The choice of bulk mass or volume also depends upon the activity or the study - dredgers report by volume dredged; marsh accretion models report by volume as accreted. The actual value of bulk density varies over time whether newly deposited or long deposited; it varies with depth due to consolidation; it varies with type of sediment and degree of sorting - poorly sorted sediments may have higher density. Sediment bulk density also varies substantially among marshes and mudflats and within marshes and mudflats. There are also a number of variables used to define bulk density - bulk density (partially and fully

saturated), dry density, bulk weight density (partially and fully saturated), and dry weight density. These all have specific uses and definitions but these are not always adequately reported. The presently available conversion factors lack specificity of application and are dated potentially leading to inconsistent or inappropriate use and the potential for large errors that may lead to less optimal decision making.

Study Objectives and Applicable RMP Management Questions

The objective is to develop bulk density estimates that help with converting between 1) mass and volume of sediment entering and moving around the Bay; and 2) mass and volume of sediment deposited in the subtidal, mudflats and marshes, accounting for the effects of consolidation and subsidence over time. This information would be helpful to link dredgers and restoration managers as one group uses mass and the other uses volume. It would also be more efficient to have an agreed on methods for this complicated conversion.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?	Develop bulk density estimates that help with converting between 1) mass and volume of sediment entering and moving around the Bay; and 2) mass and volume of sediment deposited in the subtidal, mudflats and marshes,	Restoration managers and dredgers both need this information to relate sediment loads in mass units to volume of sediment for habitat restoration projects.

Approach

The proposal is to create guidance on the definition of bulk density for use in San Francisco Bay projects, to compile a database of existing observations of bulk density with known location; to determine typical ranges of values for a variety situations (mudflat, marsh, tidal channel); examples of typical conversions (from sediment transport rate to accretion rate); protocols for measuring and reporting bulk density in the future; and recommendations for maintaining and extending the database of observations.

This work would be undertaken in two phases. **Phase 1** would create a guidance document summarising existing knowledge of bulk density in the Bay. This would be undertaken by a subset of the RMP Sediment Workgroup. It would rely on existing observations and methodologies but would provide recommendations for any further data collection as needed. **Phase 2** would occur after the completion of Phase 1 with stakeholders implementing the standard methodology each time they do a sediment removal exercise. This data would be entered into the database set up in Phase 1. This database would be reanalyzed for patterns and trends when sufficient samples from different environments had been collected.

Phase 1 Scope

1) **Small working group meetings**

A small working group meeting will be held to discuss the definition of bulk density, its common uses in studies, determine the current state of knowledge regarding bulk density estimates for sediment delivered to and transported around the Bay and for marsh and mudflat soils, and agree the scope of the study, design of the database, and outline of the guidance report. This meeting would also identify sources of measured bulk density to be collated and entered into a database. The working group will be formed by members of the RMP Sediment Work group (ca. 3-5 people).

A second small working group meeting will be held to review and summarise the database of measured bulk densities in terms of range of values for different environments. This meeting would also draft protocols for standard sampling, analysis, reporting and recording of bulk density observations in the future.

2) **Draft and final guidance**

A short document (10-12 pages) will be drafted based on the small working group meetings. This will define bulk density for use in San Francisco Bay projects, include a database of existing observations of bulk density; provide typical ranges of values for a variety situations (mudflat, marsh, tidal channel and different Bay segments if data suggest this is warranted); provide examples of typical conversions (from sediment transport rate to accretion rate); give protocols for measuring and reporting bulk density in the futures; and recommendations for maintaining and extending the database.

The draft guidance will be reviewed by the RMP Sediment Workgroup and finalised by the small working group.

Budget

The following budget represents estimated costs for Phase 1 of this proposed special study (Table 2).

Table 2. Proposed Budget for Phase 1.

Expense	Estimated Cost
Labor	$30,000
Grand Total	$30,000

<u>Phase 1 Budget Justification</u>

Labor Costs

The majority of the work in Phase 1 will be completed by Lester McKee and Jeremy Lowe (52 hours each) with research and review assistance from Scott Dusterhoff (28 hours). Some budget has also been set aside for database support and guidance report figures (68 hours). The total labor cost for this level of effort is $30,000.

Direct costs for the small working group meetings in Task 1, including lunches and travel for technical advisors, is assumed to be covered by the Sediment Workgroup general budget.

Reporting

The final report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee and published by SFEI as an RMP Technical Contribution.

References

NA