RMP Special Study Proposal: DMMO San Francisco Bay Floating Percentile Method Update

Summary: The Long-Term Management Strategy for dredged sediment in San Francisco Bay calls for 40% of dredged sediment to be used for beneficial reuse. While this objective is currently being met, the need for additional sediment volume to restore tidal marsh far surpasses the 40%. Concerns that the draft sediment screening guidelines for beneficial reuse were too restrictive resulted in a RMP-led Beneficial Reuse Workshop in September 2019. One of the recommendations from the expert panel was to compare sediment chemistry thresholds currently in use versus those generated using the Floating Percentile Method (FPM). The FPM was developed in 2002 by Avocet Consulting/SAIC, using paired sediment toxicity and chemical analysis data to develop sediment quality guidelines. This proposal seeks to use recent estuarine data reported to the Dredged Materials Management Office (DMMO) and data from the San Francisco Bay Regional Monitoring Program (RMP) to update a regional application of the FPM conducted previously in 2004 for the Sediment Screening Guidelines study and report (Germano & Associates, 2004). This method provides additional weight of evidence for the derivation of thresholds that can be used to determine whether dredged sediment can be used for beneficial reuse purposes. The outcomes of this analysis will be reviewed as an option for updating the draft sediment screening guidelines for beneficial reuse.

Estimated Cost: $34,050

Oversight Group: Sediment Workgroup

Proposed by: Donald Yee, Adam Wong,

Time Sensitive: (yes or no; if yes, why?) No

Proposed Deliverables and Timeline

Deliverable	Due Date (end of)
RMP & DMMO Data compilation	Feb 2021
Data cleanup (sample matching, tox significance)	Mar 2021
FPM runs	Apr 2021
Draft memo/report for Sed WG	May 2021
Presentation to stakeholders	June 2021
Final report & website	June 2021

Background

The RMP conducted a workshop on beneficial reuse guidelines in September 2019. External experts reviewed the current guidelines for San Francisco Bay and highlighted areas where improvements could be made, including evaluating the Floating Percentile Method (FPM) to update the sediment screening guidelines (Foley et al., 2020). Currently, the draft sediment guidelines for beneficial reuse (SFBRWQCB, 2000) are based on individual contaminant concentrations, using either ambient concentrations in the Bay or ERL (effects risk low) and ERM (effects risk moderate) thresholds. This approach may be restricting the amount of sediment that is determined as suitable for beneficial reuse purposes, which is urgently needed to restore

marshes around the Bay to make the area more resilient to sea level rise.

The Floating Percentile Method (FPM) was developed by SAIC and Avocet Consulting (SAIC/Avocet, 2002) and used paired sediment toxicity and chemical analytical data to develop sediment quality guidelines for Washington State Department of Ecology. The FPM was also used by the Oregon Department of Environmental Quality Regional Sediment Evaluation Team, for its Freshwater Sediment Workgroup (Michelsen & Anderson, 2011). The method is broadly applicable to scenarios where there is paired toxicity and chemistry data to assess risk. This proposal seeks to use recent estuarine data reported to the Dredged Materials Management Office (DMMO), combined with data from the San Francisco Bay Regional Monitoring Program (RMP) to update a regional application of the FPM conducted previously in 2004 for the Sediment Screening Guidelines study and report (Germano & Associates, 2004). This analysis found that 76% of sediment samples were falsely classified as toxic using the single contaminant threshold approach.

Between 2002 and 2012, the Regional Monitoring Program for Water Quality in San Francisco Bay has conducted annual sediment sampling at randomized sites distributed in the subtidal Bay, with concurrent chemical analysis and sediment toxicity. Since 2012, RMP has not regularly conducted toxicity testing of surface sediment samples, but the 2002 to 2012 data collected can provide a useful refinement and update to the prior FPM analysis of SF Bay data. The data from RMP studies primarily includes surface sediment (0-5 cm depth) composited and subsampled for chemical analysis and toxicity testing, so there is generally a 1:1 correspondence between samples with both types of analyses.

Another source of recent and potentially ongoing data is the chemical analysis and toxicity testing performed by dredging projects to assess contaminant risks and decide appropriate disposal or reuse options for dredged sediment. Attempts have been made to modernize their reporting by inclusion in a queryable database for the DMMO in SF Bay. That database was released for public access in 2019, and nearly all of the data present in its initial release were collected from projects occurring between 1998 and 2016, with new projects continuing to be added. Thus it would be expected that a majority of data in the DMMO database were obtained after the 2004 application of FPM to SF Bay. Pairing the sediment chemistry and toxicity data from the DMMO database is difficult because metadata do not exist for all samples. This may limit the number of samples that can be used in the analysis, but the sample size should be large enough to evaluate the usefulness of the method.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding the toxicity risks posed to resident biota by known pollutants of concern. The objectives of the project and how the information will be used are shown in Table 1 relative to the RMP Sediment Workgroup management questions.

Table 1. Study objectives and questions relevant to RMP Sediment Workgroup 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?	Determine risks associated with chemical concentrations in sediment	Output of this effort is a probability distribution for toxicity associated with chemical pollutants

2. Are there effects on fish, benthic species, and submerged habitats from dredging or placement of sediment?	Estimate effects thresholds based on regional tox testing for relevant species	Revise or provide weight of evidence for sediment beneficial reuse concentration limits for various chemicals
3. What are the sources, sinks, pathways and loadings of sediment and sediment bound contaminants to and within the Bay and subembayments?	Not applicable	Bay RMP & DMMO data provide some insight, but this is not an objective of this study
4. How much sediment is passively reaching tidal marshes and restoration projects and how could those amounts be increased by management actions?	Not applicable	
5. What are the concentrations of suspended sediment in the Estuary and its segments?	Not applicable	

Approach

For Bay RMP data, paired toxicity and chemistry data will be collated from the period 2002-2012, which includes the entire period during which the RMP sampled Bay sediment using a randomized spatial allocation scheme. This data will either be considered on its own, or compiled and analyzed with the database used for the prior Sediment Screening Guidelines analysis (Germano & Associates, 2004), depending on the sufficiency of new data spanning a range of toxicity. For example, if all newer concentration data were far lower than past concentrations, and all showed no toxicity, the new data would provide little additional elucidation of toxicity thresholds.

Chemistry and toxicity data reported for the DMMO database will also be collated for use in the FPM analysis. Past attempts to use the DMMO database (Yee & Wong, 2019) have illustrated some challenges, such as the difficulty in matching samples analyzed for different chemicals or subjected to different types of tests. Samples within a site may be composited or not, from different depths, or sub-areas within a site. Thus the exact correspondence between samples collected at a given site and date may not be as clear cut as for RMP samples. After DMMO data are collated, we will identify sets with ambiguous linkages between chemistry and toxicity data, and will engage with stakeholders for alternative matching criteria that will be “imperfect” but sufficiently similar to attempt the analysis. Whether or not such “imperfect” matches are needed will depend in large part on the characteristics and counts of the available pairwise matching data.

Some other clean-up of the data may also be needed. For example, a positive/negative determination of significant toxic effect is required for each toxicity test, and may not always be clearly summarized in the database. These cases will require re-derivation or summarization from raw test results based on the published method. In such cases, we would consult toxicologist(s) (from the reporting party if possible, or SFEI staff if needed) to summarize results appropriately for use in the FPM method.

The collated and cleaned-up data will then be run through the FPM analyses as described in the documentation and spreadsheet routines provided for the Oregon RSET Program (Michelsen & Anderson 2011). As time allows, the analyses may be re-run using different subsets of the San

Francisco Bay Data (e.g., RMP & DMMO combined, RMP or DMMO independently, different year ranges, with or without imperfect DMMO matches) to examine the robustness of the derived thresholds to the specific training data sets used.

Budget

The following budget represents estimated costs for this proposed special study (Table 2). Efforts and costs can be scaled back by reducing the effort spent in trying to clean up data that do not clearly match. This project could also be timed to follow the proposed DMMO database improvements project.

Table 2. Proposed Budget.

Expense	Estimated Hours	Estimated Cost
Labor		
Staff data compilation & analysis	110	12,375
Stakeholder/data provider consultation (dataset cleanup)	20	2,250
Staff toxicologist consultation	12	1,500
Technical memo staff	25	2,875
Technical memo Sr Sci	24	4,675
Sr Management review	8	1,735
Report finalization	8	1,640
Presentation to stakeholders	35	7,000
Grand Total		$34,050

Reporting

The primary output of this effort would be a website page similar to that provided for Dredged Material Testing Thresholds for San Francisco Bay Area Sediments:

https://www.sfei.org/projects/dmmo-ambient-sediment-conditions

A short technical memo/report and associated supplemental material, describing the methods, analyses performed, and the cleaned-up dataset used for the analyses, would be provided on the web page.

Another important by-product of this effort (and future efforts using the DMMO data) may be to establish and better enforce guidelines for data provided to the database, to better avoid ambiguities in the linkage between different types of data obtained for dredging projects.

The results of this analysis will also be communicated at a Technical Review Committee meeting, as well as to the San Francisco Bay Regional Water Quality Control Board to inform their decision to revise the current sediment screening guidelines for beneficial reuse.

References

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Temporal variability in sediment delivery to a South San Francisco Bay salt marsh

Summary: Salt marshes provide critical habitat as well as coastal protection. One of the key sediment management questions for San Francisco Bay is whether available sediment is sufficient for marshes to keep up with sea-level rise. We propose to investigate the influence of tides, waves, and water levels on sediment delivery to and deposition on a tidal marsh surface. We will measure suspended sediment concentration (SSC) and suspended sediment flux (SSF) in the shallows adjacent to a marsh, SSF into the marsh through a tidal creek, deposition and accretion on the marsh, and the variation in deposition with elevation and vegetation density and type. Data collection will be repeated in winter and summer, to determine seasonal effects. The study will be conducted in a marsh with a wave-exposed edge and large wind fetch. We anticipate a site on the eastern shore of South Bay, between the San Mateo and Dumbarton Bridges, but final site selection will depend on site accessibility and suitability for the study. Our overall objectives are to connect sediment dynamics in the shallows to rates of deposition and accretion across the marsh surface, and to assess seasonal variation in the effectiveness of sediment delivery. Results will be useful for prioritizing marsh restoration sites, assessing restoration actions, and understanding mechanisms of sediment delivery to and sea-level rise vulnerability of marshes.

Estimated Cost: $199,511.00

Oversight Group: RMP Technical Review Committee (TRC)

Proposed by: Jessie Lacy[1] and Karen Thorne[2]

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Proposed Deliverables and Timeline

Deliverable	Due Date
Data release: time-series data (PCMSC)	June 2022
Data release: deposition, accretion and vegetation characteristics (WERC)	June 2022
Report (draft paper) investigating the relationship between sediment dynamics in the shallows and sediment delivery to the marsh	December 2022
Final Presentation to RMP	May 2022
Presentation to Bay Delta Science or State of the Estuary Conference	Fall 2022

Background

Salt marshes provide critical endangered species habitat as well as coastal protection for communities. One of the key sediment management questions for San Francisco Bay is whether available sediment is sufficient for marshes to keep up with sea-level rise (SLR), and to support planned marsh restoration goals. The answers to these questions rely on understanding how and when sediment is delivered to marshes. We propose to investigate the influence of tides, waves, and water levels on SSC adjacent to a marsh and sediment deposition in the marsh. The study will be conducted in and adjacent to a marsh on the eastern shore of South San Francisco Bay, with a wave-exposed edge that is not leveed, large wind fetch, and fine-grained bed sediments in the adjacent mudflats.

The combination of sea-level rise and declining sediment supply to and suspended-sediment concentration (SSC) within San Francisco Estuary in recent decades (Schoellhamer 2011) present the threat of marsh loss due to drowning. Elevation-based modeling of San Francisco Bay marshes predicts significant marsh loss by 2100, but the extent of loss depends strongly on both the rate of sea-level rise and the magnitude of sediment supply (Swanson et al. 2014, Schile et al. 2014). In addition, lateral erosion of wave-exposed marsh edges, which can occur in vertically accreting marshes, can be a significant cause of marsh loss (Leonardi et al. 2016). Sediment availability varies spatially, and in a general sense depends on the magnitude of SSC in adjacent shallows. However, variation in processes in the shallows and marshes, including sediment resuspension by waves, edge erosion, wave attenuation in the marsh, and vegetative trapping, can influence the relationship between sediment availability and deposition or retention of sediment on the marsh. These processes vary spatially, due to wave exposure, marsh edge type, and marsh elevations, and temporally, due to variation in physical forcing on spring-neap, storm event, and seasonal time scales, as well as seasonal variation in marsh vegetation (Buffington et al. 2020).

Sediment is supplied to wave-exposed marshes both through tidal creeks and across the bay-marsh interface. In previous work, sediment flux through a tidal creek in a San Francisco Bay marsh depended strongly on SSC in the shallows and the spring-neap tidal cycle (Lacy et al. 2018). In the same study, we measured sediment supply across a bay-marsh interface with a gently-sloped depositional edge (Lacy et al. 2020). Here we propose to examine these processes at a scarped marsh edge, which is expected to be erosional, and which occurs commonly in San Francisco Bay marshes (Thorne et al. 2019, Beagle et al. 2015).

Previous work in the subtidal shallows of South San Francisco Bay has shown that both tidal currents and waves resuspend sediments, and the highest SSC is associated with large wave events (e.g. Brand et al. 2010). However, little information is available on sediment dynamics and SSC at the eastern edge of the South Bay shallows or how they relate to marsh deposition and accretion rates.

Study Questions and Applicable RMP Management Questions

The proposed work aims to address the following questions:

1. How is sediment deposition in a salt marsh influenced by SSC and SSF in the shallows adjacent to the marsh, and SSF in tidal creeks, on spring-neap and seasonal timescales?

2. How is sediment deposition in a marsh influenced by elevation, distance from source, and seasonal variation in vegetation density or type?

3. How does deposition adjacent to the bay-marsh interface compare to deposition near a tidal creek in a marsh with a wave-exposed scarp?

4. How does SSC in the eastern shallows of South San Francisco Bay vary on daily, spring-neap, storm event, and seasonal timescales, and what are the factors that govern its variability (tides, waves, sediment properties)?

This project addresses San Francisco Bay Regional Monitoring Program (RMP) Sediment Workgroup Management questions 4 and 5 (Table 1). It also informs the *Flux on shoals and into wetlands* priority identified in the Sediment Workgroup's draft Sediment Monitoring and Modeling Strategy.

Table 1: RMP Sediment Workgroup management questions and associated study questions.

Management question	Study question	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?	1, 2, 3, 4	● Understanding sediment availability for restoration ● Prioritization of restoration sites ● Inform timing of management actions such as sediment placement ● Understanding the mechanisms of sediment delivery to marshes for accretion ● Understanding marsh vulnerability to SLR
MQ5: What are the concentrations of suspended sediment in the Estuary and its subembayments?	4	● Relating SSC near marsh edges to SSC at long-term monitoring stations in deeper water ● Provide data for model calibration

Approach

Task 1. Finalize site selection

We will select a representative marsh in South San Francisco Bay, leveraging existing data (Thorne et al. 2019) in the site selection. Our goal is to conduct the study in a marsh with a wave-exposed, scarped edge that is not (or is only partially) leveed, with large wind fetch, and fine-grained bed sediments in the adjacent mudflats. Based on these criteria, primary candidates are on the eastern shore of South Bay between the San Mateo and Dumbarton Bridges (e.g., Ideal marsh). This region features active marsh restoration as well as infrastructure that is vulnerable to sea-level rise. Final site selection will be based on review of existing data and field reconnaissance, as well as feasibility of access permissions, endangered species restrictions, and Wetland Regional Monitoring Program (WRMP) recommendations.

Task 2. Data collection

Overview

We will collect time-series data (detailed in 2a) in the shallows, a tidal creek, and on the marsh, and sediment deposition data (detailed in 2b) on the marsh. In the marsh, we will establish six transects: three extending approximately 60 m onshore from the bay-marsh interface (marsh edge transects), and three extending approximately 30 m landward from the tidal creek (creek transects) (Figure 1). We will measure SSC and water level along two of the transects and sediment deposition rates at all six transects, as described below.

a. Time-series data collection

We will collect time-series data in three regions: bay shallows, a marsh tidal creek, and on the marsh plain (Figure 1). In the shallows, one station will be in subtidal waters (1 to 1.5 m MLLW), and a second in intertidal shallows within 50 m of the marsh edge. At these stations, we will measure currents, water level, SSC, salinity, temperature, and wave properties. The tidal creek station will be located in a primary creek, within 100 m of the Bay. We will measure currents, water level, and SSC in the creek to determine depth-averaged suspended-sediment flux (SSF) at a representative point. On the marsh, we will measure SSC and water along one of the marsh edge transects and the creek transect adjacent to the creek flux station (see Figure 1). On each of these two transects we will measure water level and SSC at four to five locations.

At all time-series stations, we will collect turbidity data with optical backscatter sensors (OBS) and convert the OBS data to SSC based on calibration relationships derived from SSC measured in water samples collected in the study area. Calibration samples will be pumped from the creek and shallows before and after the deployment, from an apparatus on which several OBS sensors are mounted adjacent to the pumping port. We will not collect calibration samples on the marsh to avoid disturbing the marsh surface. We anticipate that the properties of suspended particles are similar throughout the study area, so that calibration with samples collected in adjacent waters will be sufficient.

Elevations of all monitoring stations will be measured with real-time kinetic (RTK) GPS. The marsh edge time-series transect will be surveyed at least twice during the project to track scarp erosion. We will collect bed sediment samples adjacent to the shallows and the tidal creek stations and analyze the surficial centimeter of sediment for bulk density, grain size distribution, and organic matter, all of which can influence the erodibility of sediment.

Data will be collected at all stations for one two-month period in summer and a second in winter. In summer we will target June-July 2021, to capture large spring tides and dense, actively growing marsh vegetation. This time period coincides with the nesting season of the endangered Ridgway's Rail, so we will need to be flexible with the sample dates to be able to gain access to the marsh. The winter data collection is planned for December 2021 through January 2022, to capture the winter King tides, winter storms, and senescent vegetation.

b. Marsh sediment deposition and accretion measurements

The six deposition transects will be stratified by elevation gradients and vegetation type (see Buffington et al. 2020 for details). Transect length will vary from 30-50 m with 5-10 sediment deposition sampling locations per transect. At each sampling location we will deploy three replicate glass filter pads that collect mineral and organic matter deposited on the marsh

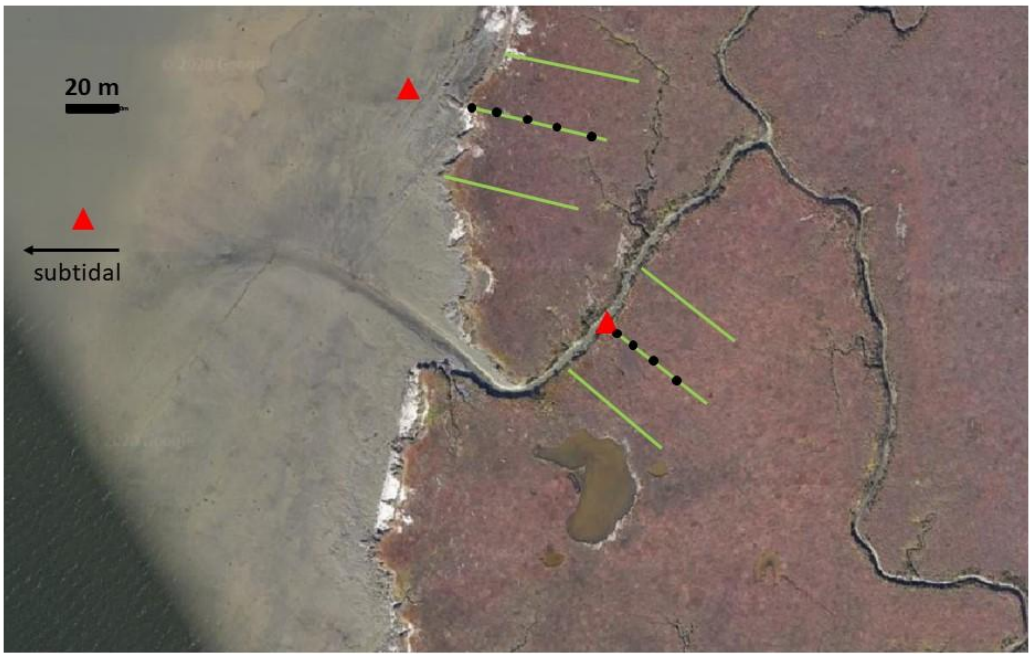

Figure 1: Conceptual study design, illustrating relative locations of flux stations (red triangles), transects of sediment pads and vegetation quadrats (green lines), and marsh SSC stations (black dots). Locations and transect lengths subject to conditions at the study site.

surface. Sediment pads will be collected every 1-2 weeks depending on site conditions. Sediment pad samples will be analyzed in the lab for mineral mass and organic matter. To translate deposition into accretion rates we will collect small soil plugs adjacent to sediment traps to analyze for bulk density and organic matter. The elevations of all sampling locations will be measured with RTK GPS.

c. Vegetation characterization

We will conduct vegetation surveys to inventory dominant plant species, density, and elevations. Along transects we will use point intercept method on 1x1 m grid at each sediment trap location. We will determine species, % cover, average height, and density by vertical strata. Results will be used to estimate cross-sectional area and volume of the vegetation per unit area.

Task 3. Data analysis

Time-series data will be reviewed to remove low-quality data and converted to a non-proprietary format (NetCDF) for publication. OBS data will be converted to SSC based on instrument-specific calibration relationships from *in-situ* samples. From the shallows stations data, wave statistics will be calculated from high-frequency bursts of pressure and velocity, and bed shear stress due to currents and waves will be determined. At the shallows and creek stations, we will produce time series of SSF from velocity, SSC, and depth. From the deposition data we will evaluate the influence of elevation, distance from source, and vegetation type on accretion across the marsh surface.

With these results we will investigate the dependence of SSC in the shallows, creek and on the marsh, as well as SSF in the shallows and creek, on wave energy, tide stage, and the spring-

neap tidal cycle. The relationship of SSC and SSF to sediment delivery to the marsh will be assessed using the deposition data. Comparison of the summer and winter results will allow assessment of seasonal variation (due to differences in wave climate and/or vegetation), in SSC, SSF, and the relationship between these parameters and deposition on the marsh. We may also be able to assess the dependence of deposition on wave energy and spring-neap tidal cycle, depending on the permitted frequency of access.

Results will connect sediment dynamics in the shallows to deposition and accretion rates across the marsh surface by elevation and vegetation type.

Task 4. Presentation of results

Results of the study will be presented to the RMP Sediment Workgroup, the WRMP Technical Advisory Committee, and either the Bay-Delta Science Conference or the State of the Estuary Conference.

Task 5. Preparing products

The data will be published as USGS data releases, one produced by WERC and one by PCMSC, within 18 months of the start of work. The final report will be a draft paper for submittal to a peer-reviewed journal, to be completed within two years of the start of work. The paper will investigate the relationship between sediment dynamics in the shallows and sediment delivery to the marsh, and its seasonal variation.

Budget

USGS Pacific Coastal and Marine Science Center (Lacy)

Expense	Estimated Cost
Task 1	$ 1,500.00
Task 2a	$ 31,000.00
Task 3	$ 30,000.00
Task 4	$ 1,000.00
Task 5	$ 13,500.00
Subtotal	$ 77,000.00
Indirect	$ 42,634.90
Total	**$ 119,634.90**

USGS Western Ecological Research Center (Thorne)

Expense	Estimated Cost
Task 1	$ 1,500.00
Task 2.b	$ 25,050.00
Task 2.c	$ 10,000.00
Task 3	$ 15,000.00
Task 4 & 5	$ 1,000.00
Subtotal	$ 52,550.00
Indirect	$ 27,326.00
Total	**$ 79,876.00**

Grand Total: $199,511.00

In-kind and leveraged contributions:

USGS PCMSC will provide in-kind all instrumentation for time series data collection (valued at more than $150k), use of vessels, vehicles, and laboratories, and $45k in salary for Lacy and technicians.
USGS WERC will provide in-kind all major field and lab equipment (boats, trucks, RTK GPS, muffle furnace, balance), and $25K in salary for Thorne. WERC will also be leveraging existing data (60K, Thorne et al. 2019) and methodology (30K, Buffington et al. 2020).

Reporting

The final report will be a draft paper for submittal to a peer-reviewed journal, within two years of the start of work. The draft paper will be provided to the RMP Sediment Workgroup and TRC for review before submittal to the journal. The data collected in this project will be published as USGS data releases within 18 months of the start of work.

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RMP Special Study Proposal: Dredged Material Management Office (DMMO) Database Enhancements

Summary: In 2018, SFEI began hosting and managing the DMMO database and website (https://www.dmmosfbay.org/). A DMMO Project Team with representatives from the partner agencies USEPA, USACE, SFBRWQCB, and BCDC convene regularly to set priorities and guide the transition from Exa Data to SFEI. Initially, the highest priorities were to assemble the various components of the DMMO information system onto SFEI's servers, maintain the domain registration, make minor updates to the website, upload new data templates into the database, and maintain the technical documentation and procedures. Now that those priorities have been addressed, the DMMO database user community seeks more database functionality and an improved user interface.

This proposed project focuses on improving the DMMO database to make it more accessible by the user community. Enhancements to the database would (1) improve efficiencies and streamline the process of making data available in a timely manner for querying; (2) enable the integration of DMMO data into SFEI's other data visualization tools, such as the Contaminant Data Display and Download tool (cd3.sfei.org), which is the primary data access and visualization tool for the Regional Monitoring Program's long-term dataset; and (3) support DMMO data mining and synthesis efforts.

This proposal will benefit the RMP by improving access to the data needed for successfully completing other RMP special studies, including updating the screening guidelines for beneficial reuse of dredged sediment.

Estimated Cost: $40,000

Oversight Group: RMP Sediment Workgroup

Proposed by: Cristina Grosso (SFEI)

Proposed Deliverables and Timeline

Deliverable	Due Date
Summarized meeting notes	June 2021

Enhanced database functionality	December 2021
Enhanced access to DMMO data	December 2021

Background

The DMMO database stores testing results for sediment quality and chemical analysis of tissues from bioaccumulation tests for permitted navigational dredging projects in the San Francisco Bay. The database supports the primary goal of the DMMO interagency group to foster a comprehensive and consolidated approach to handling dredged material management issues. The group uses the DMMO data to make suitability determinations for material proposed for disposal or beneficial reuse in and around the San Francisco Bay area.

The DMMO database was developed over ten years ago by Exa Data using Microsoft Access 2007. Currently, new data are uploaded to the Access database and then copied to another format for display on the website. By moving to a more robust database platform such as SQL Server, the process for making testing results accessible on the website could be automated and streamlined. In addition, the DMMO website currently does not provide the ability to map testing results. It is important to update this outdated technology so the DMMO data could be integrated with other relevant datasets and made accessible in online querying and visualization tools that support data synthesis and better decision-making.

Potential opportunities for enhancing the access and integration of DMMO data include synthesizing DMMO data for contamination hot spots in the margins; visualizing DMMO data through CD3; using the database to develop updated beneficial reuse guidelines; improving reporting templates that facilitate data mining; and developing an online tool to compile "Tier 1" track records for projects or project clusters.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding and analyzing dredged material in the San Francisco Bay. Table 1 shows the objectives of the project and how the information will be used relative to the management questions of the RMP Sediment Workgroup.

Table 1. Study objectives and questions relevant to the Sediment Workgroup management questions.

Management Question	**Study Objective**	**Example Information Application**
1) What are acceptable levels		The DMMO database can be

of chemicals in sediment for placement in the Bay, baylands, or restoration projects?	Provide access to dredged material testing data to synthesize with other datasets.	used to explore options for updating the draft beneficial use sediment screening guidelines.
2) Are there effects on fish, benthic species, and submerged habitats from dredging or placement of sediment?		Review of toxicity data can help inform appropriate management thresholds for dredge sediment placement and disposal.
3) What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?		
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 DMMO database was developed over ten years ago and uses outdated technology. By making enhancements to the database, it will be easier to integrate the DMMO data into existing data access and visualization tools.

The tasks are described in more detail below.

1. **Coordinate with DMMO Project Team**
   SFEI staff will meet regularly with the DMMO Project Team to ensure the development of the enhancements meet the data tracking and reporting needs of the DMMO's partner agencies.

2. **Develop DMMO database enhancements**
   Based on input from the DMMO Project Team, SFEI staff will develop and thoroughly test database enhancements. Moving the DMMO database from Microsoft Access 2007 to a more robust database platform such as SQL Server will enable the automation of procedures to make testing results accessible on the DMMO website. These enhancements would also allow the DMMO database to be managed on the same servers and use the same standard protocols as SFEI's Regional Data Center and RMP data.

3. **Develop DMMO data access enhancements**
   Based on input from the DMMO Project Team, SFEI staff will develop and thoroughly test data access enhancements by leveraging and integrating DMMO data into existing online visualization tools, such as CD3. Improving the ability to query, map, and download DMMO data will better support DMMO data mining and synthesis efforts.

Budget

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

Table 2. Proposed Budget.

Expense	Estimated SFEI Hours	Estimated Cost
Task 1: Coordinate with DMMO Project Team	12	$1,680
Task 2: Develop DMMO database enhancements	188	$26,320
Task 3: Develop DMMO data access enhancements	86	$12,000
Subcontracts		$0
Direct Costs		$0
Grand Total	**286**	**$40,000**

Budget Justification
Labor costs include SFEI staff time to coordinate with the DMMO Project Team and develop and test the new database and data access enhancements.

Reporting

Decisions and notes from meetings with the DMMO Project Team will be summarized. The new database and data access enhancements will be released to production.

References

Not Applicable

RMP Special Study Proposal: Continuous Suspended Sediment Monitoring on the Eastern Shoal of South San Francisco Bay

Summary: The proposed project aims to expand continuous suspended sediment (SSC) monitoring, and optionally adds wave characteristic monitoring, in South San Francisco Bay (SB). Continuous SSC data are essential to both empirical and model-based sediment studies but are currently only available at two channel stations in SB. The SB shoals play an important but understudied role in SB sediment dynamics, and these dynamics are strongly influenced by wind waves. This project would efficiently fill SB data gaps by leveraging monitoring at existing and proposed stations managed by the San Francisco Bay Nutrient Management Strategy (NMS). Specifically, this project would add SSC sampling and wave sensors at NMS stations and would make the associated data publically available.

Estimated Cost: $29,040 - $50,320 depending on options

Oversight Group: RMP Sediment Workgroup

Proposed by: Derek Roberts (SFEI)

Proposed Deliverables and Timeline

Task/Deliverable	Date
Begin monthly SSC sampling	Mar 2021
Deploy wave sensors	Mar 2021
Monthly updates to curated wave height/period data set	Mar 2021 - Mar 2022
Curated SSC sample dataset	Apr 2022
Technical report, including turbidity-to-SSC calibration	Apr 2022
Curated high-frequency SSC dataset from turbidity data	Apr 2022
Presentation to RMP	May 2022

Background

Understanding sediment dynamics in estuaries requires measuring time-varying suspended sediment concentrations (SSC) at sub-tidal time scales. Continuous turbidity measurements from moored sensors can be calibrated to SSC to enable high-frequency estimates of water column sediment concentrations. By leveraging existing and ongoing turbidity measurements

from a network of monitoring stations managed by the San Francisco Bay Nutrient Management Strategy (NMS; Figure 1), estimates of historical and on-going SSC concentrations at sites across South San Francisco Bay (SB) can be achieved at relatively low cost. The NMS has tentative plans to deploy two additional SB shoal stations in Winter 2020/2021 (blue stars in Figure 1).

Sediment dynamics in San Francisco Bay are driven by the interplay between inflow watershed loading, tidal currents, and wind waves. Existing watershed gauges can be used to estimate inflow loads. Tidal currents, or at least the magnitude of these currents, are somewhat easily inferred from existing field data and hydrodynamic models. However, long-term wave effects have mostly been inferred from wind speed (e.g., Thompson et al. 2008); the lack of direct measurement is an impediment to understanding and modeling sediment fluxes in shallow areas. NMS stations could be supplemented with high-frequency pressure sensors to quantify wave height and period in parallel with the turbidity/SSC signal. Continuous and spatially-distributed measurements of water-column SSC and wave characteristics are essential to sediment transport model calibration and validation. These data would also serve as valuable background data for parallel observational studies in SB.

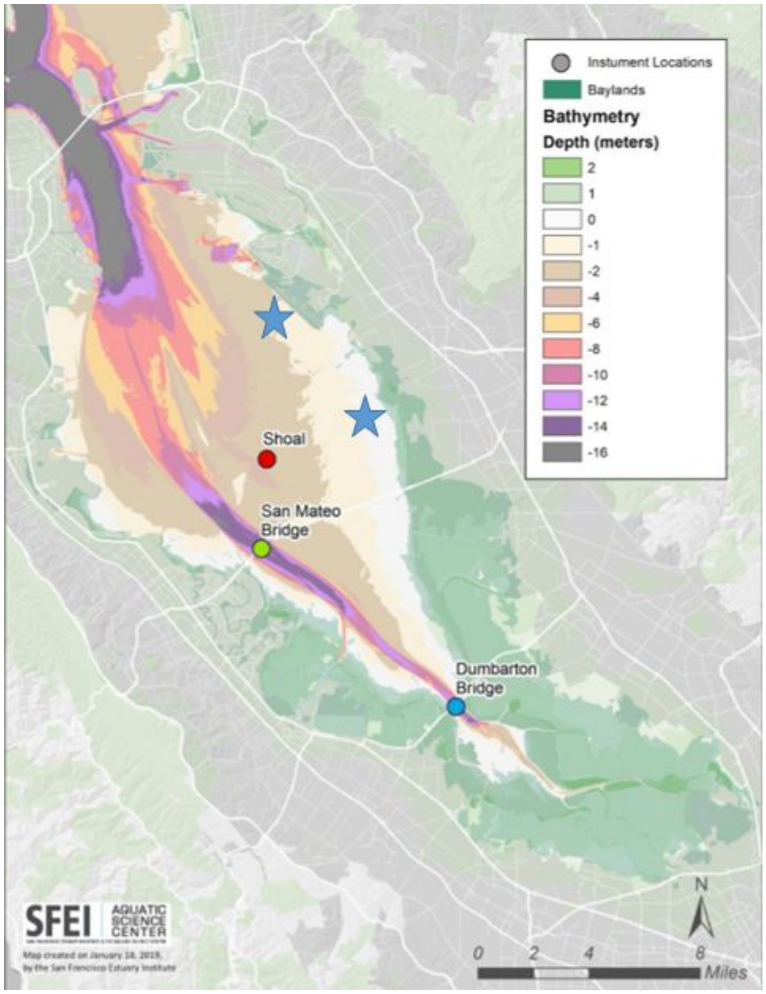

Figure 1 - NMS South Bay monitoring sites. Proposed new sites are shown as blue stars.

Study Objectives and Applicable RMP Management Questions

The study will provide essential information for understanding suspended sediment concentrations within San Francisco Bay. Table 1 shows the objectives of the study and how these objectives directly address RMP Sediment Workgroup management questions.

Table 1 - Relevant RMP Sediment Workgroup Study Question and study objectives and example application of study results.

Management Question	Study Objectives	Example Information Application
MQ5: What are the concentrations of suspended sediment in the Estuary and its sub-embayments?	Expand continuous monitoring of suspended sediment concentrations and, optionally, wind waves to the shoals of South San Francisco Bay. Curate and publically share SSC and optional wave data with the San Francisco Bay sediment research and management community, and public at large. Provide insight on the relative role of wind waves in creating elevated suspended sediment concentrations in the water column.	• Documenting inter- and intra-annual suspended sediment concentration dynamics . • Understanding drivers of suspended sediment concentrations in shallows. • Developing a key dataset for calibrating and validating sediment transport models of the Bay.

Approach

Task 0 - Associated Nutrient Management Strategy Tasks

This proposal depends on the deployment of two new shoal monitoring stations, and the maintenance of two existing stations at the SB shoal and San Mateo Bridge (Figure 1) by the NMS. The deployment of the new stations is expected in winter 2021 (independent of the outcome of this proposal) but is dependent, in part, on fieldwork limitations associated with the COVID-19 pandemic and on finalization of the fiscal year 2021 NMS budget. These stations include YSI EXO2 sensors that measure turbidity, and a suite of other standard water quality parameters, at a 15-minute time step (averages of 10 sec 1 Hz bursts).

Task 1 – SSC Sampling

March 2021 to March 2022

Technicians from the USGS California Water Science Center (USGS-CAWSC) will collect near-surface water samples during monthly maintenance trips to the three shoal sites and the

San Mateo Bridge sites. Samples will be collected following standard USGS protocols (Wagner et al. 2006) and sent to the USGS-CAWSC Santa Cruz Sediment Lab. Samples will be analyzed for SSC and, optionally, for particle size distribution (PSD).

Discrete sampling will begin when all four SB stations are fully deployed (expected Winter 2021) and is proposed to continue for one year of monthly trips (12 samples from each of the four sites). Discrete sample data will be publicly posted to the USGS National Water Information System website (NWIS).

Task 2 (Optional) – Wave Sensor Deployment

March 2021 to March 2022

SFEI will deploy high-frequency pressure sensors (RBR Solo D-wave 16 Hz) at the two shallower shoal stations (blue stars in Figure 1). These sensors will be mounted to fixed structures and set to burst sample at 16 Hz for two minutes every 15 minutes. Sensors will be maintained and data will be offloaded during monthly servicing trips that SFEI staff will join with USGS-CAWSC technicians.

The resulting data will be used to derive maximum and significant wave height, and associated periodicities, at a 15-minute time step. These data will be curated and publicly posted monthly using SFEI web-interface tools.

Task 3 – Turbidity to SSC Calibration

April 2022

After one year of sampling, the twelve SSC samples for each site will be used to calibrate a relationship between the continuous turbidity data measured by the YSI EXO2 instruments and sample SSC. Calibration will be performed following Rasmussen et al. (2009). Note that twelve samples may not yield a satisfactory calibration; costs associated with longer-term sampling are included in the budget section of this proposal.

Task 4 – Reporting and Presentation

April 2022

SFEI staff will produce a report describing the data collection methods, the calibration procedure and result, and a basic descriptive analysis of SSC (and optionally wave) patterns. In parallel to the publication of this report, continuous SSC data (from the historical and ongoing turbidity data) at each station will be posted to a publicly accessible web portal. The continued posting of SSC data, after the cessation of SSC sampling but as more turbidity data are collected, can be accomplished at very low cost (see budget).

Budget

Budget Justification

The proposed budget is shown in Table 2. Option 1 represents one year of sampling and associated analyses and reporting. Option 2 adds wave data collection, handling, and processing to Option 1. Both options include particle size distribution (PSD) sample processing which could optionally be eliminated.

The project will be coordinated by an SFEI staff person at the Environmental Scientist (ES) level (estimated $135/hour). The SFEI ES will handle the turbidity-to-SSC calibration, analysis, wave data handling, and all reporting. Some portion of the project coordination and data handling may be supported by an SFEI Environmental Analyst (EA). SFEI Environmental Informatics staff will support the data updates to a publicly accessible web database.

Sample collection and processing costs are based on budget coordination with USGS-CAWSC staff and include field preparation time, sample handling, shipping, and posting data to NWIS.

Note that twelve months of sampling may provide a weak turbidity-to-SCC calibration. Additional sampling may be needed to improve this calibration. Extending sampling by six or twelve months (without an interim report) is estimated to add $5100 or $8800 respectively (many costs are fixed).

Note that after a satisfactory calibration is achieved and SSC sampling ceases, SSC estimates from ongoing turbidity data collection can continue to be posted publicly at an estimated cost of $250/posting. Data are curated monthly but could be posted less frequently as a cost savings. Continual quarterly updates to the publically accessible SSC data would cost approximately $1000/year assuming the NMS continues to fund the stations (expected until at least 2024).

Table 2 – Proposed budget.

		Option 1		Option 2	
Expense	**Unit Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Project coordination (SFEI hours)	$135	40	$5,400	70	$9,450
SSC sample collection and processing (samples)	$100	48	$4,800	48	$4,800
PSD sample collection and processing (samples)	$100	48	$4,800	48	$4,800
Calibration of sensor turbidity data to SSC samples and accompanying report (SFEI hours)	$135	50	$6,750	50	$6,750
Maintaining web-portal with up-to-date data (SFEI hours)	$135	30	$4,050	40	$5,400
16 Hz bursting pressure/wave sensors (instruments)	$3,300	0	$0	2	$6,600

Initial wave sensor deployment (bulk labor)	$1,600	0	$0	1	$1,600
Misc. deployment hardware	$1,200	0	$0	1	$1,200
Wave data processing/curation (SFEI hours)	$135	0	$0	40	$5,400
Presentation and reporting to RMP (SFEI hours)	$135	24	$3,240	32	$4,320
Total			**$29,040**		**$50,320**

References

Rasmussen, P.P., Gray, J.R., Glysson, G.D., and Ziegler, A.C., (2009), Guidelines and procedures for computing time-series suspended-sediment concentrations and loads from in-stream turbidity-sensor and streamflow data: U.S. Geological Survey Techniques and Methods, book 3, chap. C4, 52 p.

Thompson, J. K., Koseff, J. R., Monismith, S. G., and Lucas, L. V., (2008). Shallow water processes govern system-wide phytoplankton bloom dynamics: A field study. *Journal of Marine Systems*, *74*(1–2), 153–166. https://doi.org/10.1016/j.jmarsys.2007.12.006

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., (2006). Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3; accessed June 1, 2020 at *http://pubs.water.usgs.gov/tm1d3*