PCBWG Proposal: Monitoring of Sediment Deposition in San Leandro Bay Intertidal Areas

Summary

This study proposes to measure sediment deposition within the San Leandro Bay (SLB) priority margin unit (PMU) using an array of tools, including sediment marker horizons, sediment pins, surface elevation tables, and sediment traps. Areas across a span of distances nearer and further from discharge areas in SLB for watersheds of interest for PCB loading (East Creek, Damon Slough) will be monitored for sedimentation and net sedimentation (i.e., either net deposition or erosion) quarterly over the course of one year to capture seasonal-scale processes. Measurement of grain size in sediment trap material and in surface sediment adjacent to the monitored points for two of the quarterly visits (one in wet season, one in dry season), which may help the parameterization of particle sizes for both the Watershed Dynamic Model (WDM) and in-Bay fate model locally. A potential add-on would be measurement of PCBs in sediment trap material, which will be useful in distinguishing the PCBs in newly settling mobile sediment in comparison to previous sampling efforts characterizing consolidated bed surface sediment.

Estimated Cost:	$97k
Oversight Group:	PCBWG
Proposed by:	Don Yee
Time Sensitive:	Yes, for summer 2024 SLB model completion (most useful if available before model fully calibrated). Late fall 2023 deployment needed to capture at least one wet season for model validation.

Background

Priority margin units (PMUs) are areas in the Bay near known upland sources of legacy contaminants that are likely to be most impacted by management-driven increases or decreases in pollutant loading. Cores in some vegetated wetlands have shown evidence of reductions in some legacy contaminants. Downward mixing in vegetated wetland areas is reduced due to the vegetation limiting resuspension and bioturbation. However, in many intertidal mudflats, it is unknown if contaminants present in sediment accessible to biota are due to sediment accretion, downward mixing, or some combination of both.

Models of long-term sediment and contaminant fate in PMUs, and the Bay in general, are in development and will require empirical data for the variables being simulated, including net sediment accretion or erosion. Accurate predictions of net sedimentation are critical to estimates of recovery time for persistent legacy pollutants such as PCBs, since a major PCB loss

pathway via sediment burial is anticipated to be highly sensitive to net sedimentation rate in both the regional-scale PCB fate model (Davis 2004) and local-scale conceptual models for PMUs such as SLB (Yee et al., 2019).

This study would monitor net sedimentation at sites within San Leandro Bay (SLB) in order to locally calibrate or validate estimates of expected sedimentation obtained by the integration of watershed models of flow and sediment supply (the Watershed Dynamic Model, WDM, Zi et al., 2022) being currently developed at SFEI, and high-resolution hydrodynamic and sediment transport models being developed for SLB, extended from Bay-wide hydrodynamic modeling efforts in DelftFM for the Nutrient Management Strategy (King et al., 2019).

Both WDM and DelftFM have been primarily focused to date on Bay-scale processes and have been initially calibrated to capture average responses at a regional scale, rather than within localized areas like SLB. As a result, data to locally calibrate and validate processes for SLB specifically will be needed to make predictions of recovery rates sufficiently accurate to project recovery rates from legacy contamination, and responses to reductions in inputs of sediment-bound pollutants.

Study Objectives and Applicable RMP Management Questions

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

Management Question	Study Objective	Example Information Application
1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination? a. What would be the impact of focused management of PMU watersheds?	Empirical sediment downward and net flux	1a. Sediment burial rate input to simple PCB box model, or downward flux and net sedimentation target for dynamic sediment loading and fate models
	Grainsize of settling and bed sediment	Grainsize validation for WDM loads and SLB transport models
	(Optionally PCBs in new settling sediment).	(Seasonal settling PCBs compared to event stormwater PCBs)
b. What would be the impact of management of in-Bay contaminated sites?		1b. Not directly addressed. But repeated sediment trap PCBs in future might indicate progress.

Approach

This study proposes to measure sediment deposition rates within the San Leandro Bay PMU using an array of tools, including sediment marker horizons, sediment pins, surface elevation tables, and sediment traps. Net sediment accretion or erosion estimated using these methods will be useful for calibrating and validating models of long-term sediment fate.

Sediment marker horizon methods planned will include plastic lighting grids and sediment plates (http://www.tidalmarshmonitoring.net/monitoring-methods-marker-horizons.php). The plastic grid marker will be resistant to erosion and may be able to show net erosion (up to the thickness of the grid). However, larger degrees of erosion would not be shown as the grid would simply drop down to the eroded surface. Similarly, sediment plates can show net accretion on top of the plate, or net erosion, if the plate is supported by a deeper rod less susceptible to settling to the scoured surface.

Sediment pins placed on the corners of the marker horizon plots will be used as visual markers to find the plots and provide evidence of net accretion or erosion. Sediment pins are somewhat subject to localized erosion around their points of insertion (larger for larger diameter pins), so paired sediment pins driven to equal heights spaced several feet apart, with a contractor's level carried to the field spanning them, can be used as a portable surface elevation table (SET), by measuring the distance to the sediment surface at several points from the spanning level (Prof. John Rybczyk, pers. comm.).

About 1-2m away, but at approximately the same elevation as the marker/pin/SET assemblies, mason jars equipped with coarse mesh (¼") stainless steel screened lids will be placed as sediment traps to capture downward sediment flux, which combined with the net sedimentation rate can be used to back-calculate resuspension flux. The screening will reduce disturbance of the trap contents by biota or waves and currents.

The proposed scope is for eight areas (Figure 1), with two tidal elevations each (16 installations total). Measurements in East Creek and Damon Slough are proposed at areas near (~20 m) and further (~100 m) from the main channels. An additional site pair midway between these two areas will provide information on processes further from those inputs. Site pairs further away from these inputs on the east and west sides of Arrowhead Marsh, areas without immediately proximate tributary input, and near the channel on the south end of Alameda, near SLB's exchange point with Central Bay, can provide information on longer distance transport processes, and interactions near the Bay boundary.

The deployments will be visited quarterly to check on their status and measure estimates of sediment accretion or erosion. Deployment is estimated to require several days of field work for a crew of two people. An initial site visit about a month after deployment is planned to inspect the integrity of the installations and make adjustments as needed (e.g., copper screening may be used instead on sediment traps if excessive biofouling occurs).

If the deployments remain intact, subsequent quarterly visits are planned to make measurements and collect sediment traps. The effort is scalable, and could include more areas (e.g., sites near the entry of Elmhurst Slough and San Leandro Creek, and Alameda Channel), or more elevations in each area.

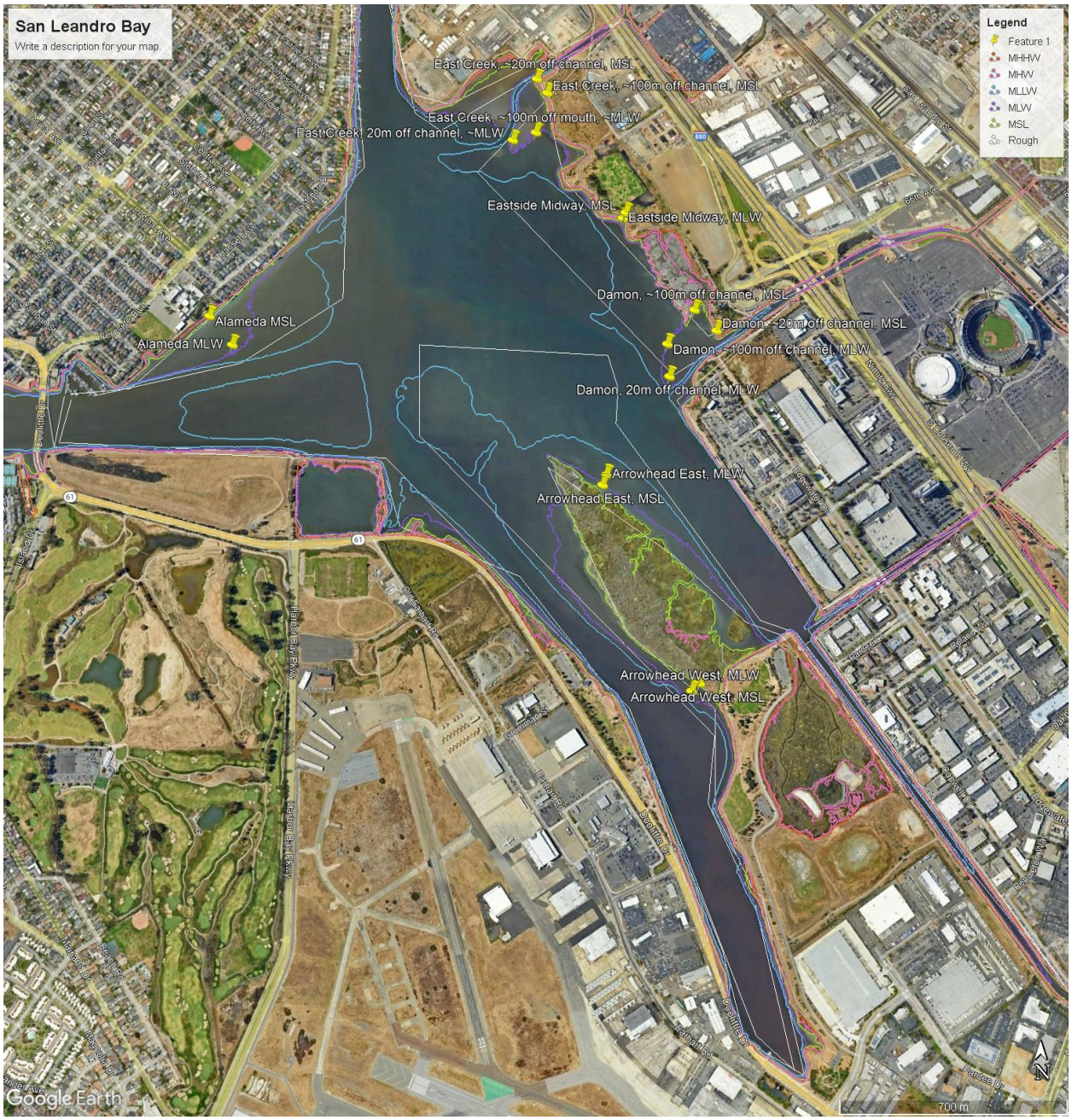

Figure 1. Proposed locations for sediment markers and traps

Grain size will be charaacterized for sediment trap material in each season, and in surface sediment near the deployments for one event. PCBs would also be measured in sediment trap material for one event (in the wet season). Costs for the monitoring plan with these analyses

are shown in Table 1. The study duration, frequency of visits, and number of sites can also be scaled somewhat.

Locations are placed at elevations around MSL and MLW near boundary inputs of sediment and water, and in central areas around Arrowhead Marsh to capture the interaction of inputs with local transport processes.

Table 1. Estimated Cost:

Expense	Estimated hours	$ Cost
Labor		
Planning & mgmt	60	10500
Field Work, pre & post	250	40000
Reporting	80	14000
Direct Costs		
Equipment		2000
Travel		400
Shipping		1200
Subtotal		**66900**
Subcontracts		
Grainsize (4 events+ 1x bed sed +QC)		10500
Data mgmt/reporting	30	4500
Subtotal grainsize		**15000**
PCBs (Feb 2024 MLW traps+QC)		9200
Data mgmt/reporting	30	4500
Subtotal PCBs		**13700**
Grand Total		**96800**

Deliverable products will include a draft and final technical report on the results of the monitoring, and upload of the field and lab results to CEDEN.

Deliverables and Schedule

Monitoring plan development	Oct 2023
Marker deployment	Mid-late Nov 2023
Site Revisits & Measurements	Dec 2023, Feb, May, Aug, Nov 2024
Lab analysis grainsize	Feb, May, Aug, Nov 2024 (+2mo lab turnaround)
Lab analysis PCBs	Feb 2024 (+2mo)
Draft technical report	Feb 2025
Final report and data upload	April 2025

References

Davis, J.A. 2004. The long-term fate of PCBs in San Francisco Bay. Environmental Toxicology and Chemistry 23(10): 2396-2409.

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