

## Special Study Proposal: Characterization of Sediment Contamination in Central Bay Margin Areas

**Summary:** Bay margins (i.e., mud flats and adjacent shallow areas of the Bay) are more productive and highly utilized by biota of interest (humans or wildlife) than the open Bay areas. This study will provide a spatially distributed urban-focused characterization of surface sediment contamination and ancillary characteristics within shallow Central Bay margin areas. The data will be used to investigate spatial distributions of pollutants, watershed influences, and regional trends. This study will complement targeted studies to link watersheds, known contaminated margins, and the open Bay, much of which will be focused in Central Bay.

**Estimated Cost:** \$257,470 over two years (\$226,370 in 2015, \$31,100 in 2016)

**Oversight Group:** TRC. On 3/11/15, the TRC recommended that the SC approve this study. On 4/21/15, the SC approved the funding for this study.

**Proposed by:** Don Yee, Phil Trowbridge (SFEI)

### PROPOSED DELIVERABLES AND TIMELINE

<b>Deliverable</b>	<b>Due Date</b>
Task 1. Project Management (write and manage sub-contracts, track budgets)	March-May 2015
Task 2. Finalized detailed sampling plan	April 2015
Task 3. Field Sampling	Summer 2015
Task 4. Lab analysis	Fall/winter 2015-2016
Task 5. QA/QC and data management	March 2016
Task 6. Data web upload	Apr 2016
Task 7. Draft & final report	Mar 2016 (preliminary), Dec 2016 (final)

### Background

The Bay margins (i.e., mud flats and adjacent shallow areas of the Bay) are important habitats where contaminant exposure is high in some known locations, but that have been largely unsampled by the RMP, due to logistical considerations; the RMP historically focused on deep water locations, limited even after the 2002 redesign to areas accessible by a moderately large boat (~3 foot draft). Aside from the margins' importance as habitats in themselves, contamination in margins may contribute to the lack of decreasing trends in biota (e.g., fish tissue) concentrations of PCBs (and other persistent bioaccumulative contaminants), despite long-term changes in sediments in some parts of the open Bay. Locations on the margins often may have a closer linkage with terrestrial sources and therefore a higher potential for showing a positive response to management actions aimed at reducing loads and impairment. Analysis of margins contaminant concentrations in the RMP Margins Conceptual Model

Report (Jones et al., 2012) suggested higher and more variable concentrations in margins, but much of the previous sampling was spatially biased to include known polluted areas in the margins associated with Superfund sites and other legacy sources, while the characteristics of contamination of other sites in the Bay margins are less known.

## **Study Objectives and Applicable RMP Management Questions**

This study will provide an unbiased spatially distributed characterization of surface sediment contamination and ancillary characteristics (grain size, TOC, etc.) in shallow Central Bay margin areas, weighted towards urbanized areas. According to the RMP Margins Conceptual Model Report (Jones et al., 2012), such data are needed to characterize and model contaminant risk, fate, and trends in the Bay margins. Otherwise, assessments of exposure and risks to margins biota would rely on extrapolation from data from deeper, subtidal, open water areas of the Bay, and/or biased margin cleanup target areas, neither likely representative of most locations the margins. Collection of representative margin data is the only real solution for obtaining such data. Ideally ambient margins sampling should recur regularly, as it is characterizing a relevant, evolving, and critical portion of the ecosystem. Deterministic sampling related to identifying sources, or to management in specific locations should be addressed by monitoring schemes specifically designed for those needs and are complementary.

Although there are broader questions and needs for ambient margins data (paralleling those for the Bay S&T), this study has evolved from a periodic synoptic Baywide survey of margins to a single pilot effort focused on Central Bay. The power to make some comparisons (e.g., with other Bay segments, if those segments are later sampled) has been reduced, in favor of obtaining information more quickly on urbanized areas in Central Bay, with likely the most areas surrounding potential management actions. This plan accelerates characterization of ambient Central Bay margins to be able to compare to and complement deterministic sampling at priority managed margin areas and watersheds, to evaluate the effectiveness of management actions, especially with regards to PCBs.

Information needs addressed by these data include:

1. Ambient concentrations of PCBs and other contaminants in sediment in the margin areas. This information will facilitate setting achievable targets for restoration and/or load reductions.
2. Mass balance calculations for PCBs and other contaminants in margin areas to show the relative importance of watershed loads in maintaining elevated concentrations in the sediments. This information will show whether taking management actions in the watersheds has the ability to change the margin concentrations.
3. Effectiveness of on-the-ground watershed management projects at reducing loads. This information will show whether the installed technology is meeting its design specifications.
4. Screening for the existence of additional hotspots in areas that have not been sampled to date

### Probabilistic vs Targeted Sampling Designs

Spatially distributed probabilistic sampling is the best design for Information Need #1, and would also be valuable for Information Need #4.

Targeted sampling is the best design for Information Needs #2 and #3. The RMP has a special study planned to monitor PCBs in priority margin units with separate funding. That targeted study will be directly relevant to Information Need #2. In the future, when on-the-ground watershed management projects start, targeted performance monitoring should be required to address Information Need #3. However, even for these targeted sampling needs, ambient data are needed to provide important complementary information, e.g., for #2, to estimate mass exchanges with adjacent less contaminated areas, or for #3 to identify which locations among targeted locations are showing mostly ambient rather than site or watershed specific influences.

### Recommended (Modified) Probabilistic Design

- Concentrating all 40 margins sites into Central Bay (see Figure 1) in order to better characterize this segment since it is of primary interest for management.

Due to the expected high variability in margins, especially in Central Bay, an effort that spread the sampling effort across the whole Bay was assumed to reduce uncertainty too slowly to address immediate Central Bay information needs. It should be noted that here the Central Bay sampling frame is delimited using the RMP rather than SFBRWQCB definition. Both definitions share a common northern limit running between Point San Pablo in Richmond and Point San Pedro in San Rafael. For the SFBRWQCB, the southern limit of Central Bay ends at the San Francisco-Oakland Bay Bridge, whereas the RMP definition includes a portion south of the Bay Bridge, extending approximately from San Francisco Airport to Oakland Airport. These margins adjoin some older industrialized areas and thus might be expected to be of interest for legacy pollutants such as PCBs and Hg.

### *Advantages*

- Central Bay is of high interest for management actions.
- Would be better able to characterize ambient concentrations in Central Bay and allow meaningful comparisons to “open bay” sediment concentrations within 1-2 years.
- The 40 probabilistic sites can be post stratified into a few “sub populations” to characterize ambient concentrations in different categories or areas of Central Bay.
- Rapid characterization of margin areas in Central Bay would be helpful to:
  - illustrate the spatial patterns of margin contamination in this segment, providing context for managing contaminated areas;
  - understand the high PCB concentrations in fish found there;
  - evaluate the influence of known hot spots or the prevalence of unknown ones; and
  - identify candidate areas for the PCB Priority Margin Unit Study.
- A focused pilot effort will provide the best chance of a study that is successful in generating the information of interest, and management success can potentially be evaluated in a short time-frame.

### *Disadvantages*

- There is uncertainty about whether even 40 samples can adequately characterize such a diverse, fragmented, and likely heterogeneous area as the margins of Central Bay.
- The sampling design will not collect data from any other Bay segments in the same years. This approach will make it more difficult to compare margin areas between segments due to possible conflation of temporal and spatial differences
- Collection of information on margins in other segments will be delayed. Information to support margin management decisions in other segments will continue to be lacking.

## **Approach**

### Study Area and Sampling Locations

The proposed margins sampling monitoring would include areas previously excluded from the sampling frame in the RMP S&T redesign process: areas shallower than 1 foot at MLLW, up to the unvegetated shoreline (roughly MHW). In most areas this is approximately synonymous with mudflat (if we include shallow subtidal areas in that definition). A margin sampling frame was defined in consultation with Josh Collins and the SFEI GIS team, minimizing overlap with other monitoring such as CRAM assessed wetland areas (by excluding vegetated areas) and the open water areas already in the RMP Bay S&T (areas below 1 foot below MLLW).

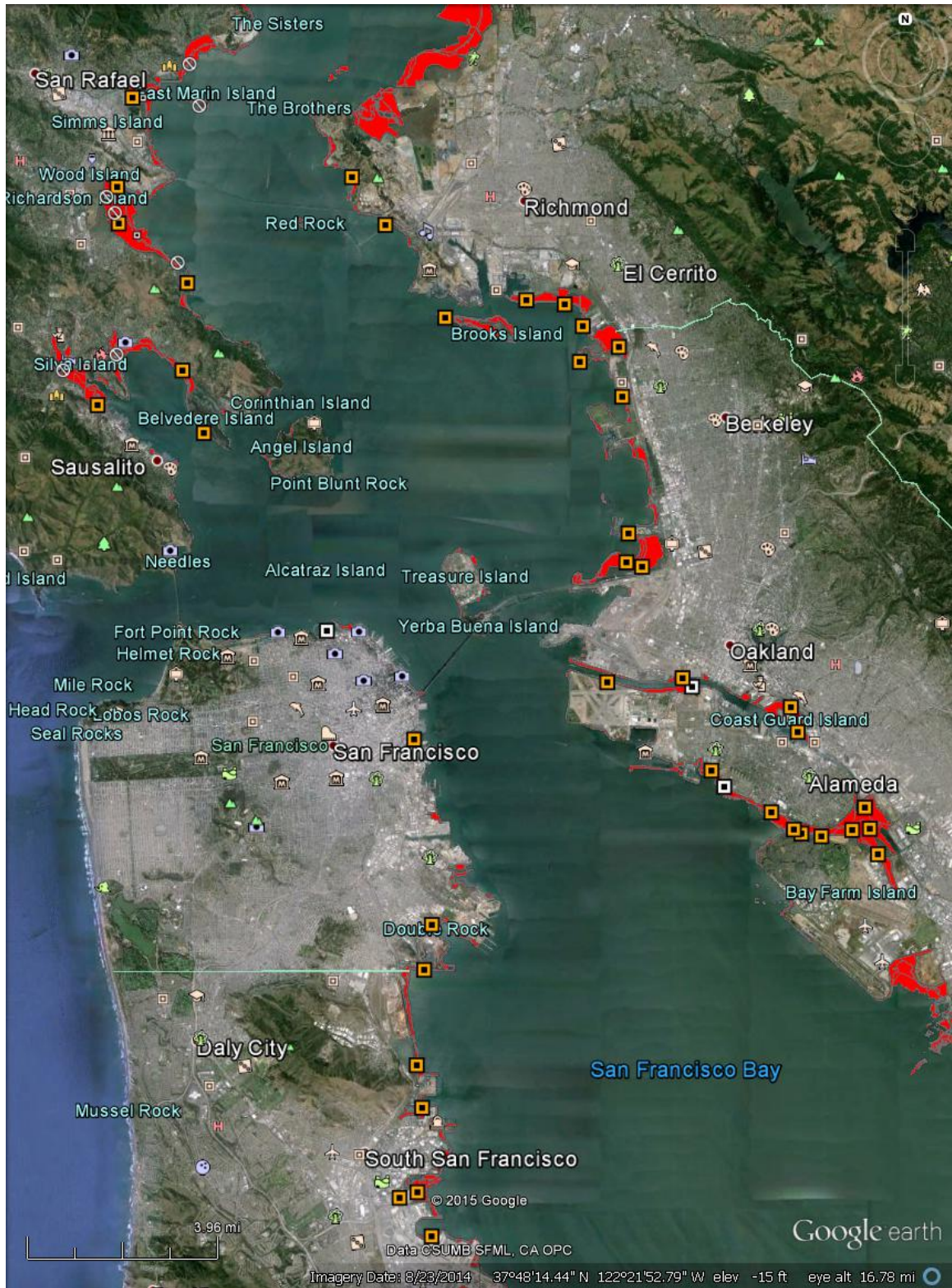
A GRTS method was used to draw sampling locations (up to 128 per segment) from this frame for the whole Bay in an unbiased manner through consultation with Don Stevens, the environmental statistician who helped design the RMP open Bay GRTS sample draw. Although it was investigated whether or not to include areas previously skipped in the Bay S&T sampling (due to water being too shallow for the vessel to access), Don Stevens recommended that they not be added, as oversample sites already have been sampled and should be adequate for characterizing the open Bay stratum.

The draw was modified by removing half (7) of the sites from Marin County margins to reduce sample density in that region. Due to the small number of samples left in Marin through this reduction, the first 7 Marin sites did not include any urbanized areas, so a subjectively chosen portion of the draw in Marin was selected to ensure representation of urban areas. The 7 Marin sites not sampled were replaced with oversample sites in other regions.

The TRC Margins Planning Subcommittee held a teleconference to discuss criteria for rejecting sites and replacing them with oversample locations. If any of the following logistical criteria occur at the planned site coordinates:

- Access/safety: The site cannot be accessed safely; OR
- Substrate: The substrate at the site is too coarse to collect a cohesive sample, is rocky shoreline, is covered with dense aquatic vegetation, or is shell hash; OR
- Upland area: The planned site is in a salt marsh or upland area.





**Figure 1. First 40 margin sites in Central Bay (orange symbols).** Red areas are margins frame sampled. White squares are sites in the original draw dropped due to unsuitable habitat, and white circles for Marin sites dropped to reduce sample density in that region.

If the logistical criteria are not met at the planned coordinates, the field team will be able to navigate within 50 meters of the planned site to find a suitable location with target habitat nearby. For sites that need to be relocated within the 50 meter allowable radius, to avoid biasing (e.g., always going to the deepest allowed depth) an attempt will be made to sample at the expected original depth for the site; sites that are not at their expected depth range but are still within acceptable habitat at their planned coordinates will not be relocated. If no suitable locations are found within 50 meters, the site will be rejected as not possible to sample. To the extent possible, unsampleable sites will be pre-identified through a desktop exercise from aerial imagery, and the next site in the overdraw list will be added in its place. Figure 1 shows the outcome of that initial desktop exercise, with sample sites skipped in Marin shown as white circles, unsampleable sites in other regions marked with white squares, and the first 40 remaining sample and oversample sites marked as orange squares.

The subcommittee also discussed and criteria for using other programs/projects data to substitute for collecting and analyzing samples from a site. While the subcommittee and the TRC were in favor of this approach, the Steering Committee felt that using data collected with different methods might compromise the accuracy of the study. Therefore, data from other studies will be gathered to provide context but will not be used as a substitute for newer data collected using standardized methods. In reality, the probability of having more than a few random sites fall on top of previously sampled locations is probably negligible.

### Sample Size

The total sample size is 40, with 7 of those sites in the margins areas of Marin County.

The reduction of sample density in Marin was an effort to pre-stratify within Central Bay to allocate even more sites to areas adjoining urbanized industrial areas. However, given the small number of samples remaining in the (presumed less variable) less urbanized area of Marin, the representativeness of the remaining sites there may need to be reevaluated after analysis of the new data.

### Sampling Frequency

This study plan represents a single effort in Central Bay to get a characterization of Bay margins focused on more urbanized areas. Results from this study may point to future possibilities or needs for site investigations, or further ambient characterization to get a better understanding/statistical certainty of patterns found. Studies of margins in other segments of the Bay may be planned as well for future years using this study as a pilot of the logistics and methods for margin sampling. However, there is not yet a plan for systematic regularly scheduled sampling of the margins akin to the Bay S&T at this time.

### Target Analytes

Sediment samples will be analyzed for grain size and ancillary parameters, mercury, methylmercury, trace metals, and PCBs (209 congeners). Extra archive samples will be collected so that additional parameters can be analyzed in the future.

## Budget

The proposed budget for the study is shown in Table 1. The study will be completed over two years. In 2015, all 40 sediment samples will be collected in order to lower field costs and to reduce temporal variability. In 2016, the data analysis and reporting will be completed. The annual costs for 2015 and 2016 will be \$226,370 and \$31,100, respectively. The total cost for the two-year program will be \$257,470.

The approved 2015 RMP budget contains \$140,000 for this effort. Another \$120,000 for the margins study is expected to be in the 2016 RMP budget. Therefore, between the 2015 and 2016 funds, there will be sufficient funds for the study. However, because most of the expenses will be in 2015, the Steering Committee will need to authorize adding \$86,370 of Undesignated Funds to the 2015 budget. This amount will be returned to Undesignated Funds from the 2016 budget.

Efforts and costs can be scaled up or down by changing the types of analyses run, number of samples per segment in a given year, or number of segments per event. For this proposal, it was necessary to drop sediment analyses for PAHs in order to balance the budget. These analyses would add \$36,000 to the cost of the study.

### Budget Justification

#### *Labor Costs*

SFEI labor costs for the planning task are for developing this proposal and a detailed cruise plan for the study. For the field work task, SFEI labor is mostly devoted to data management, managing field and lab contractors, and auditing field work. The reporting task assumes 4 weeks of work for SFEI senior scientists to prepare a report.

#### *Subcontract Costs*

Subcontract costs are based on quotes received from contractors. Field cost estimates were based on an estimate provided by Moss Landing Marine Labs, assuming all sampling would occur in summer 2015, concurrent with their efforts to sample for the National Coastal Condition Assessment.

It will be necessary to change laboratories for the PCB analyses. EBMUD has performed the sediment analyses for PCBs in recent years but is not planning to continue this type of work. Therefore, an extra \$7,200 has been allocated to complete a small interlaboratory comparison study to ensure for consistency with past results.

#### *Direct Costs*

The budget estimates the cost for supplies, travel, and shipping of samples to laboratories and the RMP archive.

## **Reporting**

After the completion of the scheduled first round of samples (all 40 in Central Bay) these results will be formalized in an RMP technical report. The report will address two of the four high priority information needs:

- Ambient concentrations of PCBs and other contaminants in sediment in the margin areas. This information will facilitate setting achievable targets for restoration and/or load reductions.
- Screening for the existence of additional hotspots in areas that have not been sampled to date

A preliminary review of the data and lessons learned will be presented to the TRC in March 2016. A draft report on the study will be produced in October 2016, with December 2016 as the target due date for final report.

Information for addressing the other two priority needs (mass balance, and tracking of watershed management impacts) will be provided through other (generally more deterministically sited) studies and will not likely be ready at the time of reporting for this study. However, data from this study may help guide ongoing and future efforts in deterministically focused studies. Raw data from this sampling effort will also be reported via RMP web tools ([cd3.sfei.org](http://cd3.sfei.org)) and can be used for other purposes.

## **References**

Jones C, Yee D, Davis JA, McKee LJ, Greenfield BK, Melwani AR, Lent MA. 2012. Conceptual Model of Contaminant Fate on the Margins of San Francisco Bay. SFEI Contribution 663. San Francisco Estuary Institute, Richmond, CA.  
[http://www.sfei.org/sites/default/files/663%20Complete\\_Margins%20Conceptual%20Model.pdf](http://www.sfei.org/sites/default/files/663%20Complete_Margins%20Conceptual%20Model.pdf)



## Appendix

Table A-1. Coordinates of 33 planned non-Marin Central Bay sample sites, with additional potential oversample sites. Dropped sites marked in strikethrough text.

SiteCode	Longitude	Latitude	Comments
CB01	-122.382351	37.722188	
CB03	-122.310862	37.878131	
CB04	-122.277808	37.767614	
CB05	-122.38605	37.668048	Oyster Pt Marina - find an undredged spot?
<del>CB08</del>	<del>-122.273028</del>	<del>37.762812</del>	<del>Drop site, Alameda sandy shore</del>
CB10	-122.346692	37.906718	Richmond, Shimada Friendship Park, move shallower
CB12	-122.244206	37.748919	70m from shore, avoid channel
CB14	-122.326734	37.888461	
CB15	-122.303561	37.827887	
CB16	-122.218611	37.750283	San Leandro Bay open water, check depth
CB17	-122.385233	37.708896	
CB20	-122.24553	37.778948	
CB21	-122.387888	37.643081	
CB24	-122.248067	37.786283	
CB26	-122.399457	37.929034	Shoreline near long Chevron Pier
CB27	-122.308601	37.83772	Emeryville Marina, go shoreward either S/SE
CB28	-122.236739	37.74807	
CB30	-122.312071	37.892829	
CB31	-122.288496	37.794937	Oakland Inner Harbor. Shore ~30m away
CB32	-122.220437	37.756571	
CB33	-122.388045	37.680658	
<del>CB35</del>	<del>-122.421463</del>	<del>37.809089</del>	<del>Drop site, Boat dock, shore too far</del>

CB36	-122.255425	37.755244	Alameda coast - sandy beach?
CB37	-122.394541	37.641418	
CB38	-122.377097	37.901622	Bird Island breakwall?
<del>CB40</del>	<del>-122.284968</del>	<del>37.792394</del>	<del>Drop site, Oakland harbor tugboat dock</del>
CB42	-122.332335	37.905501	replacement site
CB43	-122.309408	37.829205	replacement site
CB44	-122.225184	37.749936	replacement site
CB45	-122.411946	37.943148	replacement site
CB46	-122.325568	37.899036	replacement site
CB47	-122.316663	37.793778	replacement site
CB48	-122.21561	37.742746	replacement site
CB49	-122.388918	37.776982	replacement site
CB52	-122.247018	37.750125	replacement site
CB53	-122.382614	37.62998	replacement site
CB54	-122.355094	37.907329	<b>First oversample site for NON-Marin only</b>
CB56	-122.29881	37.834659	
CB58	-122.330989	37.906875	
CB59	-122.303904	37.828478	
CB60	-122.220433	37.749028	
CB62	-122.308229	37.863738	
CB63	-122.327595	37.800313	
CB64	-122.214651	37.751254	

Table A-2. Coordinates of 7 planned Marin Central Bay sample sites, with additional potential Marin oversample sites. Dropped sites marked in strikethrough text.

SiteCode	Longitude	Latitude	Comments
<del>CB02</del>	<del>-122.469677</del>	<del>37.964118</del>	<del>Marin first 7 sites dropped</del>

CB06	-122.50429	37.937035	Marin first 7 sites dropped
CB07	-122.520554	37.885843	Marin first 7 sites dropped
CB09	-122.501168	37.932339	Marin first 7 sites dropped
CB11	-122.500579	37.890492	Marin first 7 sites dropped
CB13	-122.477658	37.917642	Marin first 7 sites dropped
CB18	-122.473296	37.976462	Marin first 7 sites dropped
CB19	-122.467395	37.867506	Marin
CB22	-122.499832	37.940228	Marin
CB23	-122.475494	37.886034	Marin
CB25	-122.499415	37.929527	Marin
CB29	-122.473718	37.91195	Marin Paradise Cay look for shoal?
CB34	-122.494303	37.966809	Marin
CB39	-122.507246	37.875809	Marin City houseboat dock? 100m from shore
CB41	-122.49279	37.925963	<b>First oversample site for Marin only</b>
CB50	-122.490542	37.966632	
CB51	-122.511609	37.887021	
CB55	-122.51132	37.883362	
CB57	-122.492512	37.92215	
CB61	-122.467885	37.984082	