Analysis of Pollutants in Sediment Cores Near Storm Water Inputs – Final Report

Prepared for the Clean Estuary Partnership

by
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Executive Summary

Previous studies had documented the existence of a small site at Stege Marsh on the Bay margin with extremely high PCB concentrations in sediments. If many such sites existed, removal of their sediment as part of a strategic dredging or remediation program could be an important implementation action under the PCB TMDL. This investigation was designed to address the feasibility of such actions by sampling depositional areas downstream of watershed sites considered potential sources of concentrated PCB discharges to the Bay.

Sample sites for this investigation were selected through a set of criteria established to prioritize sites based upon likelihood of deposition of sediments with relatively high concentrations of PCBs. Four-inch diameter cores were collected by the vibracoring technique using sample collection and cleaning procedures consistent with Regional Monitoring Program (RMP) standards. Seven sites spread throughout the Bay were sampled as part of the investigation: Delta Star, Steinberger Slough, Pulgas Creek, Moffett Channel, East Sunnyvale Creek, San Leandro Bay, and Miller Sweeney Bridge. One additional targeted site, Lockheed Channel, could not be sampled because Lockheed Martin refused to authorize sampling in a conveyance for which they hold a stormwater easement on property owned by the City of Sunnyvale. From the sites sampled, twenty-six cores were selected for PCB analysis, following RMP analytical procedures.

Only one of the twenty-six analyzed cores exhibited a concentration of ∑PCBs above 1000 μg/kg (parts per billion), core MC2 from Moffett Channel (1037 μg/kg). A second core, SL4 collected in San Leandro Bay, had a concentration of 870 μg/kg. All remaining analyzed samples fell below 500 μg/kg. By comparison, the maximum concentration found in a core collected at the Stege Marsh remediation site exceeded 60,000 μg/kg, while concentrations from the central channel of the estuary reported by the RMP have ranged from <1 μg/kg to 50 μg/kg.

This investigation next used the resultant concentrations from analyzed cores to produce estimates of the volume of sediments that would be needed to remove one kilogram of PCBs from the Bay. This was done to get an indication of the scale of dredging project that could be expected to achieve a certain mass of PCBs removed. Using the maximum concentration found in any one core at a particular site, estimates of the volumes ranged from a low of just over 1000 m^3 to a high of nearly 35,000 m^3 of sediment required to remove 1 kg of PCBs from the various sites.

SFRWQCB (2003) estimated a total mass of PCBs within San Francisco Bay of 18,000 to 52,000 kg, with the active layer encompassing a smaller mass depending on how it is defined. Based upon the results of this and previous investigations, a small-scale dredging project would not be expected to greatly alter the total mass of PCBs in the Bay. It could, however, have a positive effect on the local area surrounding a particular hotspot.

PCB concentrations found previously at an investigation in Stege Marsh, ranging to a maximum of 61,000 mg/kg, prompted initiation of this investigation to determine whether other sites with similarly high concentrations of PCBs exist within the margins of the Bay. Stege Marsh is unique compared to other sites reviewed for this investigation in a number of important areas, most notably in regard to the lack of tidal mixing at the areas of highest concentration. It is worth noting that concentration of PCBs in sediments collected just downstream of the Stege Marsh hotspots quickly drop off as distance from the outfall increases.

It is unrealistic to expect that previously unidentified sites with sediments of the magnitude of the Stege Marsh concentrations can be identified within the Bay. For example, the highest concentration of total PCBs identified by the Bay Protection and Toxic Cleanup Program, a sampling program targeting PCB hotspots, was just under 10 mg/kg, with only two of the 105 within-Bay sites exceeding 1 mg/kg total PCBs. The findings of this investigation along with the BPTCP suggest that use of small-scale within-Bay remediation projects would likely require a relatively large amount of remediation effort to account for a relatively small mass of PCBs removed from the Bay system.

1. Introduction

A possible implementation action contemplated for the PCB TMDL is removal of limited volumes of highly contaminated sediment to reduce the mass of PCBs in San Francisco Bay, as there is evidence that pockets of highly contaminated sediment exist along the margins of the Bay. For example, an assessment of PCB concentrations in sub-surface marsh sediments adjacent to a contaminated storm drain in Stege Marsh (near Richmond) detected a maximum concentration of 61,000 mg/kg total PCBs in bedded sediments (URS Corporation, 2002), a concentration one million times higher than measurements from RMP sites. Recent surveys of stormwater conveyances in the Bay Area have shown discrete areas with high concentrations (> 1 mg/kg) of PCBs (KLI & EOA, 2002; Salop et al., 2002) that could serve as sources of contaminated sediment to the Bay.

In the original Scope of Work, the stated objective of the project was to

> *Identify whether there are areas in the near-shore environment of San Francisco Bay where significant removal of polychlorinated biphenyls (PCBs) and other pollutants of concern (e.g., chlorinated pesticides, mercury) can be feasibly attained through strategic dredging, capping, or other approaches to isolating the sediments from the aquatic ecosystem.*

This investigation identified and sampled depositional areas downstream from areas potentially contributing a relatively high mass of PCBs to the Bay ("source areas"), to assess whether past or ongoing PCB discharges have resulted in small deposits of highly-polluted sediments similar to concentrations detected at Stege Marsh. If many of these sites exist, their removal could be an implementation action under the PCB TMDL. As designed, this project is not intended to identify all such hotspots in San Francisco Bay, nor is it intended to fully characterize the concentrations and distribution of PCBs at the sampled sites. Rather, it is intended to test the theory that relatively small pockets of highly polluted sediments exist at the Bay margins for which sediment removal could be an effective implementation tool.

The evaluation of whether small-scale dredging could provide an effective implementation action is a multi-step process. The steps involved with this initial phase of the project were to:

- Identify five to ten sites that meet qualitative project criteria
- Obtain required access and conduct sampling to provide PCB concentration data
- Collect bivalves for archive opportunistically, should later analysis be desired
- Collect duplicate cores for archive, should later analysis be desired
- Analyze laboratory data to determine next steps.

Should significant hotspots be identified during this investigation, follow-on investigations could be implemented to better characterize depth profiles and spatial extent.

As part of the sampling effort, sediment cores were collected from small trapping zones[1] at the Bay margins that are downstream from known or suspected source areas. Composite samples from the extent of the cores were analyzed to determine total PCB concentrations in the sediments. The original project scope of work called for samples to be analyzed for presence of other pollutants of concern (e.g., chlorinated pesticides, mercury). However, as the sites were not chosen based upon their likelihood of containing a significant mass of these pollutants, these analyses were dropped as a cost saving measure at the recommendation of the PCB Workgroup. This report summarizes sampling activities, laboratory results, and initial project findings.

2. Methods

The following sections describe procedures followed for site selection, sample collection, sample handling, and laboratory analysis.

2.1. Site Selection

AMS (2003) describes procedures followed for sampling program design. In brief, sites selected for this investigation were chosen based upon a set of criteria designed to identify sites that have a high likelihood of PCB-contaminated sediments. The criteria are as follows:

- Site should be downstream of a (natural or man made) stormwater conveyance thought to have transported a significant mass of PCBs from a known source area to the Bay margin
- Site should be within the Bay or in an area where sediments from the site could be transported to the Bay or adjacent to the Bay such that biotic transfer of PCBs to estuarine organisms could easily occur
- Site should be located so sediments are unlikely to be permanently cut off from Bay processes
- Site should be a sediment trapping zone
- Site should not be subject to regular dredging
- Site should be relatively small in size (to make clean-up actions feasible)
- Site should not be undergoing current clean-up or planned clean-up over short term; however, sites downstream from clean-up locations were considered appropriate.

An overview of sampling sites is shown in Figure 1.

[1] For this study, trapping zones are defined as areas where fine materials tend to accumulate and are not regularly scoured, but are not isolated from reaching the Bay. This criterion ensures that sampled sediments will contain finer materials that are more likely to adsorb PCBs than larger materials.

Figure 1. Overview of PCB Coring Sites. Basemap property of USGS.

2.2. Sampling Methods

2.2.1. Mobilization and Laboratory Cleaning of Compositing Equipment

Compositing equipment was prepared in the laboratory a minimum of four days prior to sampling. Cleaning methods follow protocols adapted from the NOAA National Status and Trends Program for use by the Regional Monitoring Program for Trace Substances in the San Francisco Estuary (Bell et al., 1999). Equipment cleaned included:

- Kynar-coated sample scoops
- Kynar-coated compositing bucket
- Teflon wash bottles for deionized water, hydrochloric acid, and methanol.

Prior to sampling, all compositing equipment was soaked (fully immersed) for three days in a solution of Liquinox™ detergent and deionized water. Equipment was next rinsed successively with deionized water, a 1.0 % solution of hydrochloric acid, petroleum ether, and deionized water again. All equipment was then allowed to dry in a clean place, then wrapped in aluminum foil until used in the field.

2.2.2. Mobilization and Laboratory Cleaning of Vibracoring Equipment

Butyrate core liners utilized for core sample collection were steam cleaned and capped for delivery to sampling sites by TEG Oceanographic Services of Santa Cruz, CA. On site, butyrate liners were cut into four foot sections using a saw cleaned with detergent, deionized water, hydrochloric acid, and petroleum ether and capped until sample collection.

2.2.3. Sampling Procedures

The number of coring locations at each site varied between two and six according to the hydrology/geography of each site and expected likelihood of gross contamination. Where possible, duplicate cores (one for analysis, one for archive) were collected from each sampling location within a site. Each of the two cores collected at the coring locations (analysis and archive) was taken as close together as possible so to minimize spatial variation.

Four-inch diameter cores were collected by the vibracoring technique by TEG Oceanographic Services. Cores were collected from either a shallow draft vessel (Figure 2) or from shore (Figure 3), as appropriate. The core liners were cleaned on-site with native water prior to sample collection. Cores for analysis were extruded into a clean, Kynar-coated, stainless steel bucket and thoroughly homogenized, then aliquoted into two 500 mL factory-cleaned glass containers with Teflon-lined lids supplied by the analytical laboratory.

Where possible, entire four-foot cores were composited, from which one sample was dedicated for laboratory analysis and a second collected for an archive composite. At locations where four-foot penetration could not be achieved, either a shorter core was collected or a different sampling location was selected at the discretion of the sampling

Figure 2. Coring Equipment Being Deployed from a Shallow Draft Vessel within San Leandro Bay

team. The duplicate cores were sliced into two-foot sections, capped, labeled, and frozen as an archive (archives were divided to allow for ease in handling, storage, and possible future shipping). This approach makes it possible to perform an initial screening on each core, but allows subsequent analysis of the archived cores on a finer scale if desired.

All sampling equipment was rinsed with native water between uses at different coring locations within a site. All compositing equipment used at a particular sampling site was field-cleaned prior to use at a different coring location. The field-cleaning protocol calls for the following steps:

- remove sediments using native water and a scrub brush
- scrub compositing equipment with an Liquinox™ (or similar) solution
- rinse with dilute HCl
- rinse with methanol
- rinse with deionized water.

Field notes/data sheets were completed for each site, and included at a minimum: date, names of crewmembers, narrative description of the sampling site (general location), depth of penetration by core, and sampling coordinates.

Figure 3. Coring Equipment Being Deployed via Forklift at East Sunnyvale Creek

2.2.4. Sample Handling Procedures

At the conclusion of sample processing at each sampling site, all samples were stored on dry ice in the field. At the conclusion of sampling days, all samples were refrigerated or frozen overnight. At appropriate intervals, samples were distributed to the analytical laboratory via overnight delivery, with itemized chain-of-custody forms. At the conclusion of field efforts, archives were delivered to a cold storage facility, Schaefer's Cold Storage in Oakland, and were maintained between –17º C and –20º C indefinitely.

2.3. Analytical Methods

All analyses were performed by Columbia Analytical Services of Kelso, WA (CAS). All samples were sieved in the laboratory at 2 mm prior to analysis, per National Water Quality Assessment (NAWQA) procedures (Shelton, et al., 1994) and consistent with previous BASMAA sediment sampling programs (KLI and EOA, 2002; Salop et al., 2002). PCB congeners were analyzed via EPA Method 8082, with all results reported as IUPAC congeners using the RMP list of 40 congeners. TOC was analyzed via EPA Method 415.1. Grain size was analyzed using ASTM D422M/PSEP with peroxide digestion/phi size distinction.

In order to quantify data quality, the quality assurance program included use of method blanks, laboratory replicates (DUP, TRIP), matrix spikes (MS), duplicate matrix spikes (DMS), laboratory control samples (LCS), surrogate spikes, and standard reference materials (SRM). All analyses were performed by batch, with the total number of field samples not to exceed twenty samples per batch.

3. Results

The following sections describe analytical results, data quality, and spatial variability.

3.1. Concentrations of PCBs in Core Composites

A total of seven sites were sampled through this investigation. Samples were collected in two distinct phases. Phase I, conducted August 11 - 15, 2003 focused upon cores best collected via vessel with access from the Bay. Phase II, conducted from November 3 - 7, 2003, focused upon cores best collected via overland access.

Composites created from each of twenty-six individual cores were delivered to CAS for analysis (Table 1). Results for all analyses are summarized in Table 2, and shown relative to location of core placement in Figures 4 through 9. Figures 10 through 12 present dry weight PCB concentrations for three conditions, raw data, data normalized to TOC, and data normalized to percent fines, respectively. While reviewing the results, it is informative to keep in mind that PCB concentrations in sediment collected from the central channel of the estuary reported by the RMP have ranged from <1 μg/kg to 50 μg/kg. (SFEI, 2003).

Table 1. Description of Cores Collected and Analyzed Through CEP Vibracoring Project.

Site	Core	Date	Lat	Long	Core Depth (ft)	Comments
Steinberger Slough / Delta Star	ST-1	8/12/03	37.5206	122.2490	4	Downstream of holding pond
Steinberger Slough / Delta Star	ST-2	8/12/03	37.5208	122.2484	4	"
Steinberger Slough / Delta Star	ST-3	8/12/03	37.5212	122.2484	4	"
Steinberger Slough / Delta Star	DS-1	11/03/03	37.5185	122.2503	3.75	Within holding pond
Steinberger Slough / Delta Star	DS-2	11/03/03	37.5204	122.2501	3.16	"
Steinberger Slough / Delta Star	DS-3	11/03/03	37.5208	122.2506	3.08	"
Miller Sweeney Bridge	MSB-1	8/15/03	37.7669	122.2295	1	At outfall, large substrate
Miller Sweeney Bridge	MSB-2	8/15/03	37.7669	122.2296	1	4 m from outfall, large substrate
Pulgas Cr	PG-1	8/13/03	37.5077	122.2446	4	Confluence with Steinberger Slough
Pulgas Cr	PG-2	8/13/03	37.5059	122.2450	3	Compact sediments
Pulgas Cr	PG-3	8/13/03	37.5068	122.2452	4	
Pulgas Cr	PG-4	8/13/03	37.5072	122.2447	3.75	
San Leandro Bay	SL-1	8/14/03	37.7596	122.2185	4	N. side of creek mouth
San Leandro Bay	SL-2	8/14/03	37.7597	122.2180	3.33	
San Leandro Bay	SL-4	8/14/03	37.7508	122.2233	3.33	
San Leandro Bay	SL-5	8/14/03	37.7602	122.2171	4	Downstream of pedestrian bridge
E. Sunnyvale Cr.	SC-1	11/07/03	37.4181	122.0032	3.5	Between Caribbean Dr. and footbridge, taken from west bank of stream
E. Sunnyvale Cr.	SC-2	11/07/03	37.417	122.0033	3	"
E. Sunnyvale Cr.	SC-3	11/07/03	37.4162	122.0036	4	"
E. Sunnyvale Cr.	SC-4	11/07/03	37.415	122.0038	3.5	"
Moffett Channel	MC1	11/05/03	37.4195	122.0133	3.16	Eastern extent of Moffett Channel, upstream of outflow scour
Moffett Channel	MC2	11/05/03	37.4196	122.0133	3.5	"
Moffett Channel	MC3	11/05/03	37.4197	122.0135	3.75	"
Moffett Channel	MC4	11/05/03	37.4196	122.0144	3.16	"
Moffett Channel	MC5	11/06/03	37.4204	122.0175	2.58	Western extent of Moffett Channel
Moffett Channel	MC6	11/06/03	37.4204	122.0173	3	Western extent of Moffett Channel

Table 2. Analytical Results for 2003 CEP Vibracoring Project. PCB concentrations reported on a dry weight basis.

Site	Total Solids (%)	TOC (%)	% Fines	∑PCBs, ND=0 (µg/kg)	∑PCBs, ND=MDL/2 (µg/kg)
ST-1	44	2.59	58	4	7
ST-2	47.8	1.73	58	39	42
ST-3	39.1	1.79	53	150	159
DS1	48	1.59	81	5	8
DS2	47.2	1.72	86	37	40
DS3	44.1	1.72	88	16	19
MSB-1	78.9	0.36	2	5	9
MSB-2	74.5	1.44	20	41	48
PG-1	42.5	1.75	59	4	8
PG-2	59	1.01	48	31	33
PG-3	71.2	1	53	4	6
PG-4	52.8	1.78	52	238	259
SL-1	52.5	3.19	61	84	90
SL-2	59.4	1.67	47	266	301
SL-4	50.9	2.09	52	870	887
SL-5	55.3	2.13	54	84	90
SC1	43.5	2.04	87	57	67
SC2	49.1	1.68	45	28	42
SC3	50.3	16.1	47	39	52
SC4	39.4	1.75	44	32	38
MC1	52.4	1.33	39	249	278
MC2	46.7	1.89	76	1037	1176
MC3	43.2	1.94	58	281	309
MC4	39.2	1.58	63	109	121
MC5	49	2.15	68	195	252
MC6	44.5	1.99	71	105	118

Figure 4. Coring Locations and Relative PCB Concentrations (*µ*g/kg) at Steinberger Slough / Delta Star Site.

Figure 5. Coring Locations and Relative PCB Concentrations (*µ*g/kg) at Miller Sweeney Bridge Site. Core location markers were adjusted manually to better represent actual coring locations relative to channel.

Figure 6. Coring Locations and Relative PCB Concentrations (*µ*g/kg) at Pulgas Creek Site

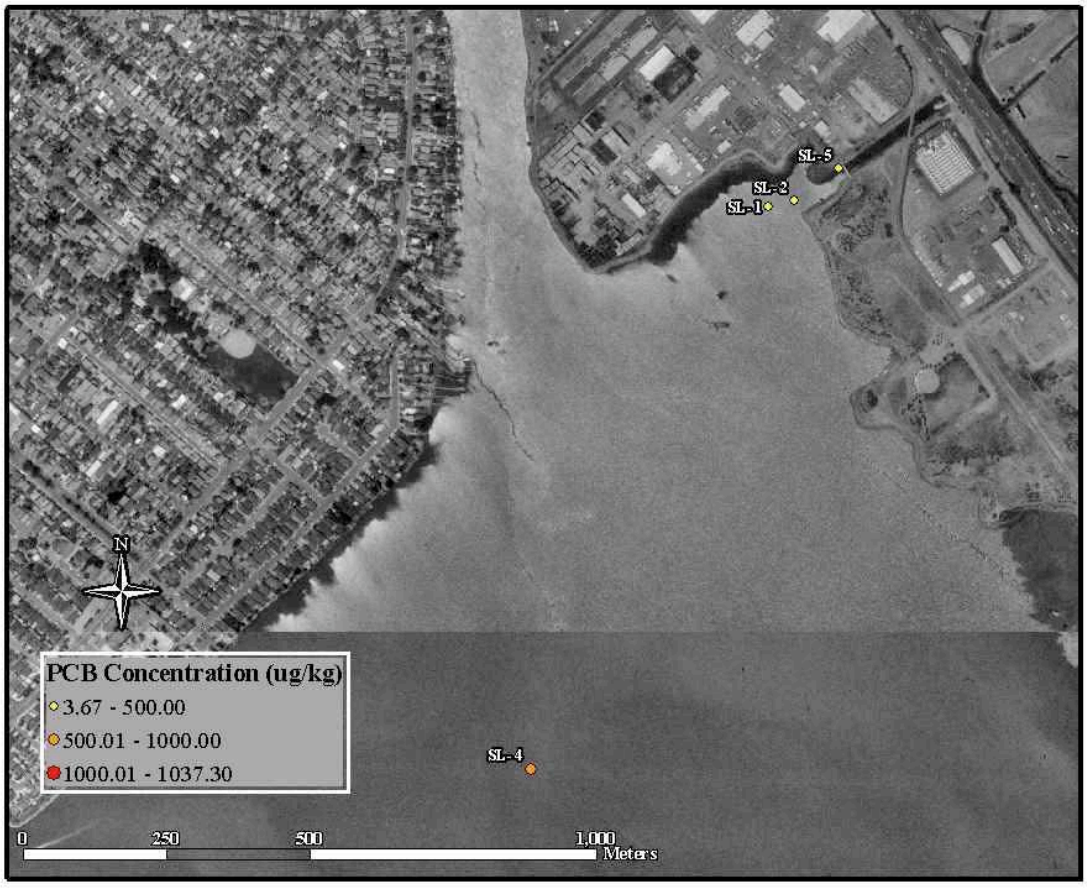

Figure 7. Coring Locations and Range of PCB Concentrations (μg/kg) in San Leandro Bay. Location of core SL-4 corresponds closely to core B8cz3 collected by Daum, et al., 2000, which showed a total PCB concentration of 1716 μg/kg.

Figure 8. Coring Locations and Relative PCB Concentrations (*µ*g/kg) at East Sunnyvale Creek Site

Figure 9. Coring Locations and Relative PCB Concentrations (*µ*g/kg) at Moffett Channel Site

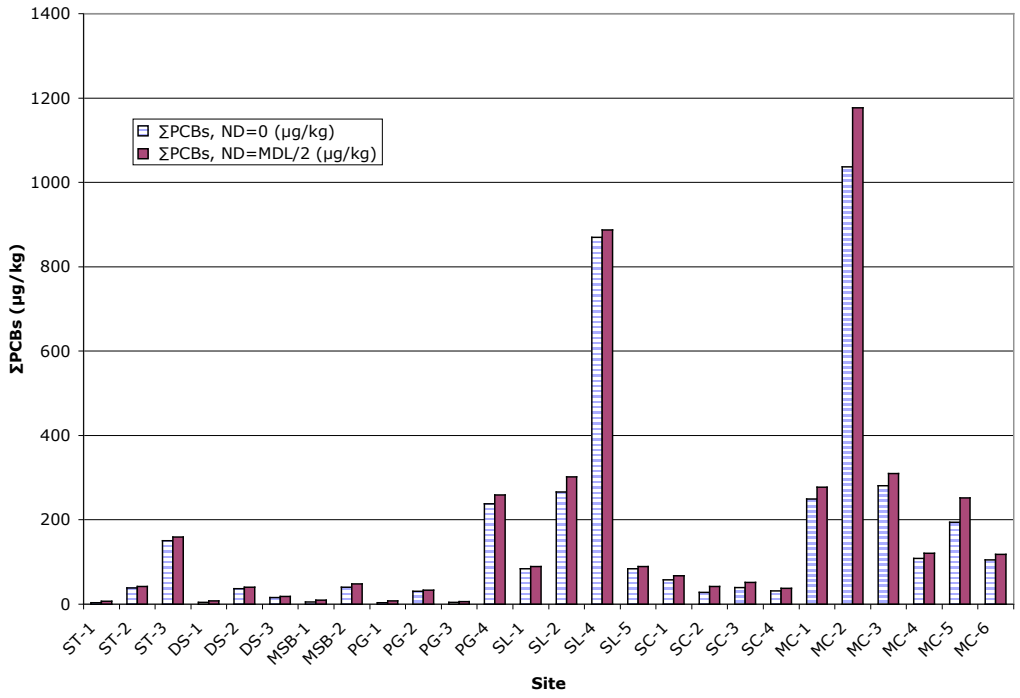

Figure 10. Total PCBs by Sample. Results are calculated for two conditions, with non-detects set to 0 μg/kg (hatched) and half the method detection limit (solid).

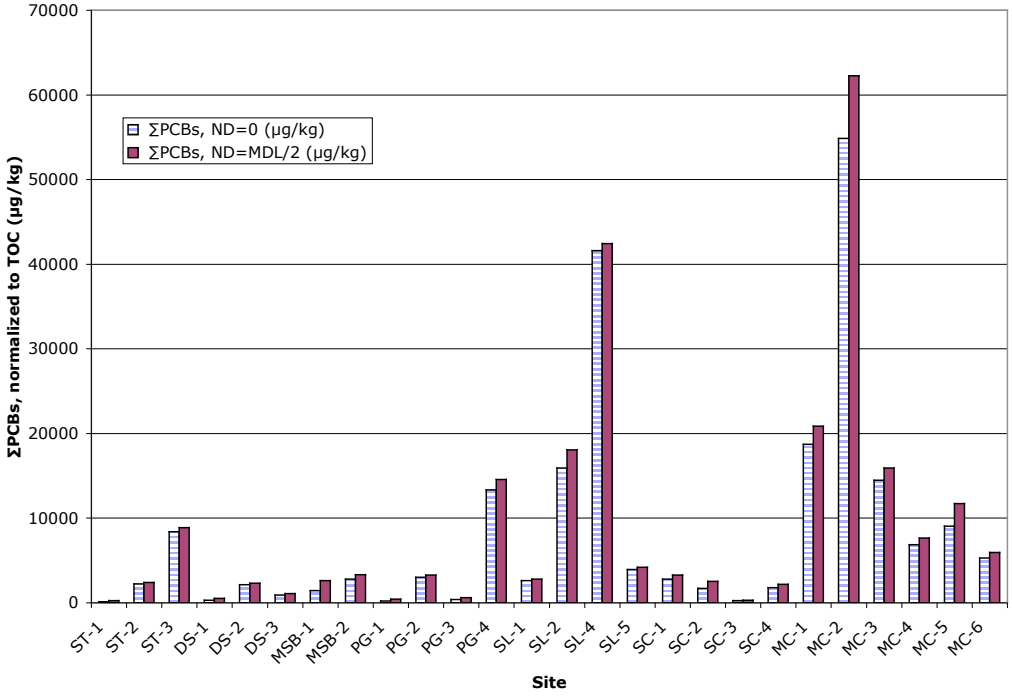

Figure 11. Total PCBs by Sample, Normalized to TOC. Results are calculated for two conditions, with non-detects set to 0 μg/kg (hatched) and half the method detection limit (solid).

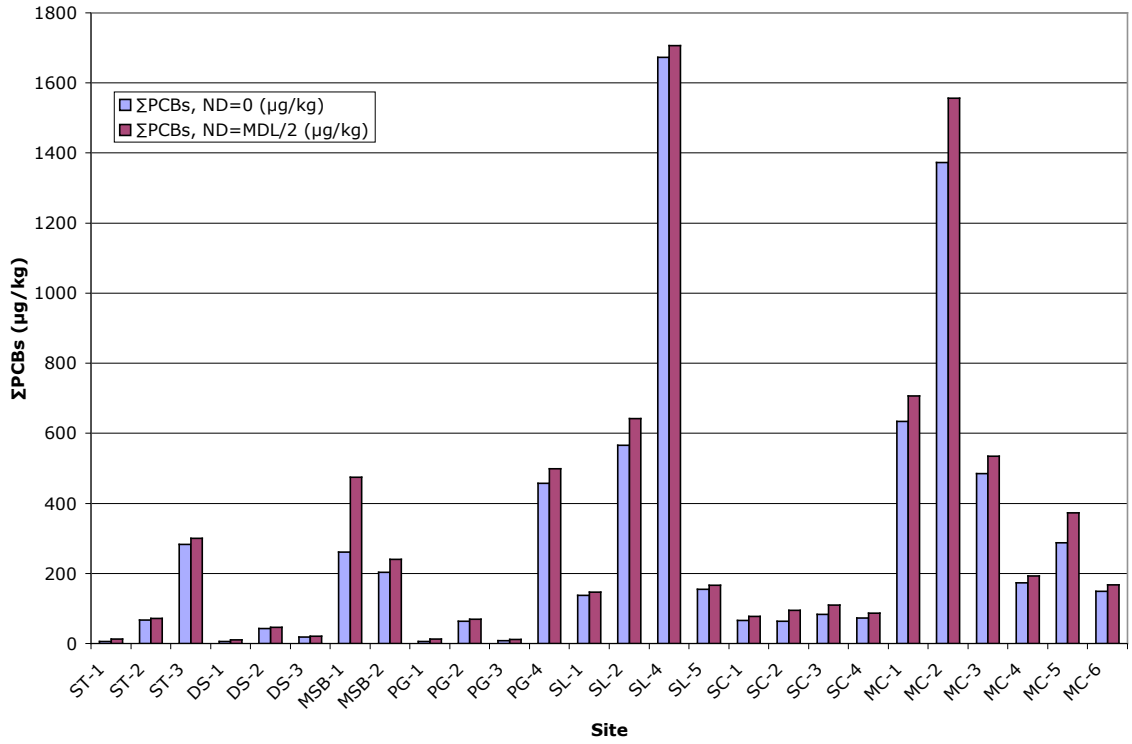

Figure 12. Total PCBs by Sample, Normalized to Fines. Results are calculated for two conditions, with non-detects set to 0 μg/kg (hatched) and half the method detection limit (solid).

3.2. Data Quality

In general, results for all analytes fell within primary acceptance criteria for data validation per the CAS Quality Assurance Project Plan (CAS, Inc., 2002). In a few cases, however, specific PCB congeners are known to co-elute and therefore cause a matrix interference with OC pesticides (and vice versa). Analysis of a subset of PCB congeners therefore required alternative evaluation criteria to verify data quality. QA case narratives for Phase I samples (Batch K2307340, samples collected August 2003) and Phase II samples (Batch K2308912, samples collected November 2003) are shown in Appendix A.

3.3. Spatial Variation

Results of this investigation suggest that a large degree of spatial variation over a small scale is possible but not present in all cases. The most consistent concentrations found at one site were found in the four cores collected from East Sunnyvale Creek, where total PCBs ranged from a minimum of 38 μg/kg to a maximum of 67μg/kg. At the most extreme case, in the four samples collected from Pulgas Creek, the minimum and maximum concentrations exhibited two orders of magnitude difference, 6 μg/kg and 259 μg/kg, respectively.

4. Discussion

The following sections translate the concentrations presented in Section 3 into estimates of dredging volumes required to remove a specific mass of PCBs. Additionally, implications of the findings of this investigation for locating other Stege Marsh-type concentrations at Bay nearshore locations are also discussed.

4.1. Calculation of Pollutant Mass Associated with Example Dredging Projects

The maximum and average concentrations for an individual core at each location were used to estimate the mass and volume of sediments required to remove 1 kg of PCBs at each site (Table 3 and Table 4, respectively). This analysis uses the same methodology for conversion of a mass of sediments to a volume as used for the PCBs TMDL (SFBRWQCB, 2003):

$$V_t = M_s\left[1 + x\left(\rho_w/\rho_s - 1\right)\right]/\left(x\rho_w\right)$$

where:

V_t = volume of sediments in L
M_s = dry mass of sediments in kg
x = percent solids per unit mass sediment (assumed to be 50%)
ρ_w = density of water (1 kg/L)
ρ_s = density of sediments (2.65 kg/L for aluminosilicates)

Table 3. Calculation of Sediment Mass and Volume Required to Remove One Kilogram of PCBs from Each Site Sampled. Calculations are based upon maximum concentration of total PCBs in one composite collected at each site.

Site	No. Cores	∑PCBs, Max (μg/kg)	Mass Sed (kg)	Volume Sed (m^3)
Steinberger Slough	3	159	6287726	8660
Delta Star	3	40	24906600	34305
Miller Sweeney Bridge	2	48	20820754	28678
Pulgas Creek	4	259	3859886	5316
San Leandro	4	887	1127269	1553
East Sunnyvale Creek	4	67	14937524	20574
Moffett Channel	6	1176	850015	1171

Table 4. Calculation of Sediment Mass and Volume Required to Remove One Kilogram of PCBs from Each Site Sampled. Calculations are based upon average concentration of total PCBs from each composite collected at each site.

Site	No. Cores	∑PCBs, Avg (μg/kg)	Mass Sed (kg)	Volume Sed (m^3)
Steinberger Slough	3	69	14436750	19885
Delta Star	3	22	44812237	61723
Miller Sweeney Bridge	2	29	34773235	47895
Pulgas Creek	4	77	13063485	17993
San Leandro	4	342	2924768	4028
East Sunnyvale Creek	4	50	20096665	27680
Moffett Channel	6	376	2660625	3665

It should be noted that at smaller sites, especially Pulgas Creek and East Sunnyvale Creek, removing the calculated volumes of sediment is not possible without significantly altering the hydrologic and physical characteristics of the site.

SFBRWQCB (2003) estimated a total mass of PCBs within San Francisco Bay of 18,000 to 52,000 kg, with the active layer encompassing a smaller mass depending on how it is defined. Based upon the results of this and previous investigations (Hardin, 2003), a small-scale dredging project would not be expected to greatly alter the total mass of PCBs in the Bay. It could, however, have an impact on the local area surrounding a particular hotspot.

PCB concentrations found previously at Stege Marsh, ranging to a maximum of 61,000 mg/kg at one site (URS, Inc., 2002), prompted initiation of this investigation to determine whether other sites with similarly high concentrations of PCBs exist within the margins of the Bay. We are able to say that Stege Marsh is unique compared to other sites reviewed for this investigation for the following reasons. The sediments associated with the maximum concentrations were collected from a depositional environment located directly below an outfall into the marsh. While at the Bay margins, this site was in fact above tidal influence and therefore not susceptible to regular dispersion of sediment-associated pollutants associated with tidal processes. It is worth noting that sediments collected just downstream of this location quickly drop off as distance from the outfall increases (e.g., maximum concentrations of 45 mg/kg at a point just before the confluence with Meeker Slough, and 0.64 mg/kg and 0.45 mg/kg at varying depths at two tidally-influenced points just downstream within Meeker Slough) [URS, Inc., 2002; URS, Inc., 2000].

It is unrealistic to expect that previously unidentified sites with sediments of the magnitude of the Stege Marsh maximum concentrations can be identified within the Bay. For example, the highest concentration of total PCBs identified by the Bay Protection and Toxic Cleanup Program, a sampling program targeting PCB hotspots, was just under 10 mg/kg, with only two of the 105 within-Bay sites exceeding 1 mg/kg total PCBs.[2] The

[2] Calculated as the sum of 36 congeners that form a subset of the RMP list of 40. Congeners not quantified include PCB33, PCB56, PCB60, and PCB141.

findings of this investigation along with the BPTCP suggest that use of small-scale within-Bay remediation projects would likely require a relatively large amount of remediation effort to account for a relatively small mass of PCBs removed from the Bay system.

4.2. Inability to Sample All Targeted Sites

The site targeted within this investigation that most closely resembles the Stege Marsh conditions is that of the Lockheed Channel. This site is downstream of a site with known PCB contamination, is depositional in nature, and is isolated from tidal influence by an embankment and tide gate. However, investigators for this project were unable to obtain permission to sample the Lockheed Channel within the time constraints of the project.

Access to Lockheed Channel was requested of the City of Sunnyvale, the property owner, beginning in August 2003. Access to the property was granted by the City, but was contingent upon agreement from Lockheed to enter the proposed sampling area, as Lockheed has easement to this City property. In October 2003, Lockheed declined to write a letter of agreement, stating that Lockheed was concerned that the CEP is "testing a theory" with this study, that "site selection seems very subjective," and that since the US Navy is currently looking for permission to sample the same general area for PCBs, Lockheed and Sunnyvale do not want to spread time and resources thin in granting two separate permits to sample the area.

Access to the adjacent Moffett Northern Channel also proved difficult, as ownership of the eastern extent of the channel is in dispute. Possible owners include Cargill Salt, Santa Clara Valley Water District, and City of Sunnyvale. This issue has not been resolved. However, as Moffett Northern channel is scheduled for complete dredging in 2005 (Scott Gromko, Navy Study Manager, personal communication), the site was dropped from the list of targeted sampling areas.

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Appendix A – Laboratory Quality Assurance Case Narratives

COLUMBIA ANALYTICAL SERVICES, INC.

Client:	Applied Marine Sciences	**Service Request No.:**	K2307340
Project:	CEP Newshore Sediment Coring	**Date Received:**	9/23/03
Sample Matrix:	Sediment		

CASE NARRATIVE

All analyses were performed consistent with the quality assurance program of Columbia Analytical Services, Inc. (CAS). This report contains analytical results for samples designated for Tier III validation deliverables including summary forms and all of the associated raw data for each of the analyses. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Thirteen sediment samples were received for analysis at Columbia Analytical Services on 9/23/03. Minor discrepancies were noted upon initial sample inspection. Additional details about the exceptions are noted on the cooler receipt and preservation form included in this data package. All remaining samples were received in good condition and consistent with the accompanying chain of custody. The samples for grainsize analysis were stored in a refrigerator at 4°C; all other samples were stored frozen at –20°C upon receipt at the laboratory.

General Chemistry Parameters

No anomalies associated with the analysis of these samples were observed.

PCB Congeners by EPA Method 8082

Elevated Method Reporting Limits:
Samples SL-1, SL-2, and SL-4 required dilution due to the presence of elevated levels of target analyte. The reporting limits are adjusted to reflect the dilution.

The reporting limit is elevated for several analytes in all samples. The chromatogram indicated the presence of non-target background components. The matrix interference prevented adequate resolution of the target compounds at the reporting limit. The results are flagged to indicate the matrix interference

Sample Confirmation Notes:
The confirmation comparison criteria of 40% difference for PCB 153 was exceeded in sample ST-1, PCB 97, PCB 201, PCB 170 in sample ST-2, PCB 97, PCB 158 and PCB 203 in sample ST-3, PCB 110 in sample MSB-1, PCB 44, PCB 151, PCB 156, and PCB 203 in sample MSB-2, PCB 18, PCB 97, PCB 151, PCB 194, and PCB 203 in sample PG-2, PCB 18, PCB 74, PCB 97, PCB 203, and PCB 170 in sample PG-4, PCB 8, PCB 18, PCB 44, PCB 74, PCB 110, PCB 151, PCB 183, and PCB 194 in sample SL-1, PCB 97, PCB 18, and PCB 203 in sample SL-2, and PCB 128, PCB 151, PCB 183, and PCB 203 in sample SL-4, PCB 18, PCB 33, PCB 74, PCB 151, PCB 95, PCB 158, and PCB 170 in SL-5. The higher of the two values is reported because no evidence of a matrix interference was observed.

The confirmation comparison criteria of 40% difference for PCB 132 in sample ST-3, PCB 128 in sample MSB-2, PCB 95 in sample PG-2, PCB 158 in sample SL-2, and PCB 31, PCB 170, PCB 201 in sample SL-4. The lower of the two values was reported because of an apparent interference on the alternate column that produced the higher value.

For several analytes, the confirmation comparison criteria are not applicable because at least one of the values is below the Method Reporting Limit (MRL).

Approved by _____ **Date** 11/4/03

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Matrix Spike Recovery Exceptions:
The recovery of PCB 18 in the Batch QC Duplicate Matrix Spike KWG031578-2 was outside the control limits listed in the results summary. The limits are default values temporarily in use until sufficient data points are generated to calculate statistical control limits. Based on the method and historic data, the recoveries observed are in the range expected for this procedure. No further corrective action was taken.

The matrix spike recoveries of PCB 44, PCB 52, PCB 66, PCB 87, PCB 158, and PCB 183 in Matrix Spike KWG0316697-1 and Duplicate Matrix Spike KWG0316697-2 for sample SL-4 was outside control criteria, Recovery in the Laboratory Control Sample (LCS) was acceptable, which indicates the analytical batch was in control. The matrix spike outlier suggests a potential bias in this matrix. No further corrective action was appropriate.

The control criteria for matrix spike recoveries of PCB 101, PCB 118, PCB 138, and PCB 153 in Matrix Spike KWG0316697-1 and Duplicate Matrix Spike KWG0316697-2 for sample SL-4 are not applicable. The analyte concentration in the sample was significantly higher than the added spike concentration, preventing accurate evaluation of the spike recovery.

Lab Control Sample Exceptions:
The advisory criterion was exceeded for the following analyte in Laboratory Control Samples (LCS) KWG0315178-3 and KWG0316697-3: PCB 18. As per the CAS/Kelso Standard Operating Procedure (SOP) for this method, this compound is not included in the subset of analytes used to control the analysis. The recovery information reported for this analyte is for advisory purposes only (i.e. to provide additional detail related to the performance of each individual compound). No further corrective action was required.

The Standard Reference Material (SRM) 1944 was outside the advisory limits for PCB 87 and PCB 156. Results for the Laboratory Control Sample (LCS) are within acceptance criteria, and no further corrective action was required.

Second Source Exceptions:
The analysis of Congener Specific PCBs by EPA 8082 requires the use of dual column confirmation. When the Initial Calibration Verification (ICV) criteria are met for both columns, the higher of the two sample results is generally reported. The primary evaluation criteria were not met on the confirmation column for PCB 28 and PCB 31 in CAL 2926. The ICV results are reported from the acceptable column. The data quality is not affected. No further corrective action was necessary.

Continuing Calibration Verification Exceptions:
The primary evaluation criterion was exceeded for the following analytes in Continuing Calibration Verification (CCV) 1003F004 and 1003F018: PCB 31. In accordance with CAS standard operating procedures, the alternative evaluation specified in the EPA method was performed using the average percent recovery of all analytes in the verification standard. The standard meets the alternative evaluation criteria.

The upper control criterion was exceeded for the following analytes in Continuing Calibration Verification (CCV) 1003F032: PCB 31. The field samples analyzed in this sequence did not contain the analyte in question. Since the apparent problem equates to a potential high bias, the data quality is not affected. No further corrective action was required.

No other anomalies associated with the analysis of these samples were observed.

Approved by _____ **Date** 11/4/05

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COLUMBIA ANALYTICAL SERVICES, INC.

Client:	Applied Marine Sciences	**Service Request No.:**	K2308912
Project:	CEP Newshore Cores	**Date Received:**	11/11/03
Sample Matrix:	Sediment		

CASE NARRATIVE

All analyses were performed consistent with the quality assurance program of Columbia Analytical Services, Inc. (CAS). This report contains analytical results for samples designated for Tier III validation deliverables including summary forms and all of the associated raw data for each of the analyses. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Twelve sediment samples were received for analysis at Columbia Analytical Services on 11/11/03 in good condition and consistent with the accompanying chain of custody form (a minor labeling discrepancy was noted). Upon receipt at the laboratory, the samples received for grainsize were stored in a refrigerator at 4°C, while the samples received for all other analyses were stored frozen at –20°C.

General Chemistry Parameters

No anomalies associated with the analyses in this batch were observed.

PCB Congeners by EPA Method 8082

Elevated Method Reporting Limits
The reporting limit is elevated for a few analytes in all samples. The chromatogram indicated the presence of non-target background components. The matrix interference prevented adequate resolution of the target compound(s) at the reporting limit. The results are flagged to indicate the matrix interference.

Sample Confirmation Notes
The confirmation comparison criteria of 40% difference for several analytes were exceeded in the samples in this SDG. The higher of the two values is reported when no evidence of a matrix interference was observed or the lower of the two values was reported when an apparent interference on the alternate column produced the higher value. No further corrective action was feasible.

Sample results flagged JP: The confirmation comparison criteria are not applicable because at least one of the values is below the Method Reporting Limit (MRL).

Matrix Spike Recovery Exceptions
The control criteria for the recovery of PCB 87 for the MS performed on sample MC5 is not applicable. The analyte concentration in the sample was significantly higher than the added spike concentration, preventing accurate evaluation of the spike recovery.

The control criteria for the matrix spike recoveries of PCB 66, PCB 60, PCB 105, and PCB 158 for the MS and DMS performed on sample MC5 were not applicable. The chromatograms indicate non-target matrix background components are contributing to the reported matrix spike concentrations, thus the reported recoveries contain a high bias. Based on the magnitude of background contribution, the interference appears to be minimal. Also note the Method Reporting Limit (MRL) for the associated unspiked sample is elevated above the background level.

Approved by _____ **Date** 12/19/03

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Standard Reference Material (SRM) Notes
The SRM 1944 is outside the advisory limits for PCB 87. Results for the Laboratory Control Sample (LCS) are within acceptance criteria. The LCS is used to control analytical batches. No further corrective action was taken.

Continuing Calibration Verification (CCV) Exceptions
The primary evaluation criterion was exceeded for the following analytes in CCV 1126F027: PCB 28 and PCB 33; CCV 1126R027: PCB 66; CCV 1126F038: PCB 28, PCB 33, PCB 194, PCB 66, and PCB 177. In accordance with CAS standard operating procedures, the alternative evaluation specified in the EPA method was performed using the average percent recovery of all analytes in the verification standard. The standard meets the alternative evaluation criteria.

Results for the following analytes: PCB 66 in sample MC6, MC5MS, and MCDMS have been reported from a column using average percent recovery of all analytes in the verification standard.

Approved by UL **Date** 12/9/03

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