Item 6 - Budget Summary of Special Studies

	Available funding
TOTAL AVAILABLE	**$678,700**
Remaining after PS (W/ S&T Water Chemistry)	**-$770**
Additional funding if S&T water chemistry is not undertaken (chemistry/logistics)	$200,000
Remaining after PS (W/O Water Chemistry)	**$199,230**
PROPOSED PILOT AND SPECIAL STUDIES	**2012**
1. Dioxins: 2012 Dioxins Studies: Sport Fish, Bird Eggs, Surface Sediment, and Tributary Waters	$119,470
2. EC: Synthesis Report on Contaminants of Emerging Concern in San Francisco Bay	$15,000
3. EC: Monitoring Perfluorinated Compounds in SF Bay Biota	$87,000
4. STLS: Develop and Update Spreadsheet Model - Year 3	$20,000
5. STLS: Stormwater Loads Monitorng in Representative Watersheds	$328,000
6. STLS: POC Loads Monitoring – Land use/source area specific EMC development	$80,000
7. EE: Hotspot Followup - Year 2	$30,000
EE Synthesis of SQO Drivers (TBD - no study included in package)	not funded
CFWG Forecasting (TBD - no study included in package)	$100,000*
Nutrients (TBD - no study included in package)	$100,000*
Total	**$679,470**

* funding contingent upon cost savings from S&T

PS/SS: 2012 Dioxins Studies: Sport Fish, Bird Eggs, Surface Sediment, and Tributary Waters

Estimated Cost: $119,470
Oversight Group: Dioxin Strategy Work Group
Proposed by: Susan Klosterhaus and Don Yee, SFEI

Background

San Francisco Bay was placed on the State of California's 303(d) list of impaired waterways in 1998 as a result of elevated concentrations of chlorinated dioxins and furans (commonly referred to as only 'dioxin') in fish. RMP studies of contaminants in Bay sport fish conducted every three years since 1994 have found that dioxin concentrations have remained relatively unchanged over this time period and in some species, continue to exceed screening values for human consumption. Our understanding of dioxin in the Bay is extremely limited however and improving this is a necessary first step in the process to reduce concentrations in Bay fish and resultant health risks to fish-eating humans and wildlife.

Strategy Update

A dioxin strategy was developed in 2008 to ensure that the RMP is providing information that is of highest value and most urgently needed by managers for development of a dioxin TMDL (see attached revised Table). An update on the status of the strategy elements is listed below:

Sample Design Element	**Status**
Quality assurance project plan (QAPP)	Completed
2009 Sport fish	Completed
2008 surface sediment (dry season sampling)	Data received; Undergoing QA Review
2009 surface sediment (dry season sampling)	Completed
2010 surface sediment (wet season sampling)	Data received; Undergoing QA Review
Sediment cores	Samples at lab
2009 in-bay surface water	Completed
2011 in-bay surface water	To be collected September 2011
2010 tributary waters (Zone 4 Line A, Guadalupe River, Mallard Island)	Completed
Atmospheric deposition modeling	In prep; anticipated completion Fall 2011
One-box and food web models	Scheduled for 2014

Strategy Questions for Dioxin

The following priority questions were developed for obtaining information on dioxin in the Bay at the 2008 Dioxin Strategy meeting:

1. Are the beneficial uses of San Francisco Bay impaired by dioxins?

2. What is the spatial pattern of dioxin impairment?

3. What is the dioxin reservoir in Bay sediments and water?

4. Have dioxin loadings/concentrations changed over time?

5. What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?

6. What future impairment is predicted for dioxins in the Bay?

Study Objectives

Following the RMP Dioxin Strategy, the analysis of dioxins in Bay sport fish, bird eggs, surface sediment, and tributary waters are proposed studies for 2012.

Sport Fish ($23,920)

Dioxins will be analyzed in 20 samples of white croaker and shiner surfperch collected from popular fishing areas in the Bay as part of S&T monitoring. White croaker and shiner surfperch were selected because their PCB and dioxin concentrations were higher than other Bay species in previous years, they are commonly caught in near shore areas by Bay anglers, and they are the main indicator species used in the PCB TMDL to assess trends in PCBs, which have physical-chemical properties similar to dioxins.

Dioxin data from both species will be used to determine whether the screening threshold continues to be exceeded (Question 1). While concentrations in white croaker will be used as an indicator of regional food web accumulation, shiner surfperch have a smaller home range and will thus be used to assess spatial variation in food web uptake (Question 2). Concentrations in white croaker will be compared to data from previous years to assess concentration trends (Question 4), and shiner surfperch concentrations can be compared to evaluate short term trends and/or variability. Data from both species can be used in foodweb modeling (Question 6).

Bird Eggs ($12,480)

Dioxins will be analyzed in nine samples of cormorant eggs collected from three sites (3 samples per site) spatially distributed throughout the Bay as part of S&T monitoring. Because of their high position in the foodweb and relatively wide foraging ranges, cormorants are valuable indicators of regional contamination in the Bay.

Cormorant egg dioxin data will be used to assess spatial variation of contamination in the Bay (Question 2) and will be compared to data from previous years to assess concentration trends (Question 4).

Tributary Loadings ($51,480)

Whole water samples from Zone 4 Line A (urban), Guadalupe River (mixed ag/urban), and Mallard Island (Delta inflow) were collected in 2010. In the Dioxin Strategy, data from two more urban tributaries are planned. In 2010, the RMP TRC decided to postpone further analysis of tributary samples until 2012 so that data on other contaminants (dioxins were not analyzed) from the 2011 tributary survey could be assessed and used to select future sampling locations for dioxins. Locations for 2012 sampling for dioxins will be determined by the Small Tributary Loading Strategy team meeting in June. The complete data set for the 2011 survey is expected to be available by September of this year.

Whole water samples will be collected for dioxin analysis alongside those for other pollutants of concern during the rising and peak stages of wet season storm events. Sixteen samples (four samples during four storm events per year) will be collected for dioxin analysis to provide an estimate of dioxin loads. The volume of water analyzed per sample in 2012 will be 4 L, a reduction from the 8 L analyzed in samples collected in 2010. AXYS Analytical recently determined that 4 L is the maximum volume they will extract due to a variety of analytical issues associated with processing larger volumes. Based on the results of the tributary water samples processed to date, we estimate that reduction of the sample size from 8L to 4L will result in a 15% decrease in the overall number of congener detections (from 90% to about 75%).

Dioxin concentrations in water samples from these studies will be used to refine the loading estimates provided in the CEP Conceptual Model/Impairment Assessment report by providing additional data on loadings from additional tributaries to supplement the existing data from Mallard Island, Hayward Zone 4 Line A, and Guadalupe River. The added tributaries are likely to be from urban and/or mixed ag/urban areas and will help in evaluating the variability in loads among areas with similar mixes of land uses. Loading estimates from these pathways will be used in development of a one-box model (Question 6) and in the dioxin TMDL to determine the focus of management actions.

Surface Sediments ($31,590)

Surface sediment samples from 2008 (n=15 dry season sampling, including fixed and repeat sites), 2009 (n=47, dry season sampling, all sites), and 2010 (n=27, wet season sampling, all sites) have already been analyzed for dioxins. According to the Dioxin Strategy developed in 2008, surface sediments collected in 2012 are also scheduled for analysis. The strategy was originally developed before RMP S&T sediment sampling switched to alternating wet and dry years, so the original plan included budget for a dry season set (n=47).

In 2012, surface sediment samples for RMP S&T monitoring will be collected from 27 sites during the wet season (likely January). Samples from all 27 sites will be analyzed for dioxins. Alternatively, a larger set of samples from summer 2011 (set aside for analysis in 2012) or in 2013 could be used, although waiting for 2013 results could delay the synthesis in 2014 to the latter half of the year.

Sediment dioxin data will be used to assess spatial variation of contamination in the Bay (Question 2) and to estimate the total reservoir in Bay sediments (Question 3). When compared

to sediment core data, surface sediment data will also be used to determine if recent loadings are different from historical loadings (Question 4). Data will be used in foodweb modeling and development of a one-box model (Question 6).

Budget

	Estimated Costs
2012 Sport Fish (n=20)	
-- Analytical ($800/sample, plus 3 QA samples)	$18,400
-- Data mgt, minimal analysis and reporting	$5,520
Total	**$23,920**
2012 Bird Eggs (n=9)	
-- Analytical ($800/sample, plus 3 QA samples)	$9,600
-- Data mgt, minimal analysis and reporting	$2,880
Total	**$12,480**
WY 2012 Tributary Loading Studies (n=16 x 2 urban tributaries)	
-- Analytical ($850 sample, plus 4 QA samples)	$30,600
-- Data mgt, minimal analysis and reporting	$9,180
-- Field work	$9,000
-- Shipping	$2,700
Total	**$51,480**
2012 Surface Sediments (n=27, collected in wet season)	
-- Analytical ($810/20g sample, plus QA samples)	$24,300
-- Data mgt, minimal analysis and reporting	$7,290
Total	**$31,590**
Total for all elements	**$119,470**

PLAN AND ESTIMATED COSTS FOR RMP DIOXIN WORK (updated May 2011)

Design Element	2008	2009	2010	2011	2012	2013	2014	Total by Element
Sport fish		$22,000 (completed)			$24,000			$46,000
Bird eggs					$12,500			$12,500
Surface sediment	$58,000	$58,000 (completed)	$58,000 (mix of 2008 & 2010 analyzed; expected summer 2011)		$31,500			$147,500
In-Bay surface water		$26,000 (completed)		$26,000				$52,000
Sediment cores	$57,000		$57,000 (at lab)					$57,000
Trib loadings, Delta outflow			$31,000 (Zone 4 Line A) $34,000 (Delta outflow) $34,000 (Guadalupe) (completed)		$51,500			$150,500
Atmospheric deposition			$20,000					$20,000
One-box model							$20,000	$20,000
Foodweb model							$20,000	$20,000
QAPP		$13,500 (completed)						$13,500
Data synthesis report						?	?	?
Total by Year	$115,000	$119,500	$119,000	$26,000	$119,500	?	$40,000	$539,000

PS/SS: Synthesis Report on Contaminants of Emerging Concern in San Francisco Bay – Year 2

Estimated Cost: $15,000
Oversight Group: Emerging Contaminant Work Group
Proposed by: Susan Klosterhaus, Meg Sedlak, and Rachel Allen, SFEI

Background

Since 2006 the RMP has been collecting data on contaminants of emerging concern (CECs) to proactively identify unregulated chemicals that have the greatest potential to adversely affect the health of San Francisco Bay wildlife and humans that are linked to the Bay food chain. With guidance from the Emerging Contaminants Work Group (ECWG), RMP pilot and special studies have focused on preliminary monitoring of pharmaceuticals, perfluorinated chemicals (PFCs), and flame retardants in Bay samples. Pro bono analyses of a variety of CECs by other laboratories have substantially augmented this work. In 2011, other information generated by the RMP, the State Water Board, and the NOAA Mussel Watch Program will be available that is expected to influence the management of CECs in San Francisco Bay and the entire state. A summary document that synthesizes these data and other information in the context of CECs management in San Francisco Bay is needed to guide future monitoring efforts by the RMP.

Study Objective and Applicable RMP Management Question

The objective of this study is to prepare a summary report that (1) synthesizes the CEC occurrence data available for San Francisco Bay, (2) relates these data to recommendations provided by the expert advisory panel for prioritization and monitoring of CECs in discharges to coastal waters, and (3) recommends next steps for monitoring CECs in San Francisco Bay. This study would address the following RMP management question (MQ):

MQ1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?

- A: Which chemicals have the potential to impact humans and aquatic life and should be monitored?
- B: What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?

Approach

The report will include occurrence data, including a comparison of Bay data to other locations, and conclusions/recommendations from the projects and information sources listed below.

RMP Preliminary Monitoring Studies

- South Bay surface water pharmaceutical study (2006)
- PFCs in mussels (2010), small fish (2009), sportfish (2009), harbor seals (2006-2008) and bird eggs (2006-2009)
- Non-PBDE, current-use flame retardants in sediments and wildlife (2008-2009)
- Triclosan in sediments (2008)

- Chlorinated paraffins in wildlife (2008)
- Nonylphenol in small fish (2009)
- PFCs in tributary waters, ambient surface water, sediment, and wastewater effluent
- PPCPs, alkylphenols, and PFCs in mussels, water, sediment (2010)
- Single walled carbon nanotubes in sediment (2010)
- Screening of biological tissues for CECs (2010-2011)

Other Peer-Reviewed Studies of CECs in San Francisco Bay
In addition to those conducted by the RMP, other research groups have conducted studies on CECs in the Bay. Studies on PFCs, the antifoulant Irgarol, and others are available in the peer-reviewed literature and will be summarized in this report.

NOAA Mussel Watch California CEC Pilot Study
A pilot study is being conducted in 2010 by state and federal agencies to determine which CECs should be added to the list of target analytes for the national NOAA Mussel Watch Program. Pharmaceuticals and personal care products (PPCPs), polybrominated diphenyl ethers (PBDEs), polybrominated biphenyls (PBBs), alternative flame retardants, PFCs, alkylphenols, and pesticides (pyrethroids, organochlorines, organophosphates, other current use pesticides) will be analyzed in resident mussels throughout the State. In San Francisco Bay, resident mussels were collected from the four core Mussel Watch sites (Yerba Buena Island, Dumbarton Bridge, San Mateo Bridge, and Emeryville). Resident mussels, caged mussels and/or passive samplers will also be deployed near three wastewater treatment plant outfalls and three agriculturally influenced sites in the Bay and analyzed for CECs. These data are expected by the end of 2010 with a report available in 2011.

Advisory Panels on Recycled Water and CECs Discharges to Coastal Waters
Expert advisory panels have been convened by the Water Board to provide recommendations on the incorporation of current knowledge of CECs into regulatory activities related to the Recycled Water Policy and the discharge of CECs to ambient coastal waters. These recommendations will include strategies for inclusion of CECs in monitoring programs and processes for determining thresholds of concern. The final recycled water report will be available in the summer of 2010 and the coastal water policy is expected in early 2012. Findings from these reports will be included in the synthesis document and data gaps will be identified.

Recommendations for Next Steps
In the context of the synthesis of available data and the advisory panels' recommendations, recommendations will be made for next steps for the RMP to address CECs.

Budget

In 2010 it was determined that the CEC synthesis would be developed in the second half of 2011 and the first half of 2012 due to the anticipated release of the final report by the Advisory Panel on CECs Discharges to Coastal Waters at the end of 2011. Therefore, $30,000 was allocated for this work in 2011, with the expectation that the remaining amount ($15,000) would be allocated to the project in 2012.

Synthesis reporting	
Year 1	
-- RMP and other peer-reviewed study summaries	$14,000
-- NOAA Mussel Watch data analysis, reporting	$16,000
Total for Year 1	**$30,000**
Year 2	
-- Comparison to advisory panel summaries	$5,000
-- Synthesis and recommendations for next steps	$10,000
Total for Year 2	**$15,000**
Project Total	**$45,000**

MONITORING PERFLUORINATED COMPOUNDS IN SF BAY BIOTA

Meg Sedlak, SFEI, Oakland, CA and Denise Grieg, The Marine Mammal Center, Sausalito, CA

ESTIMATED COST: $87,000
OVERSIGHT GROUP: Emerging Contaminants Work Group (ECWG)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	Jan – Dec 2012
Task 2. Fieldwork	Summer 2012
Task 3. Laboratory analysis	Fall 2012
Task 4. QAQC / data management	Dec 2013
Task 5. Draft and final memorandum	Mar 2013

Background

Previous RMP studies have identified elevated concentrations of perfluorinated compounds, specifically perfluorooctane sulfonates (PFOS) in cormorant eggs and seal blood from the South Bay. Cormorant eggs were sampled as part of the RMP bird egg monitoring program in 2006 and in 2009, with little evidence of a temporal decline. Of the three locations sampled in the estuary, concentrations of PFOS in eggs from the South Bay were the highest and exceed the predicted no effects concentration threshold of 1,000 ng/g. Similarly, the highest PFOS concentrations were from seals that were sampled in the South Bay. At present, there are no effects thresholds for harbor seals. Seals were sampled in the South Bay in 2004 and no additional follow up work has been conducted. There is a need to confirm whether concentrations of perfluorinated compounds remain elevated in Bay apex predators such as cormorants and seals. Additional sampling of forage fish and sediment will assist in the identification of pathways of uptake.

Applicable RMP Objectives and Management Questions

This study will address the following RMP Objectives and Management Questions.

MQ.1 Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?

- A: Which chemicals have the potential to impact humans and aquatic life and should be monitored?

MQ.2 What are the concentrations and masses of contaminants in the Estuary and its segments?

- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

MQ. 3 What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?

- A: Which sources, pathways, and processes contribute most to impacts?

This study builds upon two previous studies evaluating the concentrations of PFOS and other perfluorinated compounds (PFCs) in Pacific harbor seal blood, cormorant eggs, and small fish collected in San Francisco Bay. San Francisco Bay seal blood had concentrations of PFOS that were an order of magnitude higher than concentrations observed in seals from the reference site, Tomales Bay (approximately 45 miles to the north of San Francisco Bay). The objectives of this study are to characterize concentrations of PFCs in San Francisco Bay biota (seals, small fish, and birds) to understand pathways for accumulation of PFCs in the food web.

Relationship of the Study to the ECWG Priority Question and Current RMP List of Emerging Contaminants

The Emerging Contaminant workgroup is focused on answering the following question "What emerging contaminants have the greatest potential to adversely impact beneficial uses in the Bay?" Based on a review of literature values reported for harbor seals, San Francisco seals have some of the highest concentrations of perfluorinated compounds detected in pinnipeds. Perfluorinated compounds are associated with a number of deleterious health effects in animals including impairment of the immune system, developmental effects, endocrine disruption, cancer, and neonatal mortality. Perfluorinated compounds are included as a priority class of compounds in the ECWG five-year plan.

Approach

Sediment

Sediment samples will be collected in the South Bay from five locations which will be collocated with the small fish sampling sites. Targeted locations will be: Mowry Slough; Guadalupe Slough; Alviso Slough; Cooley Landing/San Fransquito Creek; and Coyote Creek.

Small fish

Seals are omnivores and will commonly consume fish such as herring, flounder and perch as well as crustaceans, mollusk, squid and octopus (http://www.palomar.edu/oceanography/harbor_seals/facts.htm). In prior studies, variation in small fish PFOS concentrations was observed both spatially and by species. PFOS was the major PFC detected in small fish. Interestingly, PFCs were largely not detected in mollusks which are consumed by seals. In San Francisco Bay, yellow fin gobies were observed to

comprise 45% of the harbor seals diet (Torok 1994). More recent work by Gibble (2011) found that the diet of seals varies by location, likely the result of different habits and therefore prey species. Northern portions of the Bay are dominated by rocky outcrops; southern portion of the Bay are dominated by mudsloughs. Anchovies were the most important prey fish for seals from the northern portion of the estuary; yellowfin gobies were the most important prey fish for seals from the southern portion of the estuary. Cormorants, which are diving birds, also feed on small fish. The RMP is currently undertaking a small fish study in 2011 at two sites in the South Bay to evaluate uptake of mercury into the food web. In addition, fish from three California Fish and Game monthly trawl sites will be evaluated. Research by Gibble has shown a high correlation between fish captured on the trawls and the diet of seals. Forty composite fish from this project will be analyzed for PFCs to determine the potential for uptake and to identify potential hot spots.

Fish

In 2012, the RMP will sample sportfish. In 2009, PFCs were detected in only 4 of the 20 fish sampled. Interestingly, the accumulation of PFCs appeared not to be a function of trophic status. PFCs were detected in anchovies (2 samples), sturgeon (1 sample) and leopard shark (1 sample) in concentrations less than 18 ng/g. Relatively few sportfish advisories exist. Minnesota currently has a fish advisory for fish from the Great Lakes of 40 ng/g. The contaminant list for 2012 is currently under development but is likely to include PFCs. This study is not requesting additional funding for sportfish but will consider the data in the interpretation of PFC accumulation in food webs.

Seals

The highest concentrations of PFOS were observed in seals from Mowry Slough in the South Bay. These samples were collected in 2004. It is not known whether these concentrations in seals have decreased over time. The Marine Mammal Center has archived blood samples from 2010 and 2011 including 14 blood samples that were collected in January 2010 from seals located in Mowry Slough; 9 blood samples from Redwood City seals collected in February 2011; and 10 blood samples from Castro Rocks/Richmond Bridge seals collected in January 2010. These samples will be analyzed for PFCs.

Bird Eggs

Cormorants are diving birds that feed on small fish and crustaceans. In 2012, the RMP will sample bird eggs at three locations: Wheeler Island, Richmond Bridge, and the Don Edwards Wildlife refuge. As part of the Status and Trends program, these bird egg samples will be analyzed for perfluorinated compounds. Concentrations from the Don Edwards site (South Bay) have remained relatively constant and were above the predicted no effects concentration of 1,000 ng/g in 2006 and in 2009 (Newsted et al. 2006). No additional funding is requested for this work.

Proposed Budget

The budget is presented as three separate tasks which can be performed as separate elements or combined. The results from the study will be presented to the emerging contaminants

workgroup and the TRC and summarized in a short manuscript and platform presentation at a national meeting.

Task	Estimated Cost
Analysis of seal blood (40 samples), data management and reporting	$32,000
Analysis of small fish samples (30 composites), data management and reporting	$37,000
Analysis of sediment (10 samples), data management, and reporting	$18,000
Total	**$87,000**

References

Gibbles, CM. 2011. Food Habitats of Harbor Seals (*Phoca Vitulina Richardii*) in San Francisco Bay. Master's Thesis. San Jose State University.

Torok, M.L. (1994) Movements, daily activity patterns, dive behavior, and food habits of the harbor seals (*Phoca vitulina richardsii*) in the San Francisco Bay, California. M.S. Thesis, California State University, Stanislaus. 88 pp.

Newsted, J.L., et al., *Avian toxicity reference values for perfluorooctane sulfonate.* Environmental Science & Technology, 2005. **39**(23): p. 9357-9362

DEVELOP AND UPDATE SPREADSHEET MODEL – YEAR 3

Michelle Lent, Alicia Gilbreath, and Lester McKee, SFEI, Oakland, CA

ESTIMATED COST: **$20,000**
OVERSIGHT GROUP: Sources Pathways and Loading Work Group (SPLWG) / Small Tributaries Loading Strategy Team (STLS)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Refine sediment model, as needed	4/1/2012
Task 2. Refine pollutant model, as needed	9/1/2012
Task 3. Presentation to SPWLG, update documentation to include model improvements	11/1/2012

BACKGROUND

To accurately assess total contaminant loads entering San Francisco Bay, it is necessary to estimate loads from local watersheds. Presently Hg loads entering the Bay from urban stormwater described in the San Francisco Bay TMDL have been estimated by the Water Board by combining BASMAA bed sediment data with now outdated estimates of regional suspended sediment loads. In the case of PCBs, the mass loads in the Bay TMDL were derived from scaling loads from the Guadalupe and Coyote Creek watersheds by area up to the region as a whole. Although these methods were arguably appropriate for planning and TMDL development, the implementation plans of these TMDLs call for improvements of regional scale loads estimates and to assess how these loads might be reduced. These needs are now reflected in the municipal stormwater permit (MRP) (SFRWQCB, 2009) and in the 2nd and 4th questions of the RMP Small Tributaries Loading Strategy (STLS).

"Spreadsheet models" of stormwater quality provide a useful and cheap tool for estimating regional scale watershed loads. These models are based on the simplifying factor that unit area runoff for homogeneous sub-catchments have constant concentrations, and thus have advantages over models such as HSPF and SWMM that require large calibration data sets which take money and time to collect. Such a model was developed for the Bay Area previously (Davis et al., 2000); however, at that time, there was only local land use specific data on pollutants of concern (POCs) for a drought period late 80s and early 90s, and there was no local data on Hg and PCBs. More recently, a spreadsheet model was developed for a watershed in Los Angeles that was able to predict mass emissions to within 8% of measured Zn loads and described options for loads reduction through a focus on "high leverage" areas (Ha and Stenstrom, 2008). Locally Lewicki and McKee (2009) used a combination of methods to make new watershed specific suspended sediment loads estimates. In watershed areas where there were empirical observations, these were used to estimate long-term average loads. The empirical data were also used to calculate regional regression equations that were then applied to larger watersheds dominated by non-urban land use. For urban areas, a spreadsheet model was used that combined delivery ratios calculated from watershed area and erosion estimates for specific land use classes (natural, agricultural, low density and

high density urban and industrial). These estimates are presently deemed to be the best and will need to be taken into account during year 2 and year 3 of the development of a spreadsheet model.

During the RMP 2010 calendar year (year 1 of this project), the GIS-based simple model was developed to calculate stormwater volumes and POC loads on a long-term average annual basis. (Ideally the model should operate on a storm event basis, but a massive precipitation data compilation effort will be necessary to achieve this on a regional scale.) Two base hydrology model approaches were investigated: one using runoff coefficients based on land use and the other using runoff coefficients based on impervious cover. Initial versions of each model were developed and calibrated to local hydrology data. We used empirical data from 18 local watersheds with a wide variety of soil, slope, and imperviousness to test each model. For the impervious cover model, an accuracy of +/- 66% and minimal bias (median of 2%) were achieved. For the land use based model, higher accuracy (+/-50%) was achieved, but the results showed slightly more bias (median of 5%). Initial model runs for POC loads results were of questionable quality suggesting a preliminary recommendation to complete further literature review and local EMC development is warranted. As such, the year 1 report presently in preparation contains a more thorough review of literature to 1) Make decisions on land use and source area classification for each of the MRP category 1 pollutants, and 2) Make recommendations on for which analytes literature data is sufficient to populate our model and for which analytes local empirical observations will be required to populate the spreadsheet model.

In 2011 we are continuing to refine the hydrology models and evaluating the advantages and disadvantages of each (including performance, usability, and underlying assumptions). We will also develop the sediment component to provide better agreement with local empirical sediment loads observations (Lewicki and McKee, 2009). Should monitoring go ahead in the winter of 2011/12 (see parallel Special Studies proposal), we anticipate loading estimates near the end of 2012 with a stronger basis in local data and more closely aligned to our empirical observations of loads in Guadalupe River, Zone 4 Line A, Coyote Creek, Ettie street pump station, Richmond pump station, Cerrito Creek, and any other watersheds where we can find local calibration data sets. New data generated through loading studies completed as described in the Small Tributaries Loading Strategy Multi-Year Plan (STLS-MYP, 2011) presently in-preparation will be used to help calibrate the regional spreadsheet model.

Objective:
The overall objective of this 2012 proposed study is to continue to develop and refine mass emissions estimates for the local watersheds and the region as a whole draining into the San Francisco Bay. Specifically, we propose further development and refinement of the model hydrology and sediment components in consultation with the workgroup/ STLS team and extension of the model to include preliminary runs of the MRP category 1 contaminants incorporating data from based on literature data and perhaps further manipulation of local bed sediment data.

APPLICABLE RMP MANAGEMENT QUESTIONS

Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?

Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?

Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?

Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?

Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?

Level IV STLS Q4: Support management actions: What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries and where should management actions be implemented in the region to have the greatest impact?

METHODOLOGY

Two base rainfall-runoff models were developed in 2010 (year 1 of project). One was a direct update and refinement of the regional loads model developed by Davis et al. in 2000. The other model was based on the Impervious Cover Model (Schueler 2003). Using land use-specific runoff concentration data from literature, some MRP category 1 contaminant loads preliminary estimates (e.g., suspended sediment) were incorporated in the year 1 report. In 2011, further refinement of the base hydrology model will be completed as well as preliminary calibration of the suspended sediment model. The actual uses of the continuation funds in 2012 will depend on the priorities set by the WG and the STLS team. Next steps potentially include:

- Developing methods to incorporate priority POCs source areas into model
- Applying EMC data from literature and local empirical observations for a range of selected MRP pollutants
- Performing preliminary optimization of the model to best match loads from our local observation watersheds (e.g. Guadalupe and Zone 4 Line A).
- If the budget allows, perhaps developing BMP modeling capabilities (see Level II RMP, Q3C above).

BUDGET (TO BE ADJUSTED AS NEEDED)

Proposed Cost (all labor)		
Task 1	Refine sediment model	$5,000
Task 2	Refine pollutant model	$10,000
Task 3	Presentation to WG, update documentation	$5,000
Total for the third year		$20,000
Subsequent years		$20,000*

* Could be increased to $25k if the STLS is interested developing more components, for example, a BMP module.

REFERENCES

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POC LOADS MONITORING – LANDUSE/SOURCE AREA SPECIFIC EMC DEVELOPMENT

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ESTIMATED COST: **$80,000 (2012 special studies budget)**
OVERSIGHT GROUP: Sources Pathways and Loading Work Group (SPLWG) / Small Tributaries Loading Strategy Team (STLS)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1: Project Management	Sep 2011 – Sep 2012
Task 2: Purchase, prefabricate and install field equipment	Oct 2011
Task 3: Wet weather fieldwork	Nov 2011 – Mar 2012
Task 4: Laboratory analysis	Dec 2011 – May 2012
Task 5: Data management	Jun 2012
Task 6: Reporting	Jul 2011 -Sep 2012

BACKGROUND

The PCB and Hg TMDLs for San Francisco Bay call for improved stormwater loading information and increased application of urban Best Management Practices (BMPs) for reducing pollutant loads and impacts. Since it is impossible to monitor all stormwater inputs to San Francisco Bay (there are more than 250 urban watersheds presently identified), the first report of the SPLWG recommended a combination of monitoring and extrapolation using modeling to develop regional loads estimates (Davis et al., 2001). In addition, Davis et al. identified a need to evaluate the efficacy of local and regional BMPs for influencing stormwater loads trends. Recently, these needs were refined in the 2009 version of the Small Tributaries Loading Strategy (STLS, 2009) and will be further refined in the in-preparation Small Tributaries Loading Strategy Multi-Year Plan (STLS-MYP, 2011).

To estimate regional loads, the STLS documents the consensus recommendation to develop a spreadsheet model using the methods of Ha and Stenstrom (2008). Data inputs for such a model include rainfall, runoff coefficients, and land use based contaminant event mean concentrations (EMCs). In 2010, the TRC funded the first year of development of that modeling platform (Lent and McKee, 2011). The outcomes of the first year included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds. Preliminary loads of copper and sediment were also generated but confidence was low. In 2011, the TRC provided another $20k to further the development of the model to finalize the hydrological and sediment transport components and further test contaminant data inputs from literature review. In parallel, a literature review is being completed to evaluate land use or source specific strata, to evaluate information from literature to determine local empirical EMC data development needs and to do reconnaissance of monitoring sites.

Such empirical monitoring studies have been performed in Southern California by Tiefenthaler et al. (2008) who selected eight representative land use classes based on management needs. They found statistical differences between industrial, recreational, and open space land use classes for suspended sediment, copper, lead, and zinc and no statistical difference between commercial and any category of residential urban land use or transportation.

Unfortunately these Southern California data are not directly applicable to the Bay Area, where PCBs and Hg are the pollutants of highest concern. In the Bay Area, older industrial areas are hypothesized to be more polluted with PCBs than other urban landscapes, whereas for mercury, a broader distribution is hypothesized that includes industrial and commercial areas with higher imperviousness, and older urban areas. Beyond land use, the literature review being completed presently is considering condition of development (e.g. roads cracked under the pressure of heavy vehicles, poorly maintained facilities, or the existence of bare earth or gravel on roads and industrial lots) and source areas (e.g. electrical facilities for PCBs or reprocessing facilities for Hg and PCBs). Following discussion at the May SPLWG meeting, a reconnaissance of potential sampling sites will be completed. The information generated will be taken into a STLS team meeting probably scheduled for July and a final decision of monitoring sites will be made.

The objective of this study is to complete the first field season of monitoring at 2 EMC sites and interpret data in the context of existing data from literature. Since the first round of regional loads estimates are due in 2014, we have two wet seasons (2012, 2013) in which to collect this data. The proposal may change a little depending on the outcomes of the STLS literature review task.

APPLICABLE RMP MANAGEMENT QUESTIONS

Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?

Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?

Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?

Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?

Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?

Level IV STLS Q4: Support management actions: What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries and where should

management actions be implemented in the region to have the greatest impact?

SAMPLING DESIGN / METHODS

Task 1: Project management
Task 2: Purchase, prefabricate and install ISCO auto sampling equipment (yet to be determined if triggered by stage or turbidity or a combination) at 2 EMC sites selected in response to the outcomes of the 2011 reconnaissance
Task 3: Carry out fieldwork during 4 wet season storms at these EMC sites.
Task 4: Complete laboratory analysis of water samples
Task 5: Complete data management/quality assurance
Task 6: Complete interpretative report

BUDGET

$80,000 (detail to be determined through STLS team meetings)

REFERENCES

Davis, J.A., Abu Saba, K., and Gunther, A.J. 2001. Technical report of the Sources Pathways and Loadings Workgroup. San Francisco Estuary Institute, September 1999. 55pp.

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Lent, M., Oram, J., and McKee, L., 2009. Guadalupe Watershed Model: Year 1 Report. RMP Technical Report: SFEI Contribution #564. San Francisco Estuary Institute, Oakland, CA.

Tiefenthaler, L.L., Stein, E., and Schiff, K., 2008. Watershed and land use-based sources of trace metals in urban stormwater. Environmental Toxicology and Chemistry 27, 277-87.

PS/SS: Sediment Quality Assessment of Targeted Toxic Hot Spots Previously Identified in San Francisco Bay by the Bay Protection and Toxic Cleanup Program or Other Sites on the 303(d) List. – Year 2

Estimated Cost: $30,000

Oversight Group: RMP Exposure and Effects Workgroup (EEWG)

Staff involved: Meg Sedlak and Rachel Allen , SFEI

Date: June 7, 2011

Proposed Deliverables and Time Line

Deliverable	Due Date
Task 1: Convene focus group and develop final plan	Summary report on BPTCP site status - August 31st, 2011. Focus group meeting - July 2011.
Task 2: Sample collection and data analysis	July/August 2011 - coordinated with the RMP S&T sediment sampling.
Task 3: Reporting	Draft - August, 2012 Final - October, 2012

Background and Justification

In August 2009 the State Water Resources Control Board (State Water Board) adopted the Sediment Quality Objectives for Enclosed Bays and Estuaries. These sediment assessment methods use the sediment triad approach to evaluate the ecological condition of sediments from a site, using measurements of sediment chemistry, toxicity tests, and benthic community condition (Bay *et al.*, 2009). The San Francisco Bay Regional Water Quality Control Board (Water Board) is interested in employing these SQO assessment methods to evaluate sediment condition at toxic hotspots and other sites that are on the 303(d) list[1] in support of management decisions.

Sites to be considered for this study are currently of interest to the Water Board because they were identified as impaired by the Bay Protection and Toxic Cleanup Program (BPTCP) in the late 1990s (Hunt *et al.*, 1998) or listed on the current 303(d) list, and they have not had cleanup orders or implementation plans developed for them. They include: Central Basin, Islais Creek, Mission Creek, San Leandro Bay and two sites in the Oakland Inner Harbor – Pacific Dry Dock and Fruitvale.

[1] http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

The proposed study will conduct Sediment Quality Objectives assessments (SQOs) at up to six sediment stations to support the Water Board's management decisions. Sites will be located within the general geographic region of the Estuary currently defined as the polyhaline benthic assemblage by the current SQO guidance documentation – between the Dumbarton Bridge in the south and the Richmond Bridge in the north (Bay *et al.* 2009).

The first objective of the proposed study is to conduct an assessment of sediment condition at sites of concern to the Water Board using the recently approved SQO assessment methods. If this study is funded, a focus group will be convened to consider management priorities and finalize the study design. A secondary objective of the study is to continue the RMP's ongoing effort to investigate potential causes of toxicity and develop stressor identification methods. If sediments prove to be sufficiently toxic to either the amphipod or bivalve laboratory test species, a toxicity identification evaluation (TIE) will be conducted to investigate possible causes of the observed toxicity (see below for more detail).

This study will address RMP management questions (listed below) related to pollutant effects on benthic organisms including: evaluating the long-term persistence of benthic impacts at hotspots, which pollutants are responsible for potential impacts, and the utility of the SQO approach in evaluating sediment condition. This study will provide the Water Board with SQO assessments of important estuary margin sites of concern in the Central and South Bay regions of the San Francisco Estuary in support of managing contaminated sites and 303(d) listing decisions.

Study Plan

This study will limit its focus to sites that fall within the polyhaline benthic assemblage as defined by the current SQO guidance (Bay *et al.*, 2009). Benthos samples will be further evaluated to confirm they are placed in the right benthic assemblage using salinity measures and indicator taxa defined in the SQO guidance documentation. If samples do not fall within the expected polyhaline assemblage, alternative benthic assessments may be used to provide a basis for comparison of condition. The RMP and SCCWRP are currently working on revising and formalizing the mesohaline SQO benthic assessment methods and these new methods may be used to evaluate benthic community condition in samples if the resulting samples are determined to belong to the mesohaline assemblage.

This study will consist of three tasks:

1. Convene a focus group to finalize study design:

Because a summary of the current status of the sites of interest must be compiled and considered before selecting the sites to sample, a focus group will be convened after the start of the project to develop the final study plan. After reviewing the summary of site-conditions the group will decide which sites, the number of samples to be collected per site, and the measurements to be analyzed (beyond the core SQO assessment measures) based largely on Water Board priorities and the project budget. Up to six samples will be collected under the current budget and, depending on the study design (number of sites and replicates), the full suite of RMP Status and Trends triad measures will be analyzed.

If the focus group chooses to study a site previously visited by the BPTCP, it may be possible compare SQO assessment scores from results from the earlier study. Many of the BPTCP sites were sampled in 1997 for a similar suite of sediment triad parameters as employed by the current SQO methods (Figure 1).
Some of those sites were determined to be toxic hot-spots, and remediation efforts were implemented. The focus group may decide to re-assess some of those sites to see if sediment conditions have improved.

The review document of site-condition for the candidate sites to be considered will summarize information about sediment conditions and/or rationale for a site being listed on the 303(d) list, and outline any remediation efforts that may have taken place to-date.

Figure 1. Map of the BPTCP triad stations sampled 1994 – 1997.

2. Sample collection and analyses:
This study will coordinate with the RMP Status and Trends sediment monitoring effort scheduled in the summer of 2011 to sample during the same season as the long-term monitoring program and to leverage logistics, analytical, and information-management costs. The same analytical laboratories and core analyte list as monitored by the RMP Status and Trends sediment monitoring effort will be used in this study in order to maximize the use of the data in other RMP studies.

Surface sediment will be sampled and analyzed for the full suite of RMP Status and Trends measures including:

- Sediment and water quality - grain-size, TOC, TN, and a CTD cast will be taken to record water quality conditions near the bottom.
- Trace metals
- Trace organics
- Toxicity to two test species (*Eohaustorius estuarius* and *Mytilus galloprovincialis*)
- Benthic macrofauna

3. Reporting:
Sediment assessment scores will be compared among sites and to the RMP Status and Trends program scores. The Status and Trends program began conducting SQO assessments in 2008 at a subset of the long-term sediment monitoring sites (sampled annually on an alternating wet and dry season sampling period). Those sites are located throughout the Estuary and represent ambient conditions as they are not located near known sources of pollution. Comparing the study sites to those in the Estuary will provide perspective about the respective ecological condition of sediments in the Estuary as a whole and in the Estuary margins - near pollution sources.

If previously sampled BPTCP study sites are selected for this study, it may be possible to further evaluate if sediment quality conditions have improved by using the SQO assessment scores to compare historic condition to this new study.

Contingency TIE Study for Stressor Identification
A conditional task is included in this proposal to address stressor identification at sites that are highly toxic. If <55 % mean survival or mean normal-development is observed in either the amphipod or bivalve tests respectively, a phased TIE study will be proposed and funds will be requested from the RMP contingency fund. This conditional add-on is consistent with the RMP's current standard that authorizes TIE studies to be conducted in the RMP S&T program whenever sediment samples are considered toxic enough to warrant a TIE to investigate possible causes of the observed toxicity.

This study will be conducted by the RMP's S&T toxicity laboratory (UCD-MPSL) and may include techniques developed through the RMP in the past for bivalve TIEs and through methods being developed for amphipods through the current RMP special study - Sediment TIEs (2009-2010) with oversight by the EEWG.

Applicable RMP Management Questions

EEWG benthic effects management questions:

1. What are the spatial and temporal patterns of impacts of sediment contamination on benthic biota?

   The proposed study will employ the SQO methods for Enclosed Bays and Estuaries to assess ecological condition, and if there is a potential concern of degraded conditions due to pollution. This Study will focus on impaired sites located in the Estuary margins and SQO assessment scores will be compared to the RMP Status and Trends scores from the ambient survey design. To evaluate temporal patterns, BPTCP sites that were sampled in 1997 may be re-assessed to investigate to what extent sediment conditions have improved.

2. Which pollutants are responsible for observed impacts on benthic biota?

   If the TIE study is authorized, due to significant toxicity observed in one or both toxicity tests, this study will address this specific benthic effects management question from the EEWG Five Year Work Plan (2008). TIE methods are currently being developed by the RMP and SCCWRP for both SQO test species. Employing these new developing TIE procedures on highly toxic ambient sediments begins to inform managers of the environmental stressors that may be causing the observed toxicity and provides an opportunity to improve TIE procedures.

3. Are the toxicity tests, benthic community assessment approaches, and the overall SQO assessment framework we are using reliable indicators of impacts on benthic biota?

   The SQO methods for Enclosed Bays and Estuaries will be implemented to investigate sediment conditions at sites that are the most impaired in the Estuary which will help to inform us on how sensitive these tools are and if they can detect changes in sediment conditions over time or after remediation efforts have been completed.

Budget

In 2010 it was determined that this study would be spread over two years. The final proposal development and sampling would occur in 2011, with the reporting to be performed in 2012. Therefore, $60,000 was allocated for this work in 2011, with the expectation that the remaining amount ($30,000) would be allocated to the project in 2012.

Description	Cost per Sample ($)	Cost Estimate ($)
Sediment Chemistry	3,548	**21,290**
Sediment Toxicity (Eohaustorius & Mytilus)	1,975	**11,850**
Benthos	2,200	**13,200**
Management, Sampling and Reporting		**28,776**
Other Expenses		**14,884**
Logistics contract, vessels, shipping, travel, etc.		
Total Cost Estimate		**$ 90,000**

References

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