Regional Monitoring Program for Water Quality in San Francisco Bay

2016 Detailed Workplan and Budget

Approved November 10, 2015

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Summary

In 2016 the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) is entering its 24th year of collecting data and communicating information to support water quality management decisions. This Detailed Workplan and Budget describes the activities that will be completed in 2016 and their proposed funding levels.

The overall revenue and budget for 2016 are shown in Table 1 and Figures 1-2. The planned expenses are less than the expected revenue and excess revenue will be contributed to Program reserve funds for use in future years.

Table 1: Bay RMP 2016 Budget by Task.

	Direct Cost	Labor	Subcontract	Grand Total
1. Program Management	$10,000	$383,000		$393,000
2. Governance	$66,500	$205,000		$271,500
3. Data Management		$301,000	$10,000	$311,000
4. Annual Reporting	$48,000	$94,000	$22,000	$164,000
5. Communications	$25,500	$120,000	$14,000	$159,500
6. S&T Monitoring	$32,000	$82,100	$577,000	$691,100
7. Special Studies	$28,465	$687,740	$141,795	$858,000
Grand Total	$210,465	$1,872,840	$764,795	$2,848,100
Revenue				$3,308,889
Contributions to Reserve Funds				($436,730)
Planned Surplus (Deficit)				$24,059

This Detailed Workplan and Budget report is divided into four sections that provide details on the:

- 2016 Revenue
- 2016 Programmatic Tasks
- 2016 Status and Trends Monitoring
- 2016 Special Studies

The workplan also establishes the deliverables that will be produced for each line item of the budget. RMP staff will report on progress toward completing these deliverables throughout the year using a standardized “stoplight” report.

The Steering Committee approved this workplan and budget on November 10, 2015.

Figure 1: Bay RMP 2016 Revenue and Expenses .

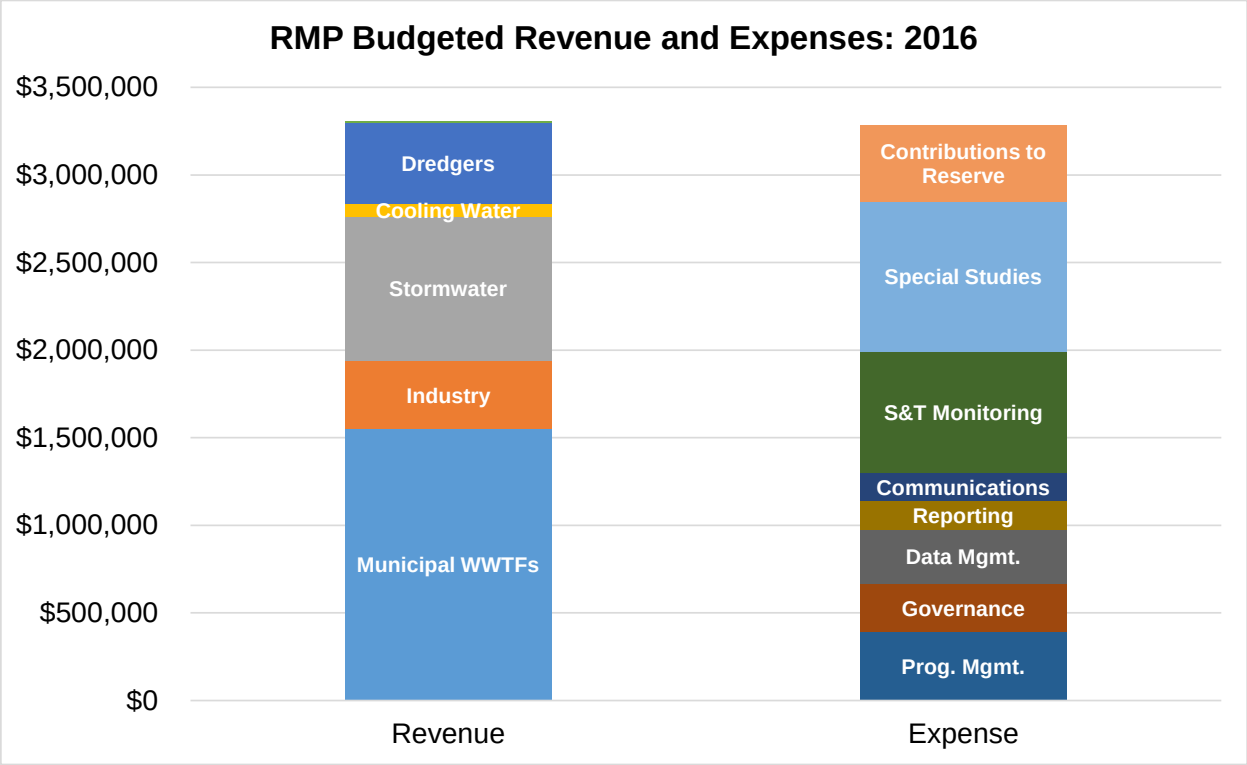
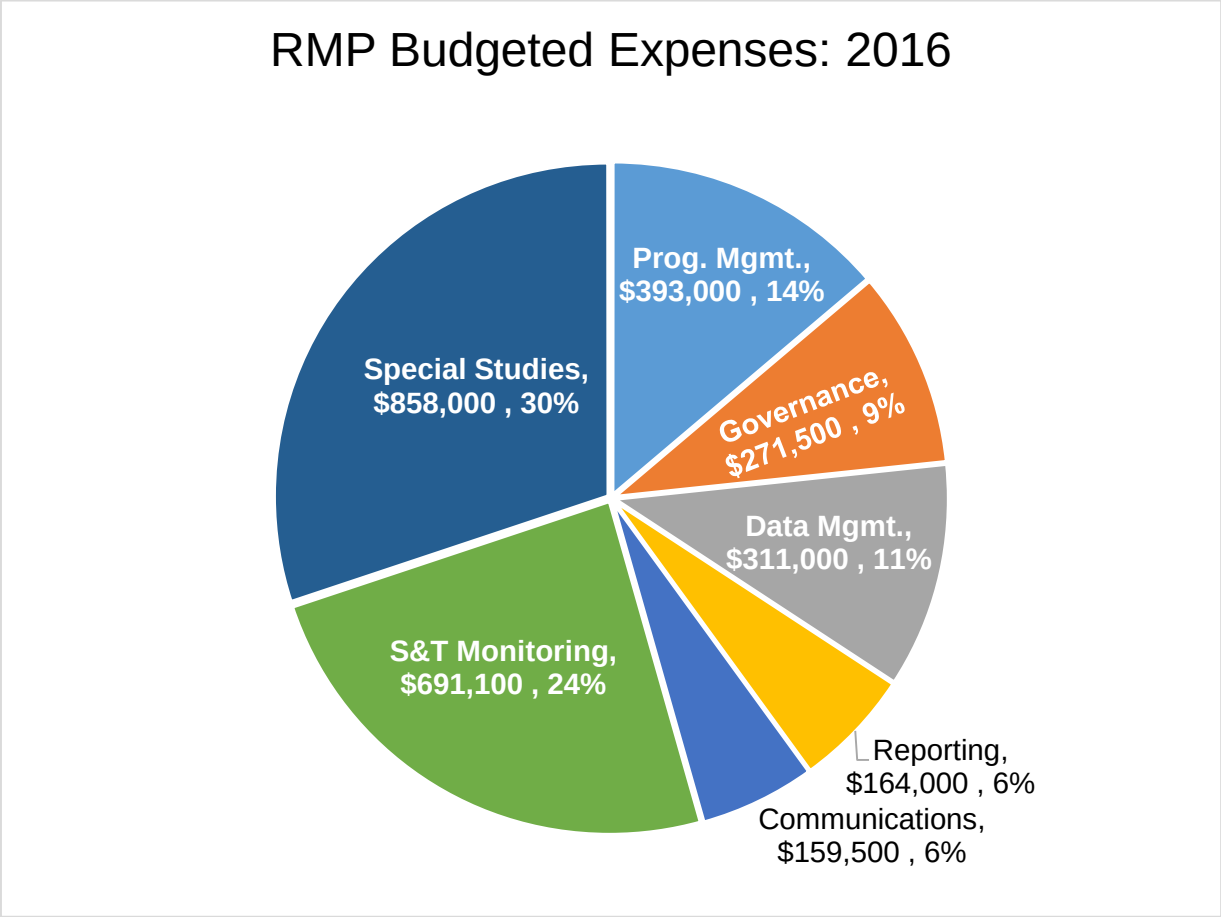


Figure 2: Bay RMP 2016 Budget by Task.



2016 Revenue

The total revenue for the RMP in 2015 is $3,309k. The breakdown of this revenue between participant fees, interest income, designated reserve funds, and undesignated reserve funds is shown in Table 2. The manner in which the fees are supposed to be divided up between Program Participants is shown in Figure 3.

a. Participant Fee Revenue

The target fee revenue for the RMP in 2016 is $3,521k. Fees were increased by 3% relative to the 2015 budget as approved by the Steering Committee on November 13, 2014.

The actual fees collected in 2016 will be $222k below the target fees. This variance is because of a shortfall in the fees paid by dredgers and a reduction in the fees paid by cooling water dischargers. Dredgers are responsible for 17.5% of the RMP fees, which would amount to $616,096. The algorithm used to collect the fees is based on the volume of dredged material that is disposed in the Bay. However, the volume of dredged material disposed in the Bay -- and the fees paid to the RMP by dredgers -- have been declining over time in accordance with sediment management plans. It is expected that dredgers will actually pay $465k in 2016, leaving a deficit of $151k. There is no money left in the Dredger Reserve Fund (extra fees paid by dredgers in previous years) to cover this shortfall. The last remaining cooling water discharger to the Bay is phasing out of operation. On April 21, 2015, the Steering Committee approved a step-wise reduction in fees for cooling water participants from 4% of RMP fees in 2015 to 2% in 2016, 1.5% in 2017 and 0.5% in 2018. Therefore, for 2016, the cooling water fees were reduced by half, resulting in $70k less revenue for the RMP.

b. Interest Revenue

RMP funds earn interest from the Local Agency Investment Fund (LAIF). For the 2015 budget, $10k in interest revenue was assumed, which is consistent with previous budgets.

c. Designated Reserve Funds

i. Dredger Reserve Fund

Dredging activity in the Bay is variable over the years. In years where there is lots of activity, any fees paid by dredgers that are greater than the target fees are stored in the Dredger Reserve Fund. These funds are held in reserve and can only be used to pay for shortfalls in dredger fees in future years. As mentioned earlier, the balance of the Dredger Reserve Fund is zero.

ii. Set-Aside Funds

The RMP uses designated funds -- called “Set-Asides” -- to smooth out the year-to-year expenses of the Status and Trends program. Rather than having a spike in expenses in one year, the Steering Committee designates some funds to be set aside in light years and withdrawn in

years with lots of monitoring. In 2016, the Status and Trends monitoring is light so funds will be contributed to the set-asides, not withdrawn. The amount contributed will be presented in the Status and Trends Expenses section.

d. Undesignated Reserve Funds

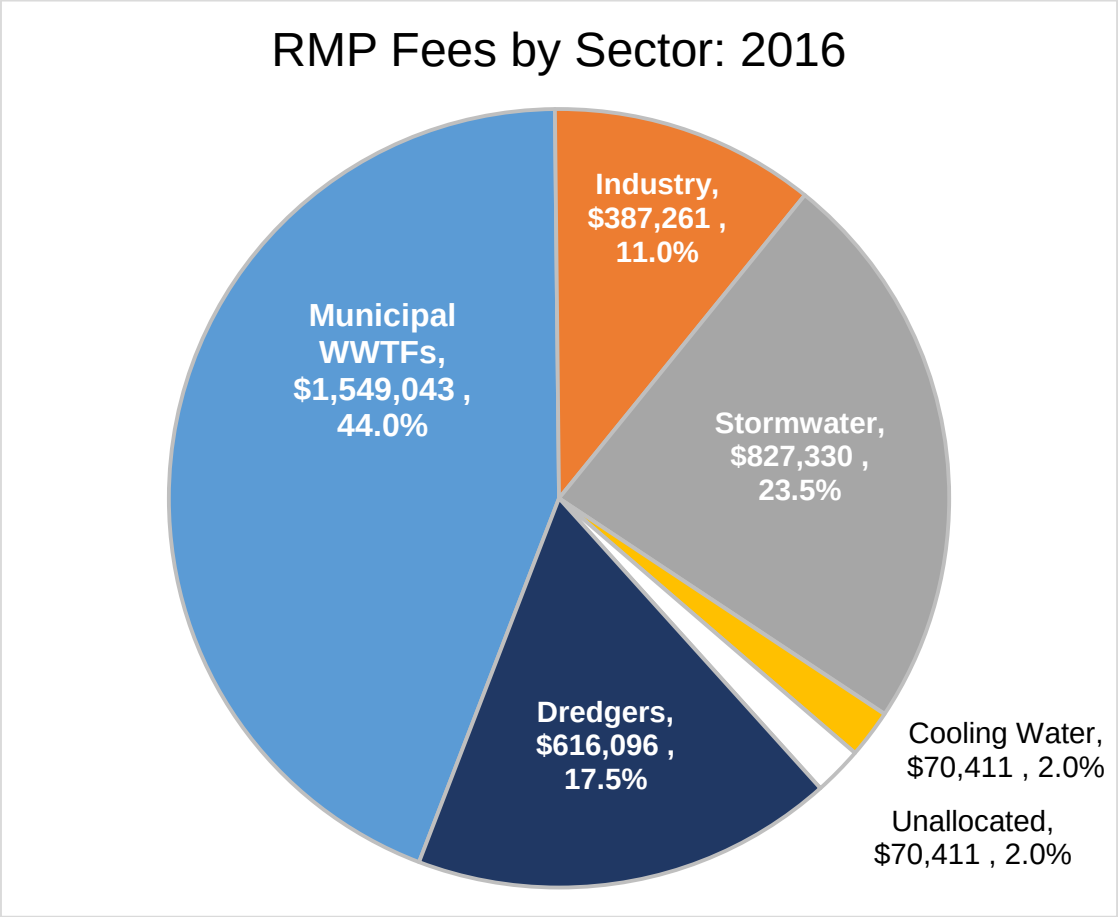
The RMP maintains a balance of Undesignated Funds for contingencies. Higher than anticipated revenues and elimination or reduction of lower priority elements sometimes lead to accumulation of funds that can be used for high priority topics at the discretion of the Steering Committee. It is the policy of the RMP to maintain a minimum balance of $200,000 in Undesignated Funds as a reserve for unanticipated urgent priorities.

No Undesignated Funds are proposed to be used for the 2016 budget. However, the Steering Committee may augment the 2016 budget with Undesignated Funds at any time.

Table 2: 2016 RMP Revenue

Revenue Category	**Subcategory**	**2016 Budget**
Participant Fees	Municipal	$1,549,043
Participant Fees	Industrial	$387,261
Participant Fees	Stormwater	$827,330
Participant Fees	Cooling Water	$140,822
Participant Fees	Cooling Water - reduced fees	-$70,411
Participant Fees	Dredgers	$616,096
Participant Fees	Dredgers - expected surplus (deficit)	-$151,252
Interest Income	Interest Income	$10,000
Designated Reserve Funds	Set-Aside Funds for S&T Monitoring	$0
Designated Reserve Funds	Dredger Reserve Funds	$0
Undesignated Reserve Funds		$0
TOTAL REVENUE		$3,308,889

Figure 3: Bay RMP 2016 Fee Allocations for Program Participants.



2016 Programmatic Tasks

RMP expenses fall into three broad categories: programmatic expenses, Status and Trends monitoring, and special studies. This section details the budgets for programmatic expenses for 2016.

The programmatic budget covers the following tasks:

- Program management
- Governance
- Data Management
- Annual Reporting
- Communications

The total cost to implement these tasks in 2016 is $1,299,000. This budget is $147,200 less than the 2015 budget. The major reasons for the cost savings are summarized in Table 3. More details about each of these tasks are provided in the following sections, on Table 4, and in Appendix A. Appendix A contains descriptions for each subtask or expense, budget justifications, and the expected deliverables.

Table 3: RMP 2016 Programmatic Budget Compared to 2015 Budget

	2015 Budget	2016 Budget	Difference	Comments
1. Program Management	$431,800	$393,000	($38,800)	Reduced costs for audit and journal subscription service. Reduced labor costs due to increased efficiency.
2. Governance	$279,500	$271,500	($8,000)	Cut costs for SC and TRC meetings. Increased costs for WG meetings and external advisors.
3. Data Management	$355,000	$311,000	($44,000)	Fewer datasets than in 2015. Data mgmt for special studies budgeted with the study.
4. Annual Reporting	$213,900	$164,000	($49,900)	Lower cost "RMP Update" rather than a Pulse report.
5. Communications	$166,000	$159,500	($6,500)	Reduced costs for stakeholder engagement. Increased costs for responding to information requests.
Total	$1,446,200	$1,299,000	($147,200)	Cumulative savings of 10% of PM costs (4% of entire budget).

1. Program Management

Program management subtasks include program planning, contract and financial management, technical oversight, internal and external coordination, and administration. The total expense for these tasks is $393,000. Approximately half of the cost for this category is fiduciary oversight of program expenses and contractors.

The major deliverables that will be completed with these funds are: the Multi-Year Plan, the Detailed Workplan, quarterly financial updates to the Steering Committee, and quarterly tracking of deliverables and action items. Funds for technical oversight allow for internal review by senior staff of the many reports, presentations, posters, workplans, memos, and other communications coming out of the RMP. The funds for external coordination cover participation in meetings with external partners to coordinate programs and leverage RMP funds (e.g., coordinating work on the Pulse Report and other reports, coordination with SCCWRP, and serving as liaison to the Delta RMP and other RMPs).

The budget for this task is $38,800 less than it was in 2015. The major cost savings came from reduced costs of audit and an online journal subscription service and increased program efficiencies.

2. Governance

Governance subtasks include convening, coordinating, and facilitating Steering Committee, Technical Review Committee, and Workgroup meetings. Tasks include preparing agendas, agenda packages, participating in meetings, writing meeting summaries, action item follow-up, reviewing minutes from past meetings, coordination with committee chairs, and honoraria and travel for external advisors. The total budget for these tasks is $271,500.

The major deliverables that will be completed with these funds are: quarterly Steering Committee meetings, quarterly Technical Review Committee meetings, and 7 Scientific Workgroup meetings with external science advisors in the spring.

The budget for this task is $8,000 less than it was in 2015. Increased funding for the Scientific Workgroups was offset by decreased costs for holding Steering Committee and Technical Review Committee meetings.

3. Data Management

Data management tasks include processing of new data, maintaining the RMP database, providing online data access, and providing quality assurance review. Results from the water samples collected in 2015 will be processed and quality assured in 2016. In addition, this budget encumbers funds for processing data from the 2016 RMP bird egg and bivalve sampling even though that work will start in 2016 and end in 2017.

In addition to processing new data, the Program needs to maintain the approximately 1.1 million records generated since it began in 1993. Database maintenance includes incorporating

updates and corrections to data, including re-analyzed results and updates implemented by CEDEN/SWAMP. RMP staff also maintain and enhance web-based data access and visualization tools such as CD3 and the archived sample tracking tool.

In July 2015, the Steering Committee agreed to add tasks to the workplan to coordinate with and support the Delta RMP. Therefore, in addition to funding critical updates to the CD3 tool, the budget allocates funding to make this tool more useful for the Delta RMP.

- Integrate the display of data from CEDEN (e.g., visualize other data from the Central Valley);
- Provide access to other types of data in database (e.g., runoff, benthic);
- Develop data exchange services so Delta RMP preliminary and final data can be easily shared with the Estuaries Workgroup Portal.

These specific updates will also benefit the Bay RMP by allowing visualization of additional data within the watershed of the Bay.

Quality assurance is a critical foundation for the scientific investigations of the RMP. The major quality assurance tasks for 2016 are keeping the Quality Assurance Project Plan up to date, preparing QA summaries for datasets, and conducting interlaboratory comparison tests.

The total cost for these tasks will be $311,000. This budget is $44,000 less than it was in 2015. The major costs savings came from having fewer S&T datasets to manage and ensuring that data management tasks for special studies were included in the budget for the study.

4. Annual Reporting

A *RMP Update* report will be produced in 2016, to be released at the Annual Meeting in October. The *RMP Update* is a less expensive product than a *Pulse* report ($85,000 vs $125,000 for the 2015 *Pulse*). The theme of the *RMP Update* report will be updates on recent studies and information for each of the Program focus areas.

Tasks related to the Annual Meeting include developing the meeting agenda, managing logistics, advertising about the meeting, managing attendee registration, preparing presentations, and staffing the meeting.

RMP staff will also prepare the Annual Monitoring Report, which will summarize the 2016 field sampling effort. The goal of the report is to document where samples were collected and any complications during field sampling. The report will not contain any data analysis or results.

The total cost for these tasks will be $164,000. This budget is $49,900 less than it was in 2015. The major costs savings came from planning for a *RMP Update* report instead of a *Pulse* report.

5. Communications

Communications tasks will implement the plans included in the RMP Communications Strategy, approved by the Steering Committee in July 2014. Tasks will include the distribution of RMP information to stakeholders, natural resource managers, and the public through multiple media channels (e.g., website, publications, email newsletters, fact sheets, social media, etc.). In 2016, the RMP will continue to provide support for *Estuary News* ($15,000) plus staff time to plan and review content.

Stakeholder engagement is critically important to addressing the information needs of RMP participants. Tasks include preparing for and attending RMP stakeholder meetings (e.g., BACWA, BASMAA, BPC, LTMS, WSPA, and RB2) as well as communicating directly with stakeholder representatives.

Other communications tasks include responding to inquiries for RMP data and reports, including press calls, and producing summary information on important topics in convenient formats. Participation in workshops and conferences for SWAMP, SETAC, ACS, and other professional organizations allows sharing of RMP information, gathering of information from other investigators on the latest advances in monitoring and understanding, and identification of opportunities for collaboration with other organizations. Presentations at local meetings and to local audiences are also important for collaboration and information dissemination to scientific partners. Keeping the website up to date is another important component of communication.

The total cost for these tasks will be $159,500. This budget is $6,500 less than it was in 2015.

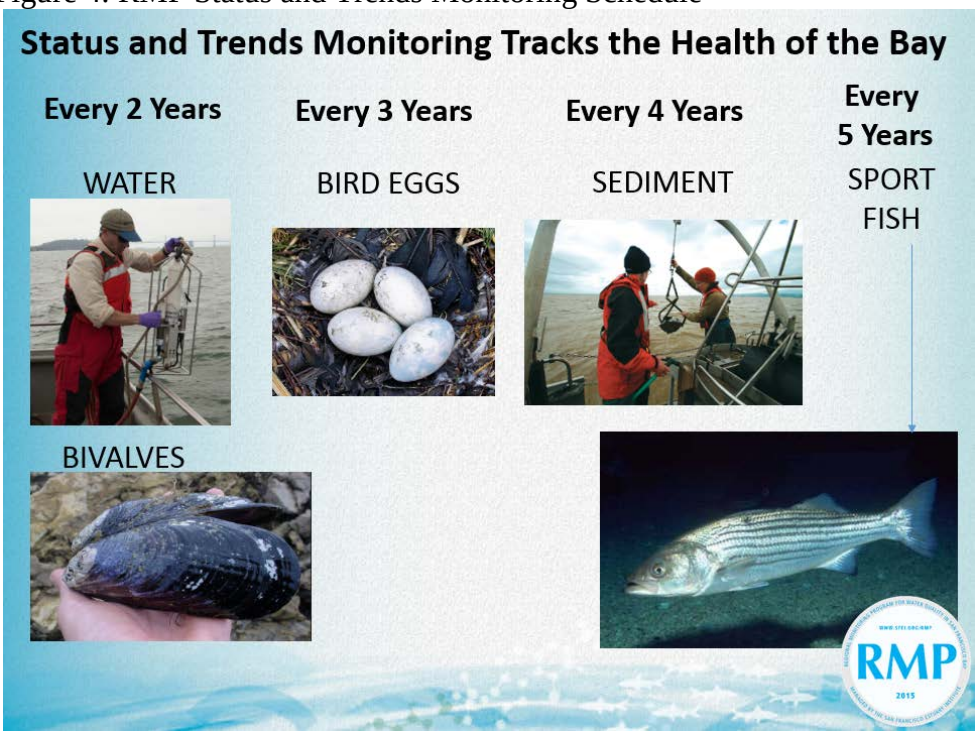
Table 4: Bay RMP 2016 Programmatic Budget by Subtask. Detailed descriptions of the tasks, budget justifications, and deliverables are provided in Appendix A.

Task	Subtask	Direct Cost	Labor	Subcontract	Grand Total
1. Program	A. Program Planning		$40,000		$40,000
Management	B. Contract and Financial Management	$4,000	$160,000		$164,000
	C. Technical Oversight		$50,000		$50,000
	D. Internal Coordination		$75,000		$75,000
	E. External Coordination		$50,000		$50,000
	F. Administration	$6,000	$8,000		$14,000
2. Governance	A. SC meetings	$2,000	$55,000		$57,000
	B. TRC meetings	$2,000	$58,000		$60,000
	C. WG meetings	$2,500	$92,000		$94,500
	D. External Science Advisors	$60,000			$60,000
3. Data Management	A. Data Mgmt for 2015 S&T Water Samples		$25,000		$25,000
	B. Data Mgmt for 2016 S&T Bird Egg Samples		$60,000		$60,000
	C. Data Mgmt for 2016 S&T Bivalve Samples		$30,000		$30,000
	D. Database Maintenance		$50,000		$50,000
	E. Online Data Access: CD3		$65,000		$65,000
	F. Online Data Access: Archive Sample Tool		$11,000		$11,000
	G. Quality Assurance System		$30,000	$10,000	$40,000
	H. Updates to SOPs and Templates		$30,000		$30,000
4. Annual Reporting	A. RMP Update Report	$25,000	$40,000	$20,000	$85,000
	B. Annual Meeting	$23,000	$44,000	$2,000	$69,000
	C. Annual Monitoring Report		$10,000		$10,000
5. Communications	A. Communications Plan Implementation	$15,000	$20,000		$35,000
	B. Stakeholder Engagement		$25,000		$25,000
	C. Responses to Information Requests		$20,000		$20,000
	D. Fact Sheets and Outreach Products	$500	$10,000	$4,000	$14,500
	E. Presentations at Conferences and Meetings	$10,000	$30,000	$10,000	$50,000
	G. RMP Website Maintenance		$15,000		$15,000
Grand Total		$150,000	$1,103,000	$46,000	$1,299,000

2016 Status and Trends Monitoring and Reserve Funds

In 2014, the Steering Committee and Technical Review Committee revised the Status and Trends (S&T) sampling schedule to free up resources. The current schedule is shown in Figure 4.

Figure 4: RMP Status and Trends Monitoring Schedule



In 2016, bivalve and bird egg sampling will occur. The costs for bird egg monitoring are not included in the 2016 budget because funds were already allocated to this task from the 2015 budget. In addition, the RMP provides annual support to the USGS for suspended sediment and nutrient monitoring. This support will continue in 2016. The total cost for S&T monitoring in 2016 will be $691,100.

Another $436,730 will be contributed to reserve fund accounts. This total amount has three components. First, $250,000 will be added to the Designated Reserve Fund for S&T Monitoring to offset future S&T costs. Second, $86,730 will be returned to the Undesignated Reserve Fund to repay monies used for the Bay Margins Sediment Study in 2015. Finally, an additional $100,000 from program management savings will be added to the Undesignated Reserve Fund for future special studies, monitoring or other Program needs.

More information about each of the S&T tasks is provided in the line item budget (Table 5) and the sections below.

1. Field Work and Logistics ($132,000)

This task includes work by SFEI to assist with sampling and coordination ($35k); a subcontractor (Applied Marine Sciences) to plan cruise logistics, collect samples, ship samples to laboratories, and manage the sample archive ($75k); funds for renting the research vessel (the R/V *Questuary*) ($15k); and funds for other miscellaneous items ($7k).

2. Continuous Monitoring of Suspended Sediment ($250,000)

This work is led by Dr. David Schoellhamer of the USGS California Water Science Center. USGS maintains five suspended sediment stations in the Estuary with RMP funding (i.e., Mallard Island, Richmond Bridge, Alcatraz, Exploratorium, and Dumbarton Bridge). This funding leverages suspended sediment monitoring at 2 other stations (Benicia Bridge, Carquinez Bridge) and salinity at 8 stations that are funded by other partners. In addition, the RMP has used Special Studies funding to add dissolved oxygen sensor to 6 stations and nutrient parameter sensors to 3 stations. Discussions are underway to determine how to maintain the existing monitoring scheme in light of increasing costs and the available budget, which has been fixed at $250,000 since 1993. Funding is provided by the U.S. Army Corps directly to USGS.

3. Monthly Basic Water Quality ($223,000)

This work is led by Dr. Jim Cloern of the USGS in Menlo Park. The study performs monthly water sampling to map the spatial distributions and temporal trends of basic water quality parameters along the entire Bay-Delta system. Measurements include salinity, temperature, dissolved oxygen, suspended sediments, and phytoplankton biomass. This basic information is required to follow the seasonal changes in water quality and estuarine habitat as they influence biological communities and the distribution and reactivity of trace contaminants.

The S&T Multi-Year Plan included a budget for $223,000 for USGS nutrient monitoring support. The USGS has requested $192,000 to continue the baseline monitoring program in the Bay. However, this cost may need to increase as the USGS transitions to a new research vessel and extra monitoring may be needed during El Nino storms to document nutrient and sediment fluxes during rare but important conditions. Therefore, the difference ($31,000) has been budgeted for additional USGS monitoring support, particularly in the South Bay. RMP staff will work with USGS to develop a workplan for these funds which will be reviewed by the Technical Review Committee in December 2015 and presented to the Steering Committee in January 2016.

4. Bivalve Monitoring ($14,000)

The bivalve monitoring component maintains the long-term database started by the State Mussel Watch Program in the early 1980s. Bivalves are excellent trend indicators, particularly for organic contaminants. Because of logistical complexities, a randomized design is not economically feasible, nor is it technically desirable for this long-term trend monitoring tool. Samples will be collected at 7 targeted sites by Applied Marine Sciences on the Romberg

Tiburon Center's *R/V Questuary*. In 2016, bivalves will be sampled for selenium, PAHs, and PBDEs.

5. Sample Archive ($25,000)

The RMP stores archives of sediment, bivalve, bird egg, and sport fish samples, as well as other miscellaneous samples, in archives for potential future analyses. Short-term archives are stored at Schaeffer's Meat and Storage in Oakland. Costs in 2016 will cover continued storage of existing archives as well as the addition of new bird egg and bivalve archive samples collected in 2016. Long-term archives are stored at NIST in Charleston, South Carolina. Payments to NIST are made in odd-numbered years.

6. Margins Sediment Sampling: Data Analysis and Reporting ($31,100)

In 2015, funds freed up by reductions in water and open-Bay sediment monitoring were used to sample sediment on the margins of the Bay. Sediment samples were collected from 40 sites on the Bay margins and are being analyzed for mercury, PCBs, and trace metals. The results of this sampling event will be analyzed and published in a report in 2016 (preliminary presentation to TRC, March 2016; Draft report, September 2016; Final report, December 2016).

7. Analysis of S&T Data ($16,000)

Every two years, following the collection of ambient water samples, measured concentrations are compared to site-specific objectives triggers for copper and cyanide. The results of this analysis will be posted on the RMP website by December 2016. Additional funds from this task will be used to support other analyses of S&T data, as requested and in support of development and publication of RMP manuscripts.

8. Contributions to Reserve Funds ($436,730)

The approved budget for the Bay Margins Sediment Study was $257,470 over two years (2015-2016). The breakdown of the work was: planning and field work in 2015 for $226,370 and reporting in 2016 for $31,100. The planning budget allocations were $140,000 in 2015 and $120,000 in 2016 ($260,000 total). Therefore, the Steering Committee allocated $86,370 in Undesignated Reserve Funds to the 2015 budget with the understanding that the same amount would be returned to the Undesignated Reserve Funds from the 2016 budget. The small table below illustrates this accounting.

RMP Year	Allocation	Undesignated Reserve Funds	Total Budget	Expense	Task
2015	$140,000	$86,370	$226,370	$226,370	Planning and Field Work
2016	$120,000	-$86,370	$33,630	$31,100	Reporting
Total	$260,000	$0	$260,000	$257,470	

S&T Monitoring costs are variable year over year. In order to smooth out the annual cost of the program, contributions to a Designated Reserve Fund for S&T Monitoring are made in

years with lower direct costs. 2016 is a lower than average cost year. Based on a 10-year plan for S&T, $250,000 needs to be contributed to the Designated Reserve Fund in 2016.

An additional $100,000 in unbudgeted revenue will be placed in the Undesignated Reserve Fund for future use by the Steering Committee. These funds may be used for anything: communications, S&T monitoring, or special studies. They are included on Table 5 in order to keep all the contributions to reserve accounts in one place.

Table 5: Bay RMP 2016 Status and Trends Budget by Subtask.

Task	Subtask	Direct Cost	Labor	Subcontract	Grand Total
6. S&T Monitoring	A. Field Work and Logistics	$7,000	$35,000	$90,000	$132,000
	B. USGS Sacramento Support			$250,000	$250,000
	C. USGS Menlo Park Support			$192,000	$192,000
	D. USGS Monitoring			$31,000	$31,000
	E. Bivalve Monitoring			$14,000	$14,000
	G. Sample Archive	$25,000		$0	$25,000
	I. Bay Margins Sediment Study		$31,100		$31,100
	J. Analysis of S&T Data		$16,000		$16,000
	Subtotal	$32,000	$82,100	$577,000	$691,100
Contributions to Reserve Funds					
	A. Bay Margins Sediment Study	$86,730			$86,730
	B. S&T Monitoring Set-Aside Contribution	$250,000			$250,000
	C. Undesignated Funds	$100,000			$100,000
	Subtotal	$436,730			$436,730

2016 Special Studies

Most of the following studies have already been reviewed by the Technical Review Committee and Steering Committee and approved for incorporation into the 2016 RMP workplan. Two changes from the previously approved plans are requested.

First, the Nutrient Management Strategy has requested to reallocate the $300,000 approved for nutrient studies to different nutrient tasks than were originally proposed. The total budget will not change, just the tasks to be completed with that budget. The proposed tasks are described in the Nutrients section below. Therefore, approval of this workplan will reallocate the funds to the new tasks.

Second, the PCB special studies budget was cut from $80,000 to $40,000 by the Technical Review Committee in order to stay within budget. The planned deliverable, a report on the conceptual model for San Leandro Bay, cannot be completed with the available funding. An additional $20,000 is needed to complete this task. The workplan assumes that $20,000 will be allocated to this task from the 2017 budget.

The total costs for special studies in 2016 will be $858,000. Additional details on each of the studies are provided below, in the line item budget (Table 6), and in the full proposals that were presented to the TRC in June 2015 (attached).

Nutrients ($300,000)

Overview

San Francisco Bay has long been recognized as a nutrient-enriched estuary, but one that has historically proven resilient to the harmful effects of nutrient enrichment, such as excessive phytoplankton blooms and hypoxia. Available information suggests that the accumulation of phytoplankton biomass in the Bay is strongly limited by tidal mixing, grazing pressure by invasive clams, light limitation from high turbidity, and potentially, altered nutrient forms and ratios in the North Bay. However, evidence is building that, since the late 1990s, the historic resilience of the Bay to the harmful effects of nutrient enrichment is weakening. In response to these apparent changes in the Bay's resilience to nutrient loading, a Nutrient Management Strategy (NMS) was developed in 2012. In 2014, the NMS Steering Committee was formed to oversee NMS implementation.

In FY 2015, RMP special study funds were combined with about $880k of Bay-wide Nutrient Watershed Permit funds for conducting nutrient-related science and monitoring. In FY 2016, RMP special study funds will again be combined with Nutrient Watershed Permit funds. The two projects listed below will receive RMP funding, and are among the highest priority projects for FY 2016 that were approved by the NMS Steering Committee in June 2015 with science advisor and Nutrient Technical Workgroup input.

Moored Sensor Monitoring ($30,000)

While monitoring has occurred regularly in the Bay over the past 40 years, most of the data have been collected at weekly or monthly time intervals. Phytoplankton, nutrients, dissolved oxygen, and other parameters such as suspended sediment (which dictates the light available for phytoplankton growth) vary strongly over much shorter time scales (e.g., on an hourly basis) due to the daily cycle of photosynthesis and respiration in phytoplankton, mixing, biogeochemical processes, and tides. To better assess the Bay's condition on these time scales, and to collect high-frequency data to calibrate water quality models, the RMP launched a moored sensor network in 2013. Since 2013, a network of four stations have been installed south of the San Mateo Bridge as part of the core NMS moored sensor program. At each station, an instrument has been deployed that houses sensors for specific conductance (or salinity), temperature, depth, dissolved oxygen, turbidity, chlorophyll-a, fDOM, and phycocyanin. The sensors record a measurement every 15 minutes.

During 2016, each of the sensor sites will be visited approximately every 3 weeks for servicing, calibration, and downloading data. Work will also include deployment of a SUNA nitrate sensor at one or two sites. No new stations are planned for 2016. In addition to sensor maintenance, a greater emphasis will be placed in 2016 on data interpretation to better understand the factors that regulate the budgets and concentrations of DO, phytoplankton biomass, and nutrients. New funding requested for FY 2016 will be supplemented by remaining funds from FY 2014 and FY 2015.

Moored sensor activities in 2016 will include:

1. Sensor maintenance and calibration;
2. Data management, including QA/QC, and applying semi-automated routines to correct for noise and sensor drift;
3. Sensor calibration through discrete sample collection to improve accuracy and precision of predictions;
4. Install SUNA nitrate sensors at 1-2 sites and assess the importance of this data;
5. Continued development of the web-based platform (www.enviz.org) for visualizing and downloading historic and real-time continuous data, and;
6. Data analysis and interpretation to inform understanding about factors that influence DO, phytoplankton biomass, and nutrient cycling.

Deliverables:
1. Results will be summarized in the FY 2016 Annual Nutrients Science Program update (Draft in June 2016, Final in September 2016). Review by the Nutrient Technical Workgroup (NTW).
2. Enhanced web-based visualization platform (June 2016)

Monitoring Dissolved Oxygen in Shallow Margin Habitats ($200,000)

Low DO is a common symptom of excessive nutrient loads to estuaries and other water bodies. Most data on dissolved oxygen concentrations over the past 20+ years have been collected in deep subtidal habitats, but considerably less data is available for shallow margin habitats. Low DO occurs naturally in margin habitats like wetlands and sloughs, but there is

currently no coordinated, systematic monitoring across a representative set of sites that can provide data to characterize the frequency, duration, and severity of low DO events, or to explore underlying causes.

In 2016, funds for this project will be used to continue this work begun in 2015 to install, maintain, and interpret results from a four-station network of continuous monitoring stations in the shallow margin habitats of Lower South Bay. The major goals include:

1. Characterize temporal (tides, diel) and spatial patterns in DO and related parameters across a sites having a representative range of physical/biological characteristics;
2. Determine the frequency and duration of events with DO < 5 mg/L (and other relevant thresholds);
3. Through additional field measurements (vertical profiles during longitudinal transects), characterize the spatial extent of noteworthy events or common conditions,
4. Through the use of basic modeling and field data, semi-quantitatively test hypotheses for why low DO occurs

During 2016, each of the sensor sites will be visited approximately every 3 weeks for servicing, calibration, and downloading data. During regular maintenance trips and special field trips, DO will be measured in vertical profiles at stations along longitudinal transects in creeks and sloughs to spatially characterize conditions.

Deliverables:
1. Results will be summarized in the FY 2016 Annual Nutrients Science Program update (Draft in June 2016, Final in September 2016). Review by the NTW.

<u>Monitoring Program Development ($20,000)</u>

Considering the many years of anticipated water quality monitoring ahead and likely costs, the monitoring program will likely account for the largest portion of overall nutrient expenditures. Therefore, there is considerable benefit to carefully planning and designing the most efficacious yet cost-effective program. The Bay-Delta is fortunate in that long-term systematically collected monitoring data (~40 years) exist, plus data from a number of special studies that can be extensively mined. Through this project we will use historic monitoring data and other more targeted data sets to explore key questions that technical advisors identified as important for informing monitoring program design (SFEI, 2014), assessment framework development, and our overall understanding of ecosystem response to identify data gaps and priority studies.

Example questions include:

1. What is the optimal spatial/temporal resolution of sampling?
    a. What set of stations along the Bay's axis is optimal for charactering condition in the Bay, for individual and combinations of parameters?
    b. What spatial resolution is needed laterally, as a function of subembayment and season?
    c. Where should moored sensors be placed?
    d. What is the optimal blend of ship-based sampling and moored sensors?
2. Identifying spatial/temporal resolution of priority "events" (i.e., what are we trying to detect?)

   a. What spatial/temporal sampling scheme would be required to accurately characterize the magnitude of phytoplankton blooms that might translate to low DO conditions?
   b. What spatial/temporal sampling scheme would be required to detect and accurately characterize a HAB bloom having toxins above a threshold level?
3. How does photosynthetic efficiency (i.e., Fv/Fm, a measure of phytoplankton "health") vary spatially, and what factors most strongly predict this variability?

We will explore these questions through developing multivariate statistical models, and/or using hydrodynamic/tracer simulations to identify efficient networks of stations for "seeing" characteristic phytoplankton and toxin blooms. A detailed study design will be developed once the project receives provisional authorization. Funds requested for FY 2016 will be supplemented by remaining funds from FY 2014.

Deliverables:
1. Results will be summarized in the FY 2016 Annual Nutrients Science Program update (Draft in June 2016, Final in September 2016). Review by the NTW.

Remaining funds: allocation TBD ($50,000)
$50,000 of the general RMP Nutrients allocation has not yet been assigned to a specific project. Project(s) to be funded with these monies will be discussed with the Nutrient Management Strategy group and brought back to the RMP Steering Committee for review, including deliverables and expected due dates.

Deliverables:
1. Deliverables will be discussed as part of later project approval

Small Tributary Loadings Strategy[1] ($311,000)

The San Francisco Bay Hg and PCB TMDLs call for a reduction in loads by 50 and 90%, respectively. In response, the Municipal Regional Permit for Stormwater (MRP) calls for a range of actions including gaining a better understanding of which Bay tributaries contribute most loading to sensitive areas of biological interest on the Bay margin, better quantification of loads of sediments and trace contaminants on a watershed basis and regionally, a better understanding of how and where trends might best be measured, and an improved understanding of which management measures may be most effective in reducing impairment. These same needs are reflected in the small tributary loading strategy (STLS) priority questions. Much has been learned over the past 15 years and during the first MRP term from 2009 to 2014 but the focus of RMP funding was largely devoted to better understanding loadings. However, during the next permit term (MRP 2.0), an increased focus is being placed on identifying watersheds and areas within watersheds that are producing disproportional concentration and loads in relation to impairment in Bay margin areas. There will still be some effort on the loadings question and developing and implementing a plan to determine trends. At this time, the Water Board and BASMAA are not recommending any RMP effort on true source area identification or predicting

[1] SPLWG = Sources, Pathways and Loadings Workgroup. STLS = Small Tributary Loading Strategy Team.

the potential effectiveness of management actions. Consistent with this new focus, the following tasks and deliverables will be completed:

Small Tributaries Stormwater Characterization ($150,435)

Nearly half of the budget for small tributary load monitoring in 2016 will support a characterization study in the winter of 2015-16 (water year 2016) to identify additional watersheds with high-concentration sources areas for potential actions to reduce loads of PCBs and mercury. This study will largely mimic the program implemented during water year 2011 and 2015.

The basic design of this effort will be to collect one composite in the downstream reaches of at least 15 selected tributaries. Concentrations of PCBs, mercury, and other metals will be analyzed in water samples at all locations. In addition, a pilot study will be conducted at a subset of 9 locations to collect fine sediments using one of two remote sampler types, adding to the data collected during the 2015 water year. If this approach works, it will provide a highly cost-effective means of characterizing watersheds and subwatersheds for particulate bound pollutant concentrations during future monitoring years.

Deliverables:
1. Collection of stormwater samples (October 2015-April 2016) in at least 15 sites.
2. Report on Pollutants of Concern monitoring in WY 2016 (Draft in December 2016, Final in March 2017). Review by SPLWG and STLS.

Regional Watershed Spreadsheet Model ($35,000)

To accurately assess total contaminant loads entering San Francisco Bay, it is necessary to estimate loads from local watersheds. “Spreadsheet models” of stormwater quality provide a useful and relatively cheap tool for estimating regional scale watershed loads. Spreadsheet models have advantages over mechanistic models because the data for many of the input parameters required by those models do not currently exist, and also require large calibration datasets which take money and time to collect. Development of a spreadsheet model for the Bay has been underway since 2010 and to-date models and software development has been completed for water and copper, and draft models have been completed for suspended sediments, PCBs, and Hg.

The primary objective of this study is to provide a defensible estimate of regional and sub-regional scale loads of PCBs and total mercury. During 2015, it is anticipated that a fully calibrated PCB and mercury model will be completed based on data from about 25 calibration watersheds. Pending the outcomes of the 2015 work plan, STLS and the SPLWG will be consulted to agree upon and recommend the workplan for 2016. However, during 2016, further improvements will be made to the regional GIS component of the model along with experimentation with an increased calibration dataset (likely in excess of 45 sample locations). If budget allows, work will begin to publish the model software for use by STLS stakeholders.

Deliverables:

1. Update to report on model calibration, sensitivity analysis and documentation (Draft in September 2016, Final in December 2016). Review by SPLWG and STLS.

Watershed Loadings Trends Strategy Support ($99,565)

The objective of this task is to develop a Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for Task 1, carry out necessary pre-field season logistical support including site selection and reconnaissance, and then implement components of a winter season field monitoring program. The details of the work plan for this task will need to be worked out during the development of the Small Tributaries Loadings Trends Strategy in consultation with STLS and will be completed during the first quarter 2016.

Deliverables:
1. Sampling and Analysis Plan and Quality Assurance Project Plan prepared (Draft in August 2016, Final in October 2016). Review by SPLWG and STLS.
2. Outcomes of site selection and reconnaissance at 15+ sites compiled in master spreadsheet.

Small Tributary Loading Strategy Coordination ($26,000)

The RMP Small Tributaries Loading Strategy Team provides the forum for planning and coordinating projects for the improvement of information on small tributary loads to the Bay. Funds from this task will be used to provide support for coordination of efforts to address Small Tributary Loading Strategy management questions funded through the RMP program and those efforts funded and carried out by BASMAA. Funds will be used to prepare for and execute local STLS meetings, phone conferences and for staff to attend key meetings (i.e. BASMAA Monitoring/POCs Committee).

Deliverables:
1. 5-8 STLS meetings (March-December 2016)

Chemicals of Emerging Concern (CECs) ($130,000)

More than 100,000 chemicals have been registered or approved for commercial use in the U.S. For many of these chemicals, major information gaps limit the ability of scientists to assess their potential risks, and environmental monitoring of these chemicals is not required. Some of these chemicals have been classified as contaminants of emerging concern (CECs), often due to due to their high volume use, potential for toxicity in non-target species, and the increasing number of studies that report their occurrence in the environment. CECs can be broadly defined as synthetic or naturally occurring chemicals that are not regulated or commonly monitored in the environment but have the potential to enter the environment and cause adverse ecological or human health impacts.

The RMP has been investigating CECs since 2001 and developed a formal workgroup to address the issue in 2006. In 2013, the RMP finalized a three-element strategy to guide future work on CECs. The first element of the strategy is a continuation of targeted monitoring of CECs in San Francisco Bay via Special Studies, an RMP effort that has generated one of the world's

most comprehensive datasets for CECs in an estuarine ecosystem. The relative risk of detected CECs is evaluated using a tiered risk and management action framework.

The second element of the RMP CEC strategy involves review of the scientific literature and other CEC aquatic monitoring programs as a means of identifying new CECs for which no Bay occurrence data yet exist. The third element of the strategy consists of non-targeted monitoring, including a) broadscan analyses of Bay biota samples, and b) development of bioassays to identify estrogenic effects, techniques designed to identify previously unknown CECs present in the Bay. The RMP's CEC program provides data critical to efforts of regulators working to manage the ever-growing variety of chemicals in commerce to ensure that they do not adversely impact human and environmental health.

Fipronil, Fipronil Degradates, and Imidacloprid in Municipal Wastewater ($30,000)

Fipronil is a moderate concern (Tier III) CEC for the Bay. Recent RMP-funded monitoring of 24-hour composite samples of influent and effluent from eight Bay wastewater treatment plants (WWTPs) assessed dissolved phase concentrations of fipronil and degradates. A lack of information concerning levels of particle-associated contaminants limits the conclusions that can be drawn from existing data concerning the effects of treatment on contaminant discharges. This study will fill this data gap, by analyzing total water samples of influent and effluent. In addition, samples will be analyzed for imidacloprid, the most widely used neonicotinoid pesticide, and a compound that has been found to produce aquatic toxicity at extremely low levels. Findings are likely to influence ongoing efforts within the California Department of Pesticide Regulation and U.S. Environmental Protection Agency aimed at reducing environmental contamination and ecological impacts of both fipronil and imidacloprid.

Deliverables:
1. Manuscript on CEC monitoring in wastewater (Draft in March 2016, Final in June 2016). Review by ECWG

Non-targeted Analysis of Water-soluble CEC Compounds ($52,000)

Non-targeted analysis, a key element of the RMP's CEC strategy and recent state CEC guidance, can help to provide a measure of assurance that the RMP is not missing unexpected yet potentially harmful contaminants simply because of failures to predict their occurrence based on use or exposure prioritization criteria. The RMP has completed non-targeted analysis of fat-soluble compounds in bivalve tissue and seal blubber, but another major class of chemicals, water-soluble (polar) organic contaminants, has not been evaluated. This study will fill this data gap by conducting a broad screen of ambient Bay water (passive and grab samples) and wastewater (composite samples) for polar organic compounds such as: detergents and other surfactants, pesticide and pharmaceutical breakdown products, and plastic additives. This type of non-targeted study will lay the foundation for future targeted CEC monitoring by helping to identify new potential contaminants of concern without a priori knowledge of their occurrence.

Deliverables:

1. Report and fact sheet on non-targeted analysis of water soluble CEC compounds (Draft in March 2017, Final in June 2017).

CEC Strategy Support ($48,000)

Increasing engagement on emerging contaminants issues by the San Francisco Bay Regional Water Board, RMP stakeholders, and the general public is reflected in headline news as well as policy actions at local, state, and federal levels. Work to advance the RMP's Emerging Contaminants Strategy has increased significantly in the last year, driven by increased demand for independent information on key contaminants. Critical new deliverables, such as assisting the Water Board as the agency prepares emerging contaminants action plans for the Bay, have been added to the primary deliverables of this strategy: Tracking new information regarding contaminant occurrence and toxicity and updating the RMP's tiered risk and management action framework for emerging contaminants in San Francisco Bay (see Sutton et al. 2013, http://www.sfei.org/documents/contaminants-emerging-concern-san-francisco-bay-strategy-future-investigations).

In 2016, CEC strategy support will also include coordination of pro bono studies on pharmaceutical concentrations in wastewater treatment plants.

Deliverables:
1. Assist the Water Board in preparing emerging contaminant action plan
2. Update the CEC Strategy document with the latest tiered placement of chemicals, information needs and proposed studies, and a 5-year plan for research (Final in March 2017). Review by Emerging Contaminants Workgroup.
3. Coordinate pro-bono study on pharmaceutical contaminants in wastewater effluent

PCBs ($40,000)

A synthesis and conceptual model update published in 2014 shifted the focus of the PCB strategy from the open Bay to the contaminated areas on the margins where impairment is greatest, where load reductions are being pursued, and where reductions in impairment, in response to load reductions, will be most apparent. The goal of the RMP PCB Strategy work over the next few years is to inform the review and possible revision of the PCB TMDL and the reissuance of the Municipal Regional Permit for Stormwater (MRP), both of which are tentatively scheduled to occur in 2020. Conceptual model development for a set of representative priority margin units (PMUs) will provide a foundation for establishing an effective and efficient monitoring plan to track responses to load reductions and also help guide planning of management actions.

Tasks in 2016 will include 1) initiating development of a conceptual site model and first order mass budget for the San Leandro Bay Priority Margin Unit (PMU) and 2) convening the PCB strategy team and updating the PCB multi-year plan in support of the PCB TMDL.

Task 1: The approach for this task will be similar to the approach used to conduct this analysis on the Emeryville Crescent Priority Margin Unity. A relatively large Conceptual Site

Model Workgroup (CSMW) will be assembled that includes members of the PCB Strategy Team, along with experts on potential biotic indicators, sediment movement from watersheds to margins to the open Bay, and local conditions. This CSMW will meet two to three times to develop and document conceptual understanding and a monitoring plan for the PMU. Task 1 cannot be completed with the funds allocated for 2016 ($30K). Task 1 will be completed in early 2017 using additional funds (estimated at $20K) from the 2017 budget.

More detailed budgets will be developed and subject to PCB Workgroup, TRC and SC approval as planning proceeds.

Task 2: Funds for this task would enable SFEI to continue to convene the PCB Strategy Team to allow discussions of plans for the next iteration of the TMDL and RMP activities that can inform the TMDL, and for any small-scale synthesis of information that is needed to support these discussions. The plan will include a multi-year plan schedule of budgets and deliverables aimed at providing a technical foundation for the next iteration of the TMDL. Depending on the outcomes of the site model evaluations, this RMP expenditure for continued Strategy Team discussions may need to be augmented or complemented by other forums for discussing TMDL revision.

Deliverables:
1. Updated PCB multi-year plan, including schedule of budget and deliverables (June 2016). Review by PCB Strategy team.
2. Priority Margin Unit Conceptual Model Report (Draft in April 2017, Final in July 2017). Review by PCB Strategy Team. NOTE: This deliverable assumes that additional funding ($20,000) will be allocated to this task in 2017.
3. PCB Strategy Team Meetings

Selenium ($47,000)

In April 2014 the RMP formed a Selenium Strategy Team to evaluate low-cost, near-term information needs that can be addressed by the Program in the next several years.

<u>Sturgeon Derby Monitoring ($37,000)</u>

A second year of Sturgeon Derby monitoring will be conducted in collaboration with an annual sturgeon fishing derby held out of Martinez. This Derby offers the opportunity to collect a variety of tissue samples from fish caught for the competition. This will allow for comparison between selenium concentrations measured in tissues that are easy to obtain non-lethally (muscle plugs, fin rays) and those that are not, but may be of greater interest toxicologically (ovaries) or analyzed for microchemistry (otoliths, compared to fin rays).

This study will be performed in collaboration with USFWS, USGS, and Stantec. SFEI staff will plan the study, perform sampling, manage the data, and write a brief technical report. USGS (Robin Stewart and her team) will analyze selenium and stable isotopes of C, N, and S in the plugs, and selenium in the ovaries. The stable isotopes will provide information on diet and

habitat use by the sturgeon. Stantec (Vince Palace and his team) will perform sampling and analysis of fin rays and otoliths. USFWS will assist with sample collection. The sampling would occur on Super Bowl weekend in 2016.

Tissues will be collected from up to fifteen female white sturgeon. Muscle plugs will be collected by SFEI and analyzed by USGS. Splits of the ovary samples will also be obtained from USFWS for analysis by USGS. Fin ray and otolith samples will be collected and processed by Stantec for selenium microchemistry analysis. Otoliths samples will be used to help develop the analysis method for fin rays, which can be collected from sturgeon non-lethally during future monitoring efforts.

Deliverables:
1. Draft and final Reports on Selenium in Fish Tissue from the 2016 Sturgeon Derby (draft December 2016, final February 2017). Review by Selenium Strategy Team.

Selenium Strategy Support ($10,000)

The Selenium Strategy Team provides the forum for planning and coordinating projects for the improvement of information on selenium in the Bay. This task will include one or two meetings in 2016 to coordinate monitoring, provide updates and solicit input on current projects, and plan projects for 2017 and beyond.

Deliverables:
1. Selenium Strategy Team meeting (May).

Exposure and Effects ($30,000)

The 10 day survival toxicity test with the amphipod *Eohaustorius estuarius* is the primary sediment protocol used in the Regional Monitoring Program and the State Water Resources Control Board's Sediment Quality Objective program. However, historical data have indicated that the mortality of this species correlates with the clay content of sediments. A 2014 RMP special study showed that sediment clay causes size-specific effects on the amphipod *Eohaustorius estuarius* in laboratory experiments.

Experiments with field sediments from the San Francisco Estuary will be used to corroborate the laboratory experiments conducted in 2014, which showed that larger amphipods were less tolerant of kaolin clay. These results have the potential to inform policy regarding the use of this species in monitoring clay-rich sediments. These experiments may result in a revision of the toxicity testing protocol to use smaller test organisms to minimize the confounding effect of clay on toxicity test results.

Deliverables:
1. Draft and final report on study results (March 2016, June 2016). Review by Exposure and Effects Workgroup.
2. Recommendation for revision of the 10d sediment protocol using *E. estuarius* for high clay sediments (June 2016).

Table 6: Bay RMP 2016 Special Studies Budget by Subtask.

Task	Subtask	Direct Cost	Labor	Subcontract	Grand Total
7. Special Studies	Nutrient Moored Sensor Monitoring	$0	$30,000	$0	$30,000
	Nutrients Margins DO Monitoring	$10,000	$150,000	$40,000	$200,000
	Nutrient Monitoring Program Development		$20,000		$20,000
	Nutrient Program Unallocated		$50,000		$50,000
	STLS Wet Weather Characterization	$13,415	$108,400	$28,620	$150,435
	STLS Regional Watershed Model		$35,000		$35,000
	STLS Trends Strategy		$99,565		$99,565
	STLS Strategy Coordination		$26,000		$26,000
	EC Fipronil Report	$1,150	$23,150	$5,700	$30,000
	EC Non-Targeted Analysis	$3,150	$25,850	$23,000	$52,000
	EC Strategy Support		$33,000		$33,000
	EC Strategy Update		$15,000		$15,000
	PCB: PMU Conceptual Model		$40,000		$40,000
	Selenium 2016 Derby Monitoring	$750	$21,775	$14,475	$37,000
	Selenium Strategy Support		$10,000		$10,000
	EE Sediment Toxicity Study			$30,000	$30,000
Grand Total		$28,465	$687,740	$141,795	$858,000

Appendix A: Bay RMP 2016 Programmatic Task Descriptions, Budget Justifications, and Deliverables.

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
1. Program Management	A. Program Planning	Labor	$40,000	$25,000 to produce the annual workplan and Multi-Year Plan (40 hours for Program Manager, 20 hours for Lead Scientist, 40 hours for Environmental Analyst, 8 hours each for 7 senior staff to contribute to the plans). $15,000 for miscellaneous activities as needed.	Preparing annual workplans and budgets (Detailed Workplan, Multi-Year Plan) plus other program planning activities.	2017 Multi-Year Plan (draft in October '16, final in January '17), 2016 Detailed Workplan (draft in October '16, final in January '17)
1. Program Management	B. Contract and Financial Management	Labor	$160,000	580 hours for Contracts Manager and staff. 432 hours for accountant. 410 hours (8 hr/wk collectively) for Program Manager and 3 staff.	Tracking expenditures versus budget, accounting, updating planned hours, working with auditors, preparing financial updates to RMP SC, developing contracts, overseeing contracts, invoicing stakeholders, updating the MOU between SFEI-ASC and the Water Board as needed.	Quarterly financial updates to SC. Quarterly updates to planned budget in accounting software.
1. Program Management	B. Contract and Financial Management	Direct Cost	$0	Audit fees will be covered by SFEI-ASC.		
1. Program Management	B. Contract and Financial Management	Direct Cost	$1,000	Bank activity charges		
1. Program Management	B. Contract and Financial Management	Direct Cost	$3,000	Fees for legal consultations		

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
1. Program Management	C. Technical Oversight	Labor	$50,000	For Lead Scientist 80 hours (1.5 hr/wk) each. For 3 Senior Scientists: 60 hours (1.2 hrs/wk) each. For Program Manager 40 hours.	Review of work products by Lead Scientist, Program Manager, and Senior Scientists to ensure the quality of RMP deliverables.	Improved quality work products
1. Program Management	D. Internal Coordination	Labor	$75,000	For Program Manager: 140 hours (2.8 hr/wk) for workflow planning, deliverables tracking, and planning meetings with Lead Scientist and staff. For Lead Scientist: 80 hours (1.6 hr/wk) for planning meetings with Program Manager and other staff. For Environmental Analyst: 100 hours for planning meetings. For other RMP Staff: 32 hours each for quarterly RMP All Staff meetings and quarterly meetings with Program Manager.	Workflow planning, tracking deliverables, and holding staff meetings.	RMP Deliverables Tracking System and Stoplight Reports (quarterly at SC meetings)
1. Program Management	E. External Coordination	Labor	$50,000	280 hours total, assuming 5.6 hours/week for senior scientists and ED collectively.	Participation in meetings with external partners to coordinate programs (e.g., linking RMP monitoring with SWAMP, meeting with SCCWRP, serving as liaison to the Delta RMP and other RMPs)	Program efficiencies through coordination with partners.

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
1. Program Management	F. Administration	Labor	$8,000	86 hours (1.7 hr/wk) for administrative staff.	Office management assistance (e.g., ordering supplies, arranging travel) plus direct costs of supplies, postage, technical reports and software.	
1. Program Management	F. Administration	Direct Cost	$500	Office Supplies		
1. Program Management	F. Administration	Direct Cost	$500	Project-specific mailings		
1. Program Management	F. Administration	Direct Cost	$500	Courier expenses for documents. Charges for shipping samples are not included in this line. They are included in S&T monitoring budgets		
1. Program Management	F. Administration	Direct Cost	$2,000	Specialized technical and program management software. Includes $100 for SmartSheet license		
1. Program Management	F. Administration	Direct Cost	$2,500	Subscriptions to access online scientific articles. Technical books or journals. Downloads of journal articles.		

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
2. Governance	A. SC meetings	Labor	$55,000	4 meetings per year. For each meeting: 33 hours for Program Manager, 40 hours for Environmental Analyst, 12 hours for Lead Scientist, 6 hours each for RMP senior scientists to prepare and participate in part of the meeting.	Preparing agendas, agenda packages, participating in meetings, writing meeting summaries, action item follow-up, reviewing minutes from past meetings. Pre-meeting with Chair and Co-Chair.	4 SC meetings
2. Governance	A. SC meetings	Direct Cost	$2,000	Catering for Steering Committee meetings. Typical catering cost is $400 per meeting. 4 meetings per year.		
2. Governance	B. TRC meetings	Labor	$58,000	4 meetings per year. For each meeting: 33 hours for Program Manager, 40 hours for Environmental Analyst, 12 hours for Lead Scientist, 6 hours each for RMP senior scientists to prepare and participate in part of the meeting. 16 hours for data mgmt staff to prepare for December presentations.	Preparing agendas, agenda packages, participating in meetings, writing meeting summaries, action item follow-up, reviewing minutes from past meetings.	4 TRC meetings
2. Governance	B. TRC meetings	Direct Cost	$2,000	Catering for Technical Review Committee meetings. Typical catering cost is $400 per meeting. 4 meetings per year.		

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
2. Governance	C. WG meetings	Labor	$92,000	7 workgroup meetings. For each senior scientist, 70 hours to prepare proposals and participate in workgroup meeting (140 hours for ECWG). Staff support to take notes.	Preparing proposals for special studies, agendas, agenda packages, participating in meetings, writing meeting summaries, action item follow-up, reviewing past meeting minutes.	7 Workgroup meetings - ECWG (April), SPLWG (May), EEWG (TBD), PCB (TBD), Dioxin (TBD), Selenium (TBD), Sport Fish WG (spring)
2. Governance	C. WG meetings	Direct Cost	$2,500	Catering for Workgroup meetings. Typical catering cost is $300 per meeting. 7 meetings per year.		
2. Governance	D. External Science Advisors	Direct Cost	$50,000	Honoraria for external advisors to RMP Workgroups, including the nutrient workgroup. Assumes $2k honoraria for 25 advisors	Honoraria and travel for external science advisors.	
2. Governance	D. External Science Advisors	Direct Cost	$10,000	Travel expenses for external advisors		
3. Data Management	A. Data Mgmt for 2015 S&T Water Samples	Labor	$25,000	115 hours for Data Mgmt staff and senior scientists for ratio review.	Formatting, performing QA/QC review, and uploading RMP field and analytical results from laboratories to SFEI's RDC database and replicating to CEDEN. Maintaining the database of archived RMP samples and coordinating with archive facilities.	Processing and upload 2015 S&T water data (December). QA dataset summaries for 2015 S&T water data (December).

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
3. Data Management	B. Data Mgmt for 2016 S&T Bird Egg Samples	Labor	$60,000	340 hours for Data Mgmt staff and senior scientists for ratio review.	Preparations, formatting, performing QA/QC review, and uploading RMP field and analytical results from laboratories to SFEI's RDC database and replicating to CEDEN. Maintaining the database of archived RMP samples and coordinating with archive facilities.	EDD templates for 2016 S&T bird egg data (February). Preparations, processing and upload 2016 S&T bird egg data (December). QA dataset summaries for 2016 S&T bird egg data (December).
3. Data Management	C. Data Mgmt for 2016 S&T Bivalve Samples	Labor	$30,000	208 hours for Data Mgmt staff and senior scientists for ratio review.	Preparations, formatting, performing QA/QC review, and uploading RMP field and analytical results from laboratories to SFEI's RDC database and replicating to CEDEN. Maintaining the database of archived RMP samples and coordinating with archive facilities.	EDD templates for 2016 S&T bivalve data (September). Preparations, processing and upload 2015 S&T bivalve data (July '17). QA dataset summaries for 2016 S&T bivalve data (July '17).

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
3. Data Management	D. Database Maintenance	Labor	$50,000		Incorporating updates and corrections to data as needed, including re-analyzed results and updates implemented by CEDEN/SWAMP.	(1) Update data results as requested by PIs, data providers and CEDEN. (2) Apply updates to servers as needed; create backups of data on a regular basis. (December). (3) CEDEN uploads or updates for past RMP datasets: (a) 2005-2012 EBMUD reanalyzed sediment samples, (b) 2005-2007, 2011, 2012, 2014 Revised EBMUD sediment results for Fipronil, (c) 2014 seal serum data, 2014 effluent data for PFC and Fipronil, and 2006-2013 PRC data. (d) 2014 alternative flame retardants data (December).(4). Additional Data cleanup tasks: (a) Update QA Code for PCB coelutions to be CEDEN comparable; (b) investigate records that have a rejected QA Code but do not have a Compliance Code that indicates rejection; (c) Review archive database and identify old archive samples for possible disposal (December).

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
3. Data Management	E. Online Data Access: CD3	Labor	$65,000		Adding enhancements and updates to web-based data access tool CD3.	(1) Enhance Direct Download by adding spatial selection functionality (July); (2) Integrate the display of data from CEDEN (e.g., visualize other data from the Central Valley) (September); (3) Provide access to other types of data that are stored in database (e.g., runoff, benthic) (December); (4) Transition to new Pulse graphic procedures (December); (5) Develop data exchange services so Delta RMP preliminary and final data can be easily shared with the Estuaries Workgroup Portal (December); (6) Provide general tool upkeep and maintenance (December).

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
3. Data Management	F. Online Data Access: Archive Sample Tool	Labor	$11,000		Maintaining and enhancing the Archive Data Review Tool	(1) Enhance archive tool based on user feedback: (a) Add handling for import from .xls and . xlsx (currently only csv), (b) Refresh grid after successfully saving transaction, (c) Add better error/success reporting for uploads, (d) Add validation for uploads (on a field by field basis) for field specific data types and business rules; include useful, field specific messages, (e) Change items per page to have an unlimited option, (f) Create standardized upload template, (g) Set-up active fiters to filter select list options, (h) Add in Sample Availalbe Yes/No Field for users; (2) Develop documentation (December); (3) Provide general tool upkeep and maintenance (December)

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
3. Data Management	G. Quality Assurance System	Labor	$30,000		Updating the Quality Assurance Project Plan, writing a summary QA Report, conducting interlaboratory comparison tests, and researching analytical methods. Maintaining the SFEI laboratory SOP file system.	Updated QAPP (March). Summary memo for 2015 S&T Monitoring (December).
3. Data Management	G. Quality Assurance System	Subcontract	$10,000	Funds for interlaboratory comparison studies		
3. Data Management	H. Updates to SOPs and Templates	Labor	$30,000		Developing and enhancing software tools and processes such as EDD templates and writing and maintaining internal SOPs to increase efficiency of data management tasks	(1) Modify QA queries for the tissue template to meet CEDEN's business rules; (2) Make any modifications needed to accommodate revisions in CEDEN's business rules and data checker.
4. Annual Reporting	A. RMP Update Report	Labor	$40,000	Assuming 80 hours for Lead Scientist, 180 hours for technical staff, and 40 hours for graphics/web staff. Additional Notes: 2014 RMP Update cost $83k ($65k labor, $18k printing/postage).	Preparing technical content (text, analyses, graphics) and web presence. Managing contractors for design, editorial content, and printing/mailing.	2016 RMP Update Report (September)
4. Annual Reporting	A. RMP Update Report	Direct Cost	$25,000	Printing and mailing costs for hard-copy report. For RMP Updates, the print run will be 1,200 copies.		
4. Annual Reporting	A. RMP Update Report	Subcontract	$20,000	Subcontracts for graphic design.		

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
4. Annual Reporting	B. Annual Meeting	Labor	$44,000	Budget assumes 60 hours for Environmental Analyst, 36 hours for Program Manager, 35 hours for Lead Scientist, 30 hours for Design, 64 hours for administrative staff, 8 hours for IT staff, presentations by 4 Senior Scientists (20 hrs to prepare and deliver each), and attendance at the meeting by 8 additional RMP staff for a total of $45k.	Developing the meeting agenda, managing logistics, advertising about the meeting, managing attendee registration, preparing presentations, staffing the meeting. Direct costs for Save the Date mailings, venue, and catering. Travel funds for outside speakers.	2016 Annual Meeting (September)
4. Annual Reporting	B. Annual Meeting	Direct Cost	$1,000	Save the Date cards printed and mailed to RMP distribution list (900 people). Costs include printing and mailing since this will be done by the same contractor (Bay Area Graphics).		
4. Annual Reporting	B. Annual Meeting	Direct Cost	$20,000	Venue rental and catering for RMP Annual Meeting or contribution to SOE Meeting		
4. Annual Reporting	B. Annual Meeting	Subcontract	$2,000	Design consultant for Save the Date card		
4. Annual Reporting	B. Annual Meeting	Direct Cost	$2,000	Travel to RMP Annual Meeting for invited speakers.		

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
4. Annual Reporting	C. Annual Monitoring Report	Labor	$10,000	Assuming 40 hours for Environmental Analyst and 60 hours for other technical staff.	Preparing a summary report to document the outcome of the previous S&T field season (stations visited, samples collected, target analytes).	2016 Annual Monitoring Report (December)
5. Communications	A. Communications Plan Implementation	Labor	$20,000	Each quarter: 10 hours for Lead Scientist and 5 hours for Program Manager, Environmental Analyst, Senior Scientist, Graphic Designer, and Web Manager.	Coordinating the distribution of RMP information to stakeholders, natural resource managers, and the public through multiple media channels (e.g., Estuary News, website, publications, email newsletters, fact sheets, social media, etc.). Coordinating and reviewing content for the newsletter.	4 issues of Estuary News with RMP content (quarterly). 4 RMP eUpdate Newsletters (quarterly).
5. Communications	A. Communications Plan Implementation	Direct Cost	$12,000	Contribution to SFEP to Estuary News		
5. Communications	A. Communications Plan Implementation	Direct Cost	$3,000	Subcontract for Estuary News content		
5. Communications	B. Stakeholder Engagement	Labor	$25,000	80 hours for Program Manager, 24 hours for Lead Scientist, 20 hours for Executive Director, 8 hours each for Senior Scientists.	Preparing for and attending RMP stakeholder meetings (e.g., BACWA, BASMAA, LTMS, WSPA, RB2) as well as communicating directly with stakeholder representatives.	RMP presentations at BACWA, BASMAA, LTMS, BPC, WSPA, and RB2 Meetings.

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
5. Communications	C. Responses to Information Requests	Labor	$20,000	Assuming 160 hours (3 hrs/wk) for all technical staff.	Responding to inquiries for RMP data and reports, including press calls.	Timing delivery of RMP information to stakeholders. Timely responses to press calls.
5. Communications	D. Fact Sheets and Outreach Products	Labor	$10,000	Assuming 32 hours of design staff time and 76 hours of technical staff time.	Producing technical content and design for fact sheets on high profile RMP topics	2 Fact Sheets (content TBD).
5. Communications	D. Fact Sheets and Outreach Products	Direct Cost	$500	Printing costs		
5. Communications	D. Fact Sheets and Outreach Products	Subcontract	$4,000	Subcontractor for graphic design		
5. Communications	E. Presentations at Conferences and Meetings	Labor	$30,000	Assumes partial coverage for RMP posters or presentations at up to 6 conferences or local meetings (a total of 205 hours of technical staff time).	Preparation for and participation in workshops and conferences for SWAMP, NorCal SETAC, ACS, and other professional organizations; as well as presentations at local meetings. Direct costs for travel and conference registration. Subcontracts for poster design and layout.	Presentation of RMP data at up to 6 conferences or local meetings (December).
5. Communications	E. Presentations at Conferences and Meetings	Subcontract	$10,000	Subcontractor for graphic design		Up to 6 posters with RMP data for conferences.

Task	Subtask	Expense Type	Budget Final	Budget Estimate Notes	Description	Deliverables
5. Communications	E. Presentations at Conferences and Meetings	Direct Cost	$10,000	Travel and registration costs for RMP staff to attend conferences, workshops, and local meetings. Assuming 4 conferences at $2,000 per conference plus $2,000 for travel costs for local meetings.		
5. Communications	G. RMP Website Maintenance	Labor	$15,000	Assuming 60 hours for IT staff, 40 hours for design staff, 40 hours for Environmental Analyst, 8 hours for EI Director.	Updating the RMP website with new reports and items. Funds for online data access tools (e.g., CD3) are in the Data Management budget.	Updates to website with new reports and content (at least quarterly).

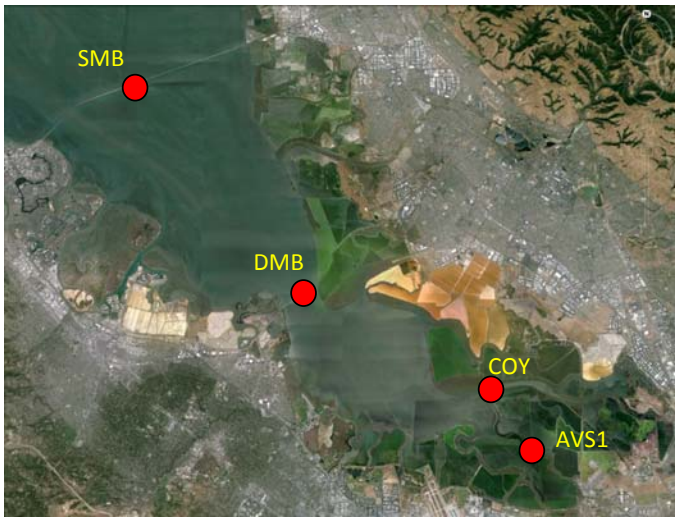
Special Study: Nutrients Strategy

Program

Since 2012, San Francisco Bay regulators and stakeholders have been working collaboratively to implement the San Francisco Bay Nutrient Management Strategy (NMS). In 2014, the NMS Steering Committee was formed to oversee NMS implementation. The Regional Monitoring Program was an early and important funder of NMS efforts. In FY2015, RMP special study funds were combined with ~$880,000 from a Bay-wide Nutrient Watershed Permit, to conduct nutrient-related science and monitoring. In FY2016, RMP special studies will again be combined with Watershed Permit funds. At its June 12 2015 meeting, the NMS Steering Committee approved a slate of recommended projects and budget for FY2016. The two projects below, which are among the highest priority projects for FY2016 based on science advisor and Nutrient Technical Workgroup input, are being proposed for RMP 2016 funding.

Proposal 1A: Moored Sensor Monitoring

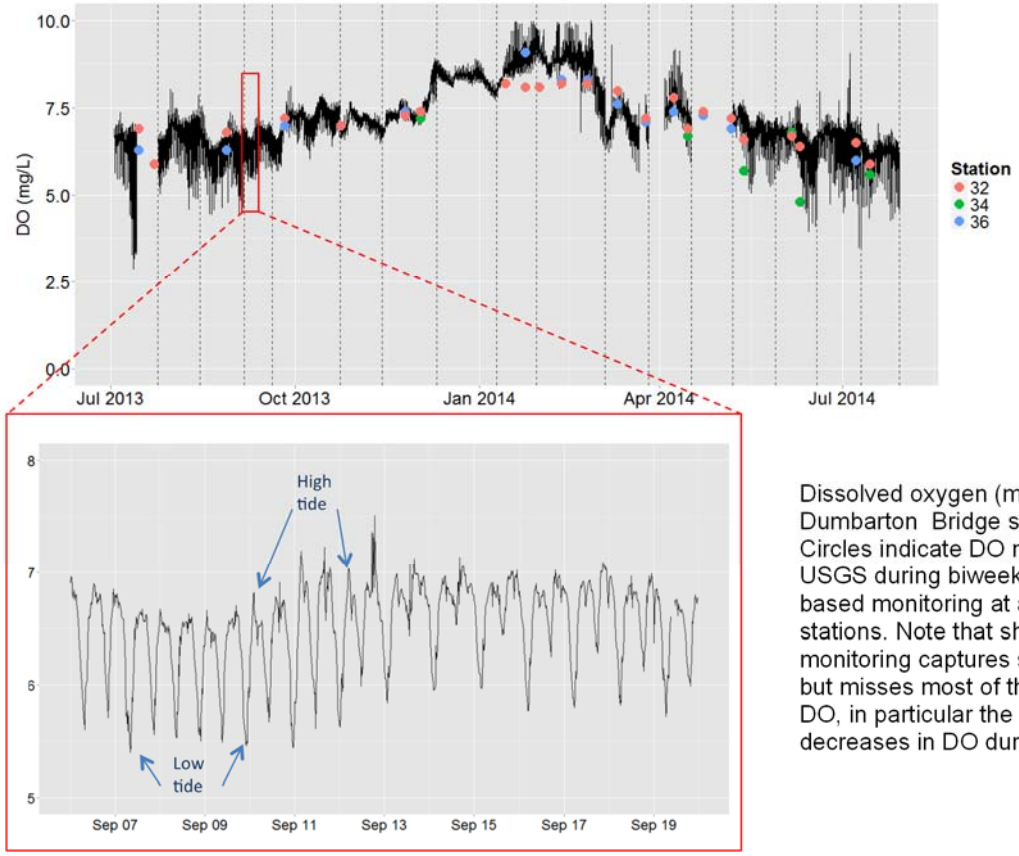
While scientific studies and monitoring by the USGS, DWR-EMP, and RMP have provided several decades of water quality data in the Bay, most of the data have been collected at weekly-monthly time intervals. Phytoplankton biomass and related parameters such as nutrients, dissolved oxygen, and light levels vary strongly over much shorter time scales (hours) due to diel cycles, mixing, biogeochemical processes, and tides. To better assess the Bay's condition, and to collect high-frequency data to calibrate water quality models, the RMP launched a moored sensor network in 2013. We propose this work be continued in 2016, with an increased emphasis on data interpretation to better understand the factors that regulate the budgets and concentrations of DO, phytoplankton biomass, and nutrients.



Over the past 2+ years, a network of 4 stations has been installed south of the San Mateo Bridge as part of the core Nutrient Management Strategy (NMS) moored sensor program (left). At each station, an instrument has been deployed that houses sensors for specific conductance (or salinity), temperature, depth, dissolved oxygen, turbidity, chlorophyll-a, fDOM, and phycocyanin. During 2016, each sensor sites will be visited every ~3 weeks for servicing, calibration, and downloading data. The sensors record a measurement every 15 minutes.

The high-frequency data from these moored sensors are already offering new insights into the processes that regulate observed phytoplankton abundance and dissolved oxygen in the open Bay

(SFEI 2014). Exchange with the shallow margin habitats, like sloughs and creeks, appears to have a strong influence on water quality in open-bay areas of Lower South Bay (see DO and chl-a graphics below). The substantial changes in some parameters over periods of just a few hours demonstrate that such high frequency data are going to be essential for accurately calibrating the biogeochemical models needed to predict ecosystem condition and evaluate the effectiveness of potential management actions.

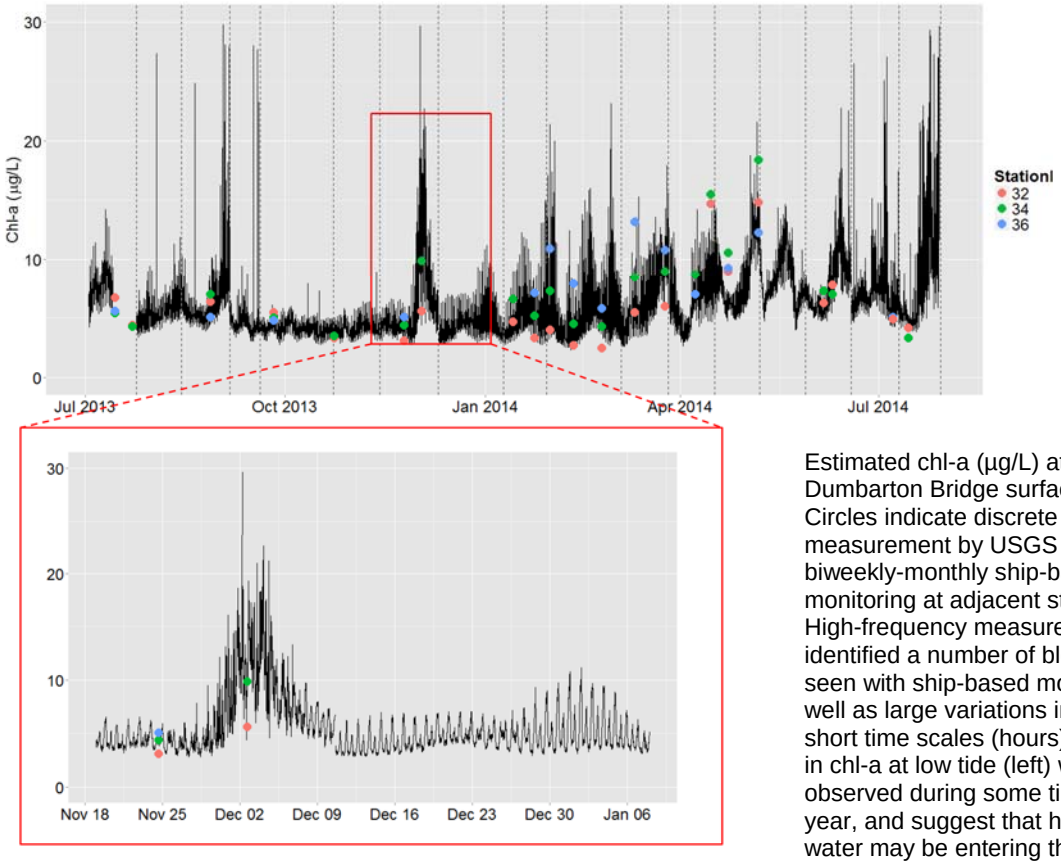


Dissolved oxygen (mg/L) at the NMS Dumbarton Bridge surface sensor. Circles indicate DO measurement by USGS during biweekly-monthly ship-based monitoring at adjacent stations. Note that ship-based monitoring captures seasonal trend but misses most of the variability in DO, in particular the substantial decreases in DO during ebb tides.

In 2016, moored sensor activities will include:

- Sensor maintenance and calibration. Periodic maintenance will occur every ~3 weeks, requiring 2-3 boat days per maintenance cycle.
- Data management, including QA/QC, and applying semi-automated routines to correct for noise and sensor drift
- Sensor calibration through discrete sample collection, as well as data analysis and possible field experiments, if possible, to improve accuracy and precision of predictions.
- Install SUNA nitrate sensors at 1-2 sites and assess the importance of this data (one sensor already purchased).
- Continued development of the web-based platform (www.enviz.org) for visualizing and downloading historic and real-time continuous data, where stakeholders and scientists can visualize and download data.
- Data analysis and interpretation to inform understanding about factors that influence DO, phytoplankton biomass, and nutrient cycling.

Over the past 2 years, the moored sensor effort has been understaffed in terms of time available to more fully interpret the large volume of data that is being amassed. A new full-time scientist will begin at SFEI in August 2015 whose time will be split between moored sensor and DO in margin work (discussed below). This will greatly increase our capacity for interpreting the moored sensor data, and identifying future directions for this program. No new stations are planned for 2016.



Estimated chl-a (µg/L) at the NMS Dumbarton Bridge surface sensor. Circles indicate discrete chl measurement by USGS during biweekly-monthly ship-based monitoring at adjacent stations. High-frequency measurements identified a number of blooms not seen with ship-based monitoring, as well as large variations in chl-a over short time scales (hours). Increases in chl-a at low tide (left) were observed during some times of the year, and suggest that high-chl-a water may be entering the open bay from sloughs and creeks.

Deliverables

- Technical report (draft, Q2 of 2016) that analyzes and interprets data from 2013-2015, and uses that data to quantitatively explore carbon, oxygen, and nutrient budgets. The report will also offer recommendations for continued moored sensor program work.
- Enhance the web-based data visualization platform to include new stations added in 2015, and add important features (e.g., real-time data, data-download) or enhancements.

Estimated cost: Option 1-$200,000; Option 2-$150,000
Oversight Team: Nutrients Strategy Team
Proposed By: David Senn and Emily Novick

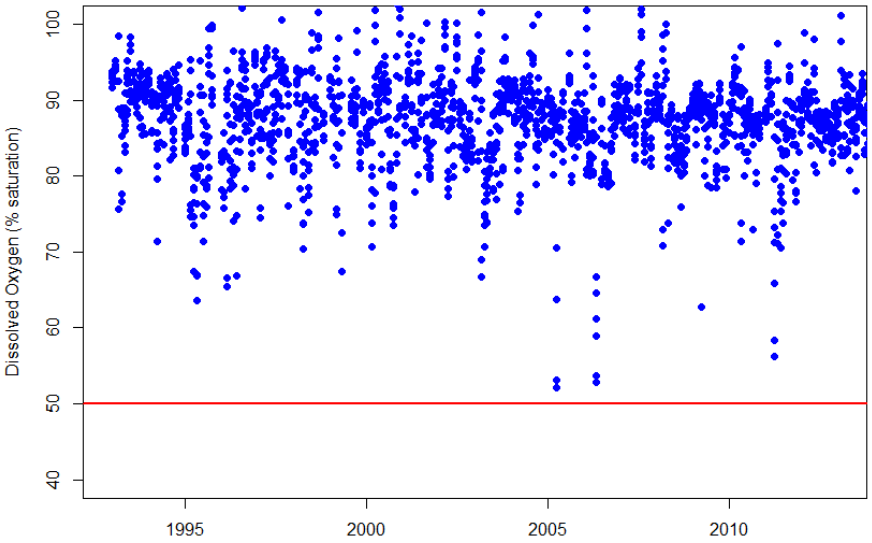
Budget Justification

Of the proposed $200,000, $150,000 will be used to support personnel working on maintenance, data interpretation, etc. $40,000 will be directed to USGS-Sacramento for field logistic support and scientific support (e.g., time series analysis). Small equipment, consumables, and discrete sample analysis will cost $10,000.

Proposal 1B: Monitoring Dissolved Oxygen in Shallow Margin Habitats

This proposed project will continue work begun in 2015 to install, maintain, and interpret results from a several-station network of continuous monitoring stations for low dissolved oxygen (DO) and other parameters in shallow margin habitats (creeks, sloughs) in Lower South Bay. The overall goals of the project include collecting monitoring data to assess condition with respect to DO in sloughs, and to inform our understanding of the major factors regulating DO in sloughs and creeks

Low DO is a common symptom of excessive nutrient loads to estuaries and other water bodies, and results from oxygen consumption during microbial degradation of organic matter (e.g., phytoplankton). Because of its well-established mechanistic link to nutrients, dissolved



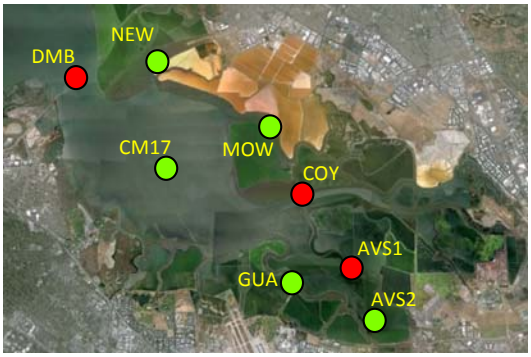
DO %saturation in bottom waters in deep subtidal areas at all USGS stations south of the Bay Bridge, 1993-2013. 100% saturation corresponds to 8.5±1.5 mg/L depending on temperature and salinity.

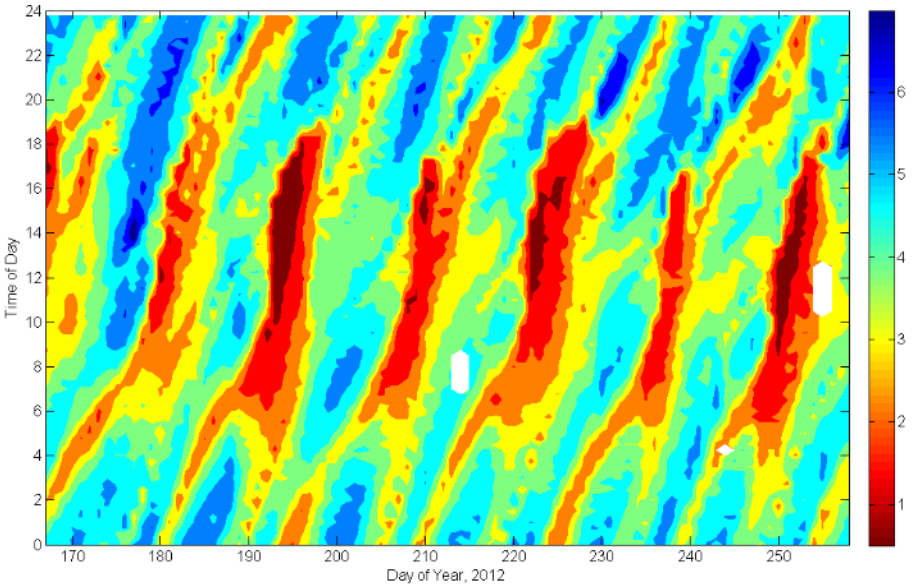
oxygen concentration is among the likely indicators of nutrient-related ecosystem health in San Francisco Bay. Most data on dissolved oxygen concentrations over the past ~20+ years have been collected in deep subtidal habitats, and DO concentrations, in general, have met or exceeded the Basin Plan criterion of 5 mg/L or 80% saturation (above).

Considerably less data is available for shallow margin habitats in San Francisco Bay, including sloughs, creeks, tidal wetlands, and former salt ponds undergoing restoration. Although these areas represent important habitats for aquatic organisms at certain life stages, there is no coordinated, systematic monitoring across a representative set of sites. A recent survey of existing continuous DO data collected over a 12 year period by assorted programs in South Bay and Lower South Bay margin habitats showed that DO was frequently below 5 mg/L (40% and 55% of the time, averaged across sites, in slough and former salt ponds, respectively; SFEI, 2015). Low DO occurs naturally in margin habitats like wetlands and sloughs. However there is currently insufficient information to characterize the frequency, duration, and severity (how low) of events, or to explore the underlying causes (importance of natural vs. anthropogenic factors). One excellent data set, collected in Alviso Slough demonstrates that low DO exhibits strong periodicity and persists at levels <2-3 mg/L for 12 hours or more over several

days (below). This station is 4 km upslough from the confluence with Coyote Creek, and the spatial extent of low DO there, and how representative this condition is of other sites, are unknown.

Funding was allocated in 2015 and work moved forward on study design, field reconnaissance, equipment purchasing, and sensor deployment. Moored sensor locations for this project include 4 slough sites sloughs (green circles, plus AVS1) and 1 open Bay site (CM17). NEW, MOW, GUA have been installed; AVS2 and CM17 will be installed in June 2015. Stations AVS2 and CM17 will be operated and maintained by collaborators (UC Berkeley and USGS-Sac, respectively), and NMS sensors will be deployed alongside other packages to cost-effectively maximize data collection. Although sensor deployment commenced in 2015, the new staff person who will work ~50% on this project (other 50% on moored sensors) will not begin until August 2015 and unspent personnel funds were returned to NMS reserves.





DO (contours; mg/L) as a function of date and time of day, Jun 15 –Sep 14 2012. Sensor was ~2 ft above the bottom. Low DO occurred during strongly periodic windows that coincided with weak neap tides. During these windows, DO was lowest during daylight hours when oxygen production would otherwise be expected, and DO increased during highest tide of the day, which occurred during the late evening. One hypothesis that can explain the daily pattern is that stratification developed due to low tidal mixing energy during these weak neap tides, and oxygen was rapidly consumed in the bottom layer due to sediment oxygen demand. An alternate hypothesis is that the entire water column had low DO concentrations, and the low DO water mass was pushed further upstream during high tide. Data: M Downing-Kunz; SFEI 2014.

Funding is being requested for 2016 to continue this project, which will determine the frequency, duration, and spatial extent of low DO in representative margin habits (sloughs, creeks) using moored sensors complemented by field sampling/calibration. This project's major goals, include:

1. Characterize temporal (tides, diel) and spatial patterns in DO and related parameters across a sites having a representative range of physical/biological characteristics;
2. Determine the frequency and duration of events with DO < 5 mg/L (and other relevant thresholds);
3. Through additional field measurements (vertical profiles during longitudinal transects), characterize the spatial extent of noteworthy events or common conditions,
4. Through the use of basic modeling and field data, semi-quantitatively test hypotheses for why low DO occurs

Instruments will require maintenance and data download approximately every 3 weeks, depending on the time of year and rate of biofouling. During regular maintenance trips and some special field trips (to coincide with events), DO will be measured in vertical profiles at stations along longitudinal transects in creeks and sloughs to spatially-characterize conditions.

Deliverables

- A Year 1 progress report will be prepared in Q2 of 2016 summarizing major observations from year 1 of DO in margin monitoring work, and describing interpretations that can be made at that point. Since deployments began in May/June 2015, the report will be limited in its depth of interpretation, based simply on the amount of data available. To the extent possible, we will also use DO-related results from stations funded by project 1A, since that will be a longer record. Progress updates (powerpoint) will also be given at NTW meetings, at RMP TRC and SC meetings.
- A final technical report will be produced at the project's completion.

Estimated cost: Option 1-$200,000; Option 2-$150,000
Oversight Team: Nutrients Strategy Team
Proposed By: David Senn and Emily Novick

Budget Justification

During 2016, funds will be directed toward staff time for field work and data interpretation ($150,000), field support and science support from USGS-Sacramento ($40,000), and small equipment, consumables, and discrete sample analysis ($10,000). No new major equipment will be purchased in 2016, since all necessary equipment and instrumentation for the current deployment was purchased with 2015 funds; however, additional sites or equipment may be needed in 2017.

Total Proposal Request

Task Description	**Task Budget Option 1**	**Task Budget Option 2**
Moored sensor monitoring	$200,000	$150,000
Dissolved oxygen monitoring	$200,000	$150,000
TOTAL	$400,000	$300,000

Special Study Proposal: Small Tributaries Loading Strategy Program

Summary: The goal of the Small Tributaries Loadings Strategy (STLS) Program over the next few years is to continue to provide information to RMP Stakeholders and the public that directly supports the identification and management of PCBs and Hg sources, concentrations, loads, and the determination of trends in relation to management efforts and beneficial uses in San Francisco Bay. These information needs are called for in the Draft Tentative Order of the second Municipal Regional Permit (MRP 2.0) issued on May 11, 2015 (SFRWQCB, 2015). Four elements are proposed to continue to support these needs:

- Small tributaries wet weather characterization
- Regional Watershed Spreadsheet Model (RWSM)
- Small Tributaries Loadings Strategy Trends (STLS_T) support
- STLS coordination support

In addition, the STLS program will provide a suitable framework for supporting other RMP elements including providing information on concentrations in watersheds upstream from priority margin units (PMUs) and where needed, carrying out sampling for other analytes including emerging contaminants.

Estimated Cost: Option 1: $311k; Option 2: $416k
Oversight Group: STLS/SPLWG
Proposed by: Lester McKee, Jennifer Hunt, Alicia Gilbreath, Jing Wu, and Don Yee (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Task	Deliverable	Due date														
		2015				2016										
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1	Small tributaries wet weather characterization [MQ 1,2]																
1a	Wet season monitoring		!	!		!		!	!								
1b	Quality Assurance & Data Management									!!							
1c	Interpretation & reporting													!!		!	
2	Regional watershed spreadsheet model (RWSM) y5 [MQ 4]																
2a	Finalize work plan based on latest info. and priorities									!!							
2b	Compile latest data (GIS & stormwater data										!	!	!				
2c	Recalibrate model, estimate loads, & update model report													!!	!	!!	
3	Watershed loadings trends strategy support [MQ 5]																
3a	Sampling and Analysis Plan and Quality Assurance Project Plan (SAP & QAPP development)					!		!	!								
3b	Field season preparation									!!				!!			
3c	Fieldwork																
4	Small tributaries loading strategy coordination support					!		!		!		!		!		!	

[MQ] = Management Questions given in the Municipal Regional Stormwater Permit (MRP 2.0)
! = STLS check in for review and course corrections
!! = STLS/SPLWG oversight and review

Background

The San Francisco Bay Hg and PCBs TMDLs call for a reduction in loads by 50 and 90% by 2028 and 2030, respectively. In response, the first Municipal Regional Permit for Stormwater (MRP) Provision C.8.f. (SFRWQCB, 2009) called for a range of actions including gaining a better understanding

of which Bay tributaries contribute the most loading to sensitive areas of biological interest on the Bay margin, better quantification of loads of sediments and trace contaminants on a watershed basis and regionally, a better understanding of how and where trends might best be measured, and an improved understanding of which management measures may be most effective in reducing impairment. These same needs were reflected in the small tributary loading strategy (STLS) priority questions (SFEI, 2009) and the annual updates of a Multi-Year-Plan (MYP) (e.g. BASMAA, 2013). On May 11, 2015, a Draft Tentative Order of the second MRP was issued and provided an updated set of management questions (provided below) (SFRWQCB, 2015).

Beginning with planning efforts in 1999 -2002 ("First report of the Sources, Pathways and Loadings Workgroup" (Davis et al., 2001) and the "Urban run-off literature review" (McKee et al., 2003)), the RMP along with other funding sources made considerable effort to measure loads at a number of strategic locations (i.e. Sacramento River at Mallard Island in Pittsburg, Guadalupe River at Hwy 101 and Almaden Expressway in San Jose, Zone 4 Line A in Hayward). These studies provided basic information to inform the PCB and Hg TMDL development as well as providing a valuable dataset for many other purposes, including reevaluating study design in relation to the issuance of the first MRP in October 2009.

During the first term of the MRP, the RMP initially funded two studies: a reconnaissance study, and a loading study. The data from the reconnaissance study, along with information from other studies and knowledge from program reps, supported the implementation of four fixed-station loading studies in WY 2012 and two more in WYs 2013 and 2014, for a total of six stations. These watersheds were deemed "no regret watersheds" in areas that had suspected elevated level of pollutant loading suitable for baseline information on which to measure future pollutant trends for priority contaminants. The RMP also funded the development of the Regional Watershed Spreadsheet Model (RWSM), a tool for estimating regional and sub-regional pollutant loads and a study component using GIS layer development to improve our understanding of source areas and event mean concentrations (EMCs).

The data obtained from the reconnaissance study and the loading studies, as well as efforts to better quantify the characteristics of PCB and Hg source areas, together constituted the entire program of investigation. This work occurred in relation to other strategies being performed to locate PCB and Hg source areas (e.g. the Bay modeling strategy, the BASMAA Source Property Identification screening). The ongoing success of the STLS program component as a whole cannot occur without sustained support from the RMP and a programmatic vision with appropriate linkages across other pollutant strategies. The individual studies described above are interrelated. For example, characterization data obtained from field studies primarily aimed at finding high leverage watersheds are also needed to provide calibration data for the RWSM modelling effort being developed to estimate regional loads. Likewise, the data gathered at the fixed monitoring stations to provide baseline loading data against which to measure future trends in relation to management actions also provide data to verify the RWSM. BASMAA utilized these data in Part C of their Integrated Monitoring Report (2013) to independently estimate regional loads, loads associated with specific land uses (i.e. for PCBs it was Old Industrial, Old urban, New Urban/Other, Open Space, and Hot spots) and to provide the basis for predicting the effects of management actions. The development of GIS data and the back-calculation of EMC

data in relation to source identification provided the necessary input data for the RWSM and also provided the starting point for source identification efforts conducted by BASMAA.

Much has been learned over the past 15 years and more recently during the first permit term (McKee et al., 2015) much of which was overseen by the Sources Pathways and Loadings Workgroup (SPLWG). The focus, in terms of RMP funding during the first permit term, was largely devoted to better understanding of loadings. Estimates for PCBs and Hg and other contaminant loads are now available for the Sacramento River at Mallard Island and 11 other local smaller tributaries locations (McKee et al., 2015). In addition, particle ratio data collected during storm events are available for 27 local smaller tributary locations (McKee et al., 2015). Despite this growing powerful data set, the remaining information include weaknesses such as learning more about which watersheds are most contaminated, source identification within contaminated watersheds, regional scale loads, where and which management actions will be most cost effective, and concentration and loadings trends in relation to management efforts (McKee et al., 2015). As such, during the next permit term (MRP 2.0), an increased focus is being placed on identifying watersheds and areas within watersheds that are producing disproportional concentration and loads in relation to impairment in Bay margin areas. There will still be some effort on the loadings question and developing and implementing a plan to determine trends. At this time, the Water Board and BASMAA are not recommending any RMP effort on true source area identification or predicting the potential effectiveness of management actions. Substantial efforts by BASMAA have been and are ongoing in relation to these management questions outside of RMP funding.

During 2015, the RMP funded the first phase of a new watershed characterization study aimed at locating more high leverage watersheds and sub-watersheds and developing a remote sampler method. This method will help to decrease costs and increase ease of data collection in locations where sampling may be logistically too challenging during storms. In addition to three locations tested with the pilot remote samplers, samples from 22 additional watershed locations were collected using manual methods. Also during 2015, funding was provided for further development and calibration of the RWSM, with progress made up to May 2015 indicating improved calibration. Funding was provided for developing the STLS trends strategy. So far, a general workplan has been developed and reviewed by the SPLWG, and a mission statement and a refined set of management questions are currently being developed. The "kickoff" meeting is planned for July 29th, 2015. Funds carried over from 2014 monitoring are being expended on field monitoring, GIS source work in relation to the RWSM, trends strategy support, remote sampler support, program management and updating the STLS in relation to MRP 2.0. These funds are expected to be sufficient to complete the first version of the calibrated RWSM for PCBs and mercury, the completion of the trends strategy, and completion of testing of up to three remote sampler options.

Study Objectives and Applicable RMP Management Questions

The main study objectives are three fold:

1. Find watershed or sub-watershed locations with high concentrations of PCBs, Hg and other priority pollutants and rank these locations relative to each other and in relation to potential sources.

2. Determine regional scale loads of PCBs and Hg and determine which individual watersheds may be producing disproportionally high loads per unit watershed area.
3. Develop and implement a sampling program to provide suitable baseline data to support the identification of trends in concentrations and loads over appropriate spatial and temporal scales, connecting management effort on land with water quality improvements in the Bay.

MRP 2.0 Q1: Source Identification / Leverage: Which sources or source areas provide greatest opportunity for load reductions?
MRP 2.0 Q2: Impairment: Which source areas contribute most to impairment of Bay?
MRP 2.0 Q3: Management effectiveness: Provide support for planning future management actions or evaluate existing actions.
MRP 2.0 Q4: Loads: Assess POC loads, concentrations, or presence/absence.
MRP 2.0 Q5: Trends: What are the spatial and temporal trends in loads or concentrations?

Approach

Task 1. Small Tributaries Stormwater Characterization Field Study [MQ1&2]

The objective of this study is to characterize concentrations of key pollutants (PCBs and Hg) in watersheds suspected of having elevated concentrations. A wet weather field monitoring program will be implemented during the winter of 2015/2016 (Water Year 2016) that largely mimics, with the exception of some improvements, the program implemented during water year 2011 (McKee et al., 2012) and 2015.

- Monitoring Design:
  - 1 composite sample per site (unless unexpected low concentrations result, in which case additional samples may be considered)_
  - Methods development for one remote sampler type at another nine locations.
- Site Selection: A balance between two overarching rationale:
  - Nested sampling design to track sources upstream in known polluted areas to help better define source areas and management options.
  - Finding new polluted watersheds or sub-watershed areas (watershed locations near the Bay margin or further downstream than the source tracking approach).
  - Other selection rationale:
    - 1 large watershed per year
    - Re-sampling potential false negatives
    - Contingency for resampling Guadalupe River for trends
    - Filling gaps along environmental gradients in relation to source areas (most specifically to support RWSM development [MQ4])
- Number of sites: Dependent on site logistics, proximity, analyte list, budget and other factors, likely in excess of 15 sites.
- Funding levels: $150k (more than 15 sites); 200k (more than 20 sites).

Task 2. Regional Watershed Spreadsheet Model (RWSM) [MQ4]

The primary objective of this study is to provide a defensible estimate of regional and sub-regional scale loads of PCBs and total mercury. During 2015, it is anticipated that a fully calibrated PCB and mercury model will be completed based on data from about 25 calibration

watersheds. Pending the outcomes of the 2015 work plan, STLS and the SPLWG will be consulted to agree upon and recommend the workplan for 2016. However, during 2016, further improvements will be made to the regional GIS component of the model along with experimentation with an increased calibration dataset (likely in excess of 45 sample locations). If budget allows, we will start the process of publishing the model software for use by STLS stakeholders. If not, publishing will be postponed until the next fiscal year.

- Funding levels: $35k (Completion of the calibration for 45 sites, as much work as possible on model publication including a user manual); $40k (further work on model publishing)

Task 3. Watershed Loadings Trends Strategy Support [MQ5]
The objective of this task is to develop a Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for Task 1, carry out necessary pre-field season logistical support including site selection and reconnaissance, and then implement components of a winter season field monitoring program. The details of the workplan for this task will need to be worked out during the development of the Small Tributaries Loadings Trends Strategy that is occurring during 2015.

- Funding levels: $100k (Completion of the SAP, QAPP, site reconnaissance, and sampling collection at an unspecified number of sites (budget dependent)); $150k (samples at more sites).

Task 4. Small Tributaries Loading Strategy (STLS) coordination support
The objective of this task is to provide support for coordination of efforts to address Small Tributary Loading Strategy management questions funded through the RMP program and those efforts funded and carried out by BASMAA. Funds will be used to prepare for and execute local STLS meetings, phone conferences and for staff to attend key meetings (i .e. BASMAA Monitoring/POCs Committee.)

Budget

Table 1. Budget summary.

Task #	**Task description**	**MRP 2.0 STLS Management Questions**	**2016 (low)**	**2016 (medium)**
1	Small tributaries stormwater characterization field study	MQ1: Identify source areas. MQ2: Identify watershed areas contributing most to Bay impairment.	150	200
2	Regional Watershed Spreadsheet Model (RWSM)	MQ4: Loads information / presence/absence.	35	40
3	Watershed loadings trends strategy support	MQ5: Evaluate POC trend.	100	150
4	Small tributaries loading strategy (STLS) coordination support	STLS communication support	26	26
			311	416

Reporting

Task 1. Small Tributaries Stormwater Characterization Field Study

The draft report written during 2015 will be updated to include the 2016 data. The main objectives of the report will be to document:

1. The outcomes of the remote sampler sub-study and make recommendation for situations when use is appropriate.
2. The concentrations and particle ratios observed in each watershed location, comparing these to existing data and ranking the watersheds from greatest to least pollutant concentrations.
3. Any loads estimates for watershed locations where there are flow measurements

Task 2. Regional Watershed Spreadsheet Model (RWSM)

The short report written during 2015 will be updated and finalized.

Task 3. Watershed Loadings Trends Strategy Support

Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) will be written. The outcomes of the site selection and reconnaissance efforts for the 2016 wet season will be recorded in the master spreadsheet that will also compile information generated during all previous site selection exercises. This information will form a useful basin relation to site selection and reconnaissance for the trends strategy.

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Special Study Proposal: Fipronil and Degradates in WWTP Influent and Effluent

Summary: Fipronil is a moderate concern (Tier III) CEC for the Bay. Recent RMP-funded monitoring of 24-hour composite samples of influent and effluent from eight Bay wastewater treatment plants (WWTPs) assessed dissolved phase concentrations of fipronil and degradates. A lack of information concerning levels of particle-associated contaminants limits the conclusions that can be drawn from existing data concerning the effects of treatment on contaminant discharges. The proposed study aims to fill this data gap, by analyzing total water samples of influent and effluent. Findings are likely to influence ongoing efforts within the California Department of Pesticide Regulation aimed at reducing environmental contamination and ecological impacts of fipronil and its degradates.

Estimated Cost: $30,000

Oversight Group: ECWG

Proposed by: Rebecca Sutton and Jennifer Sun (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Project Management (write and manage sub-contracts, track budgets)	Winter 2015 – Summer 2016
Task 2. Develop detailed sampling plan	Summer 2015
Task 3. Field Sampling	Early fall 2015
Task 4. Lab analysis	Fall 2015
Task 5. QA/QC and data management	Winter 2015
Task 6. Draft report (manuscript)	3/31/2016
Task 7. Final report (submitted manuscript)	6/30/2016

Background

Fipronil, a broad-spectrum insecticide widely used to control fleas, termites, and ants, is considered a moderate concern contaminant for San Francisco Bay (Sutton et al. 2013). Fipronil and its degradates (including fipronil sulfide, fipronil sulfone, and fipronil desulfinyl) are highly toxic to aquatic organisms (CVWB 2012). It has been detected in stormwater in the Bay Area and elsewhere, but few measurements exist regarding its presence in wastewater (Ensminger 2012; Weston and Lydy 2014; Heidler and Halden 2009). Potential sources of fipronil to wastewater include wash off from pets treated with topical fipronil flea-control pesticides, seepage into sewers from belowground application of fipronil to control termites, improper disposal, and post-application cleanup.

To evaluate the importance of the wastewater pathway and investigate the potential impacts of treatment technologies on levels of fipronil and degradates to the Bay, the RMP funded a 2015 Special Study to analyze 24-hour composite samples of influent and effluent from eight Bay wastewater treatment plants (WWTPs). The findings of this study do not indicate wastewater treatment significantly reduces levels of dissolved fipronil (Table 1).

Table 1: Influent and effluent concentrations (ng/L) of fipronil and its three degradates from the eight WWTPs. The concentrations only include the contaminants present in the dissolved phase.

WWTP	**Influent (ng/L)**	**Effluent (ng/L)**
SFO	10	ND
Palo Alto	78	53
Fairfield Suisun	85	57
San Leandro	119	63
EBMUD	76	86
San Mateo	52	112
San Jose-Santa Clara	135	113
Central Contra Costa	168	121

However, the analyses were conducted on the dissolved phase of the samples only, and did not characterize the particle-associated contaminant load. Fipronil and its degradates have K_{ow}s ranging from three to four (Gunasekara 2007), suggesting particle-bound contamination may be an important factor.

The USGS conducted a similar study in the Columbia River Basin: effluent grab samples from nine WWTPs were collected and analyzed (Morace 2012). The samples were also filtered before analysis and the dissolved concentrations of fipronil were comparable to the RMP 2015 special study levels. The USGS found that the concentration of fipronil on the filtered solids was negligible compared to the concentration in the dissolved phase, suggesting that particle-bound fipronil may not be an important loading pathway to the Bay. However, influent contains a significantly higher amount of solids than effluent and filtered influent samples may not characterize the total fipronil load to WWTPs.

In 2012 and 2013 fipronil stormwater samples were collected from six Bay Area creeks. The stormwater samples were also lab filtered and the dissolved phase was analyzed. The highest Bay Area effluent concentrations were five times the concentrations in stormwater. The level of suspended solids is considerably higher in stormwater than in effluent; comparing effluent and stormwater concentrations is less useful until total water concentrations are available for both matrices. Lacking Bay Area stormwater total water concentrations, data from the California Department of Pesticide Regulation on stormwater measurements in other regions may provide useful upper and lower bounds (Budd et al. 2015).

Study Objectives and Applicable RMP Management Questions

This study will provide data essential to determining the impact of wastewater treatment on fipronil discharges to the Bay. Currently available RMP data are limited to the dissolved phase, and suggest treatment does not significantly modify levels of fipronil and degradates in discharges. However, given K_{ow}s of 3-4, particle-associated contamination may be important, particularly for influent. Fipronil is classified as a moderate concern (Tier III) contaminant for the Bay, and greater knowledge of pathways can guide management actions to reduce pollution.

Management questions to be addressed by monitoring fipronil and degradates in WWTP effluent are the same as those of the overall RMP program, as shown in Table 2.

Table 2. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?	Compare measured concentrations to toxicity thresholds, ambient Bay measurements, and influent/effluent measurements in other regions.	Are findings consistent with the current designation of fipronil as a moderate concern CEC with potential to cause low level impacts to Bay wildlife? Do data indicate a need for management actions?
2) What are the concentrations and masses of contaminants in the Estuary and its segments? 2.1 Are there particular regions of concern?	Compare levels discharged by WWTPs in different embayments.	Could relative wastewater discharges cause regional variations in ambient Bay fipronil?
3) What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary? 3.1. Which sources, pathways, etc. contribute most to impacts?	Obtain information on the potential effects of wastewater treatment on effluent discharged to the Bay. Evaluate wastewater pathway relative to stormwater.	Are there indications that any treatment technologies employed by participating WWTPs can reduce levels of fipronil or degradates discharged to the Bay?
4) Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased? 4.1. What are the effects of management actions on concentrations and mass?	Review new results alongside available data from previous RMP studies for indications of trends in contamination over time.	Are discharges of fipronil and degradates increasing?
5) What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?	Review measured results alongside available projections of use and anticipated changes to wastewater treatment.	Which anticipated changes or actions are likely to have the greatest impact on fipronil pollution? Are additional/different actions needed?

This monitoring effort would most directly address question 3, characterizing contaminant discharges from the effluent pathway. It will also provide an indication of whether any of the broad range of treatment types employed by participating WWTPs are useful in reducing discharges to the Bay. Results may provide some information useful to addressing questions 1, and 4, characterizing fipronil pesticide contamination and its potential for impacts at the current time and relative to past data. Inferences regarding regional or future pollution patterns could involve interpretation of the data within the context of regional use data and potential changes in wastewater treatment technologies, all of which may play a role in addressing questions 2 and 5.

In addition, the study will address the emerging contaminants priority question: What emerging contaminants have the potential to adversely impact beneficial uses of the Bay? The RMP's tiered risk and management action framework lists fipronil as a moderate concern (Tier III) contaminant; CECs in this category may be recommended for Special studies of fate, effects, and sources, pathways, and loadings, and may be recommended for inclusion in Status and Trends Monitoring (Sutton et al. 2013). This proposal will improve our knowledge of an important pathway of fipronil contamination to the Bay.

Approach

Effluent Sampling

24-hour composite samples of WWTP influent and effluent voluntarily provided by eight Bay WWTPs will be collected. A replicate sample and a field blank will be collected as well, for a total of 20 samples. Sampling will occur in the summer of 2016, when inflow and infiltration are insignificant. WWTPs will provide measurements of total suspended solids on the day of sample collection.

The eight WWTPs that volunteered to provide samples for the previous study of fipronil are expected to participate in this study, and include facilities employing secondary and advanced treatment, and located in South, Central, and North Bay. Previous participants include: Central Contra Costa Sanitary, East Bay MUD, Fairfield Suisun, Palo Alto, SFO, San Jose, San Leandro (EBDA member), San Mateo. As with the previous RMP fipronil monitoring project, participating dischargers are not guaranteed anonymity. Measurements for each discharger will be reported individually.

Analytical Methods

Samples will be analyzed by Dr. Rolf Halden (Arizona State University) or a comparable laboratory. Per sample analytical costs range from $200 to $300, depending on the matrix.

Dr. Halden's lab employs isotope dilution liquid chromatography tandem mass spectrometry (ID-LC-MS/MS), and can perform total water analyses (as opposed to dissolved phase analyses). Instrument detection limits for fipronil and degradates were previously reported at 10 ng/L, with the exception of desulfinyl fipronil (IDL 500 ng/L). Lower detection limits are preferred, and are now available in the range of 41 - 480 pg/L (Halden, personal communication).

Budget

The following budget represents estimated costs for this proposed special study (Table 3). Efforts and costs can be scaled up or down by changing the number of WWTPs sampled. Pro bono collaborations between the Halden lab and individual WWTPs may be leveraged to further reduce costs.

Table 3. Proposed Budget.

Expense	Estimated Hours	Estimated Cost
Labor		
Project Staff	156	14,400
Senior Management Review	8	1600
Project Management	0	NA*
Contract Management	0	NA*
Data Technical Services		6000
GIS Services	4	400
Creative Services	10	750
IT Services	0	
Communications	0	
Operations	0	
Subcontracts		
Name of contractor		
Dr. Halden or comparable lab		5700**
Direct Costs		
Equipment		400
Travel		350
Printing		0
Shipping		400
Other		0
Grand Total		
		30,000

*services included in the base RMP funding
**costs may be reduced due to existing, independent collaborations between the Halden lab and individual WWTPs

Budget Justification

Field Costs
Field costs include staff time and vehicle miles required to visit WWTPs and collect samples, as well as sample containers and shipping. Increased efficiency is possible through scheduling visits to multiple WWTPs on the same day.

Laboratory Costs
Analytical costs per sample are estimated to be $300. For 19 samples, including influent, effluent, a duplicate for each matrix, and a blank, the total analytical costs will be $5,700

Data Management Costs
Standard data management procedures and costs will be used for this project.

Reporting

Results will be reported to the RMP committees in the form of a draft manuscript for publication in a peer-reviewed journal by 3/31/17.[1] Comments will be incorporated into the manuscript submitted by 6/30/17.

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Special Study Proposal: Non-targeted Analysis of Water-soluble Compounds in Ambient Bay Water and Wastewater to Identify Emerging Contaminants

Summary: Non-targeted analysis, a key element of the RMP's CEC strategy and recent state CEC guidance, can help to provide a measure of assurance that the RMP is not missing unexpected yet potentially harmful contaminants simply because of failures to predict their occurrence based on use or exposure prioritization criteria. The RMP has completed non-targeted analysis of fat-soluble compounds in bivalve tissue and seal blubber, but another major class of chemicals, water-soluble (polar) organic contaminants, has not been evaluated. This proposed study will fill this data gap by conducting a broad screen of ambient Bay water (passive and grab samples) and wastewater (composite samples) for polar organic compounds such as: detergents and other surfactants, pesticide and pharmaceutical breakdown products, and plastic additives. This type of non-targeted study will lay the foundation for future targeted CEC monitoring by helping to identify new potential contaminants of concern without *a priori* knowledge of their occurrence.

Estimated Cost: $52,000

Oversight Group: ECWG

Proposed by: Rebecca Sutton (SFEI), Lee Ferguson (Duke University)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Project Management (write and manage sub-contracts, track budgets)	Winter 2015 – Spring 2017
Task 2. Develop detailed sampling plan	Spring 2016
Task 3. Field Sampling	Summer 2016
Task 4. Lab analysis	Fall 2016
Task 5. QA/QC and contaminant risk review	Winter 2016
Task 6. Draft report and fact sheet	3/31/2017
Task 7. Final report and fact sheet	6/30/2017

Background

The RMP has developed a pro-active emerging contaminants program, and conducts policy-relevant monitoring via Special Studies to help identify and address problematic, unregulated contaminants before they cause significant harm to the Bay. The RMP has established a unified emerging contaminants strategy (Sutton et al. 2013) with three elements: 1) targeted chemical monitoring and relative risk evaluation using a tiered risk and management action framework; 2) review of the scientific literature and other aquatic monitoring programs as a means of identifying new emerging contaminants for which no Bay occurrence data yet exist; and 3) non-targeted analysis to create inventories of unanticipated contaminants in tissues, sediment, or water that can be used to direct targeted chemical monitoring or toxicity identification evaluations.

Recently completed state guidance on emerging contaminants in aquatic ecosystems echoes many aspects of the RMP strategy (Dodder et al. 2015). In particular, non-targeted analysis plays a key role in the comprehensive CEC management framework (see pg 40 Dodder et al. 2015). Non-targeted analysis is an essential means of assuring focus on the contaminants with greatest potential to impact an ecosystem, by seeking to remove a "knowledge bias" on previously identified problem chemicals. One form of non-targeted analysis specifically recommended by the state guidance document is development of bioanalytical tools; the RMP has commissioned one such study from scientists at the Southern California Coastal Water Resources Project (SCCWRP) and the University of Florida, which is nearing completion.

Other non-targeted methods highlighted by the state guidance are those "designed to screen for new or unexpected contaminants; i.e., unknown CECs" (pg 29, Dodder et al. 2015). The RMP, in collaboration with the National Institute of Standards and Technology (NIST), recently completed a non-targeted analysis of Bay harbor seal blubber and mussel tissues, which focused on persistent, fat-soluble (nonpolar), chlorine and bromine-rich chemicals (Sutton and Kucklick 2015). This investigation brought to light five contaminants not previously identified in Bay wildlife, and for which toxicity is largely unknown. However, most of the Bay chemical contamination was from high priority contaminants that the RMP already monitors, or closely related compounds. More polar, water-soluble organic compounds were not covered by this recent non-targeted tissue analysis. Polar organic contaminants are of significant concern to the water quality of the San Francisco Bay, as they may exhibit meso-range transport, be difficult to remove through treatment strategies, and cause effects on wildlife through endocrine disruption and other mechanisms. The following monitoring proposal would fill this important data gap. Detergents, plastics, and medications are examples of products that can contain such water-soluble, polar organic contaminants.

Study Objectives and Applicable RMP Management Questions

Given the increased burden on the RMP from multiple areas of interest to stakeholders, it is imperative that the RMP focus on those CECs that are the highest priority. Traditional, targeted contaminant monitoring focuses on specific lists of chemicals already identified as potentially problematic through either expert judgement, anticipation of high toxicity, use-

based prioritization, or other *a priori* methods. Through non-targeted monitoring, we can provide a measure of assurance that the RMP is not missing unexpected, potentially harmful contaminants in the Bay water simply because of failures to predict their occurrence based on use or exposure prioritization criteria.

Non-targeted analysis is an essential element of the RMP's CEC Strategy (Sutton et al. 2013). The RMP recently completed a non-targeted analysis focusing on fat-soluble (hydrophobic) compounds in tissue samples (Sutton and Kucklick 2015). This study identified a few unexpected contaminants, but the good news is that the majority of chemical contamination was from high priority contaminants that the RMP already monitors, or closely related compounds.

The current proposal is to use non-targeted analysis to scan for more water-soluble (polar) organic contaminants in the Bay (grab and passive samples) as well as in treated wastewater effluent, which is anticipated to be a major and important source of these compounds to the Bay. A special study on water-soluble contaminants would provide data on those contaminants that were not part of the study of fat-soluble compounds, essentially filling a major data gap in characterizing possible contaminant chemistries in the Bay. This would make the Bay the first ecosystem to be studied via non-targeted methods for both water- and fat-soluble contaminants.

Using the proposed non-targeted analytical strategies outlined below, Dr. Lee Ferguson at Duke University has tentatively identified 52 water-soluble compounds from seven functional classes including pharmaceuticals, flame retardants, pesticides, and consumer product chemicals in wastewater effluent discharged to surface waters in central North Carolina (Ferguson et al., in prep). Nine of these compounds have not been detected in the environment previously. Examples include ZPCA (a transformation product of the sleep-aide zolpidem [Ambien]), raltegravir (HIV treatment), and Atorvastatin lactone (transformation product of atorvastatin [Lipitor]).

Should a non-targeted study of the Bay identify unexpected water-soluble contaminants such as these, the information could indicate a need for a follow-up RMP Special Study designed to specifically assess the new "candidate" CECs on a quantitative basis. It could also point to ecotoxicity data gaps or suggest new management priorities. Thus, we anticipate that positive identifications resulting from the proposed study would be potentially very high in impact.

In contrast, because of the comprehensive nature of the non-targeted methods proposed herein, should few unexpected contaminants be identified, the RMP would then have considerable evidence that existing polar organic CEC monitoring is indeed already focusing on the highest priority contaminants for the Bay.

Table 1: Study objectives and questions relevant to RMP management questions

Management Question	Study Objective	Example Information Application
1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?	Identify water-soluble contaminants not yet characterized by targeted monitoring efforts. Evaluate future monitoring needs and toxicity data gaps.	Have previous targeted monitoring efforts focused on contaminants with the highest relative risk to the Bay? Which newly identified contaminants merit further monitoring?
2) What are the concentrations and masses of contaminants in the Estuary and its segments? 2.1 Are there particular regions of concern?	Initial comparison of specific sites influenced by different pathways (agriculture-dominated river, stormwater, wastewater) with respect to detection.	Are there regional or pathway-related differences in the presence of newly identified contaminants?
3) What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary? 3.1. Which sources, pathways, etc. contribute most to impacts?	Gain an unbiased inventory of water-soluble (polar) organic contaminants in key, high-volume wastewater discharges. Allow an initial exploration of differences between secondary and advanced wastewater treatment with respect to contaminant removal. Investigate the influence of stormwater and river discharges on contaminants.	Are any newly identified contaminants in wastewater also detected in the Bay? Do differences in detection for wastewater and ambient Bay water suggest persistence, degradation, or additional pathways (e.g., stormwater) for specific contaminants? Do sites influenced by stormwater or agricultural discharges show different patterns of contamination?
4) Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased? 4.1. What are the effects of management actions on concentrations and mass?	Establish a baseline for future studies.	
5) What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?	Identify sources of newly identified contaminants to evaluate effects of current management actions on potential discharges and project trends with likely changes in use and wastewater treatment technology.	Are relevant management actions having the intended effect? Will newly identified contaminants suggest the need for additional or different management actions?

This monitoring effort would most directly address questions 1, 2, and 3, identifying water-soluble contaminants not yet characterized by targeted monitoring efforts, and providing information useful to initial comparisons with respect to contaminants in sites influenced by different pathways (rural river, stormwater, wastewater) and discharged from secondary versus more advanced water treatment facilities. This proposal does not include an examination of potential sources of newly identified contaminants. Such a study could be completed in future years and would provide information useful in addressing questions 4 and 5, concerning likely past and future trends.

In addition, the study will directly and explicitly address the emerging contaminants priority question: What emerging contaminants have the potential to adversely impact beneficial uses of the Bay?

Approach

Ambient Bay Water Sampling

Bay water sampling will be conducted using both grab samples and passive sampling devices called Polar Organic Chemical Integrative Sampler (POCIS, see Figure 1; Environmental Sampling Technologies, St. Joseph, MO). Grab samples have the advantage of providing analytical data for polar organic contaminants that is less convoluted by sampling bias and more representative of actual water conditions, but also has the disadvantage of providing only a snapshot of the pollutants in a particular location at a particular time, rather than more broadly integrated information. Passive samplers, while semi-quantitative at best, can be used to provide an integrated assessment of the pollutants present (or absent) in a location over a longer time span (e.g., 28 days). The lengthy time of deployment also means contaminants at trace levels are more likely to be detected, provided they have favorable uptake dynamics into the sampler.

Three POCIS canisters will be deployed, one at each of three sites: 1) a site at or near the mouth of the Napa River, probing potential agricultural and pesticide influences (spring or summer 2016 deployment, timed to coincide with pesticide applications); 2) a site influenced by stormwater discharges, San Leandro Bay for example (winter or spring 2016 wet season deployment); and 3) a site in the Lower South Bay influenced by WWTP discharges (summer 2016, when WWTP-derived contaminant levels are often highest due to low river inflow and POTW-system infiltration/inflow). Site selection and deployment will be conducted in collaboration with nutrients researchers at SFEI and elsewhere, as they have deployed and are monitoring and servicing a number of moored nutrient sensors throughout the Bay. Each POCIS holder will be deployed for a maximum of 28 days. The POCIS samplers contain a solid phase sorbent (Waters Oasis HLB) that is widely used for sampling a large range of water-soluble organic chemicals from water.

Each POCIS canister will contain three POCIS samplers to provide triplicate measurements at each location; however, only two of the three will be analyzed using RMP funds. The third POCIS from each site will be kept in reserve and would be analyzed at no additional cost to the RMP if unusual variability is observed in the first two POCIS. A total of seven POCIS samples will be analyzed using RMP funds, two from each of three sites and a single blank.

Grab samples (4 L glass) will be collected in the same locations on deployment and retrieval of the POCIS, to provide a snapshot, non-integrated picture of polar organic contaminant loadings in water at each location. A total of eight grab samples will be analyzed, two from each of three sites, along with a field duplicate and a blank. Each grab sample will be shipped (on ice) to Dr. Ferguson's laboratory at Duke University (NC) after collection for immediate extraction and analysis as described below.

Figure 1. Deployment holder featuring one POCIS holder containing three POCIS. Dimensions 15 cm high x 16 cm wide. Environmental Sampling Technologies, est-lab.com

Effluent Sampling

Effluent samples provide essential information on a major pathway for polar organic contaminants to enter the Bay. The state guidance on CECs directs agencies to include sampling wastewater treatment plant (WWTP) effluent when screening for emerging contaminants (Dodder et al. 2015). Compounds that persist in treated effluent at significant levels are likely to be polar and water-soluble rather than fat-soluble, making the focus of this proposed study particularly useful to the wastewater community.

24-hour composite samples of WWTP effluent (4 L glass) voluntarily provided by two to four high volume Bay Area dischargers will be characterized. Participants will include a WWTP employing secondary treatment, as well as one using more advanced measures. Sampling will occur in the summer of 2016, when inflow and infiltration are insignificant. A total of five samples will be analyzed, up to four effluent samples and a blank. As with water samples described above, these will be shipped (on ice) to Dr. Ferguson's laboratory at Duke University (NC) immediately after collection for extraction and analysis as described below.

One local discharger has agreed to participate and contribute in-kind services for sample collection but is not specifically named here, as dischargers will have the option to keep their identities confidential in subsequent reporting of the data. Measurements for each discharger will be reported individually.

Analytical Methods

Non-targeted analysis of 20 samples will be conducted by Dr. Ferguson's Lab (Duke University) using cutting-edge Orbitrap liquid chromatography high resolution mass spectrometry (LC-HRMS). POCIS samples (shipped directly from SFEI to Duke University) will be processed as recommended by the vendor (e.g., elution with methanol/MTBE prior to evaporation and reconstitution in HPLC-MS mobile phase). Water samples will be immediately filtered (< 0.45μm GF/F) for particle removal and processed for solid-phase extraction using an automated SPE system (Dionex Autotrace 280) fitted with custom layered-bed extraction cartridges (containing cation exchange, anion exchange, hydrophobic, and amphiphilic resins) and eluted with sequential basic and acidic methanol/MTBE solvent systems prior to combination and concentration of the extracts.

Extracts will be separated using UHPLC (Thermo Hypersil Gold column, 1.9 μm particle size, 2.1 x 100 cm) over a 70 minute gradient prior to introduction into the mass spectrometer. The LTQ-Orbitrap MS/MS will be operated at 100,000 resolution to achieve < 2 ppm mass accuracy across the mass range of interest. Sample extracts will be spiked with internal mass calibration/quantitation standards (chosen from a set of stable-isotope labeled compounds available in the PI's laboratory) immediately prior to injection. Ionization will be performed by either electrospray in either positive or negative polarity mode, depending on the analyte. High resolution detection of analytes in MS mode will be performed by the Orbitrap analyzer, while simultaneous data-dependent MS/MS will be performed in the LTQ Velos module before the Orbitrap. Ions for MS/MS analysis (10 per Orbitrap scan) will be dynamically chosen on a per-scan basis, with priority given to accurate mass values corresponding to compounds in compiled "suspect" lists (already compiled based on production volume, toxicity, and/or literature reports), with secondary priority given to "non-target" analytes in order of decreasing intensity. These MS/MS data will provide important information to aid in identification of non-target analytes.

Data generated through these approaches will be applied to both commercially-available (ThermoFisher Scientific TraceFinder, Compound Discoverer, and MassFrontier) and custom-written processing software designed to aid in identifying polar organic compounds based on HRMS/MS data. Final validation of tentative identities will be made based on authentic standard match wherever possible.

The Ferguson laboratory has extensive experience in use of accurate mass MS and MS/MS for identifying non-target compounds in complex mixtures (Benotti et al. 2003; Eichhorn et al. 2005; Cui et al. 2009; Stapleton et al. 2011), and this strategy has proved successful for identifying emerging contaminants in wastewater (preliminary work as described above), as well as in coastal surface waters impacted by water reuse activities (e.g., on Kiawah Island, SC). These new identifications include several micropollutants that have not, to our knowledge, been previously reported to occur in environmental media such as wastewater or surface water. Dr. Ferguson's laboratory was chosen for this work because it is uniquely qualified and experienced to undertake the experiments described. The Ferguson Lab has also agreed to contribute up to $10,000 of in-kind services to the project (e.g., technician and PI effort) because of the high priority and potential for high-impact results to be generated from the work.

Budget

The following budget represents estimated costs for this proposal. Efforts and costs can be adjusted by changing the number of matrices explored or the number of samples evaluated.

Table 2. Budget summary.

Expense	Estimated Hours	Estimated Cost ($)
Labor		
Project Staff	135	19000
Senior Management Review	21	4200
Project Management	0*	
Contract Management	0*	
Data Technical Services	0	
GIS Services	8	650
Creative Services	25	2000
IT Services	0	0
Communications	0	0
Operations	0	0
Subtotal		
Subcontracts		
Name of contractor		
Lee Ferguson		20000
Linda W.		3000
Direct Costs		
Equipment		2000
Travel		400
Printing		250
Shipping		500
Other		
		52000

*Not needed because core RMP funding provides this service.

Budget Justification

Field Costs

Details concerning passive sampling equipment:
POCIS: $65/each x 3/site x 3 sites + 1 blank = $260
POCIS holder (rental): $220 x 3 sites = $660
Total POCIS equipment costs ~$1,000

Reporting Costs

Preparation of a draft manuscript for publication in a peer-reviewed journal would be the responsibility of the analytical partner, and will require relatively little RMP staff time. RMP staff will produce a 2-page fact sheet to describe the results and their implications for RMP stakeholders and the general public. This fact sheet would be a companion to one recently completed for non-targeted analysis of fat-soluble compounds (Sutton and Kucklick 2015).

Laboratory Costs

The RMP can benefit from a significant discount in laboratory costs currently available due to outside funding of the Ferguson Lab. This discount will *not* be available in the future. For non-targeted analyses conducted in 2016, the estimated cost is $1,000/sample; in the future, the cost will be at least $1,500/sample.

Data Management Costs

No data management is needed for this proposed project, as it is not targeted, analyte-specific analysis.

Reporting

Deliverables will include: a) a draft manuscript[1] that serves as an RMP technical report due by 3/31/2017; b) a plain language RMP fact sheet describing the results and their implications due by 3/31/2017; and c) additions to other RMP publications such as the Pulse.

[1] The draft manuscript will be distributed by email, not published on the website, so as to not jeopardize publication of the manuscript in a peer-reviewed journal.

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Benotti, M. J.; Ferguson, P. L.; Rieger, R. A.; Iden, C. R.; Heine, C. E.; Brownawell, B. J., HPLC/TOF-MS: An alternative to LC/MS/MS for sensitive and selective determination of polar organic contaminants in the aquatic environment. *Acs Sym Ser* **2003,** *850*, 109-127.

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Sutton R, Sedlak M, Davis J. 2013. Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations. SFEI Contribution 700. San Francisco Estuary Institute, Richmond, CA.
http://www.sfei.org/documents/contaminants-emerging-concern-san-francisco-bay-strategy-future-investigations

Special Study Proposal:
Emerging Contaminants Strategy

Summary: Increasing engagement on emerging contaminants issues by the San Francisco Bay Regional Water Board, RMP stakeholders, and the general public is reflected in headline news as well as policy actions at local, state, and federal levels. Work to advance the RMP's Emerging Contaminants Strategy has increased significantly in the last year, driven by increased demand for independent information on key contaminants. Critical new deliverables, such as assisting the Water Board as the agency prepares emerging contaminants action plans for the Bay, have been added to the primary deliverables of this strategy: Tracking new information regarding contaminant occurrence and toxicity and updating the RMP's tiered risk and management action framework for emerging contaminants in San Francisco Bay (see Sutton et al. 2013). Coordination of pro bono analyses is another rapidly expanding component of the strategy fund. For this reason, this proposal requests an additional $13,000 for strategic emerging contaminants tasks.

New developments like the recently disseminated pilot CEC study guidance (Dodder et al. 2015), along with the completion of critical RMP studies on non-targeted analysis, and frequent questions concerning process, indicate the need to formally revise the RMP CEC strategy document (Sutton et al. 2013). This proposal requests an additional $15,000 to create a fully updated strategy document as a key deliverable for the 2016 Emerging Contaminants Strategy Special Study.

Estimated Cost: $48,000
Oversight Group: ECWG
Proposed by: Rebecca Sutton (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Information gathering from a variety of sources throughout the year, including presentations at scientific conferences	2016
Task 2. Assist Water Board and other stakeholders with science summaries relating to policy including emerging contaminants action plans and comment letters regarding proposed actions of other agencies	12/31/2016
Task 3. Present an update of emerging contaminants strategy, ongoing or completed special and pro bono studies, and new studies to the Steering Committee	12/31/2016
Task 4. Review tiered monitoring and management risk framework, present findings to the Water Board	9/30/2016
Task 5. Complete update of RMP CEC strategy document, including discussion of pilot CEC study guidance, conclusions of non-targeted studies (broad scan, bioanalytical tools), revised tiered framework tables, outline of process	3/31/2017

Background

The science and management of contaminants of emerging concern (CECs) is an area of dynamic recent development. Competing Senate bills introduced this year to reform the federal Toxic Substances Control Act are a clear sign of the growing concern surrounding the widespread introduction of thousands of chemicals into commerce without significant testing to establish safety for humans or wildlife. The general public has become increasingly engaged on issues of chemical safety and potential ecological harm, informed by headlines in major newspapers across the country. The RMP's recent study documenting declines in flame retardant contamination in San Francisco Bay (Sutton et al. 2015) made the front page of the San Francisco Chronicle, and and was broadcast widely via local print, radio, and television news, as well as in major publications like Scientific American.

The RMP, a global leader on contaminants of emerging concern (CECs), stays ahead of the curve by identifying problem pollutants *before* they can harm wildlife. The RMP has completed a strategy document outlining a comprehensive, forward-looking approach to addressing CECs in San Francisco Bay (Sutton et al. 2013). The RMP's CECs strategy consists of three major elements. First, for contaminants known to occur in the Bay, the RMP evaluates relative risk using a tiered risk and management action framework. This risk-based framework guides future monitoring proposals for each of these contaminants. The second element of the strategy involves review of scientific literature and other aquatic monitoring programs to identify new contaminants for which no Bay data yet exist. Finally, the third element of the strategy consists of non-targeted monitoring, including broadscan analyses and development of bioanalytical tools.

For the RMP's CECs strategy to remain relevant and timely, it needs regularly updates with new information on analytical methods and study findings from the RMP and others. Funds are needed to review new results, track research conducted elsewhere, and keep stakeholders apprised of findings. At the same time, it is important for the RMP to provide relevant, objective science to inform the growing number of policy actions concerning emerging contaminants, an increasing demand on staff time. In the last six months, RMP emerging contaminants experts have responded to a Water Board information request concerning the state of science surrounding perfluorochemicals as it relates to developing emerging contaminant action plans, and provided necessary scientific support for Water Board comment letters regarding two USEPA proposed significant new use rules concerning nonylphenol ethoxylates and perfluorochemicals.

By the end of 2015, a number of new developments will necessitate a thorough revision of the RMP CEC strategy document to assure it evolves with the latest science. These new developments include: 1) a SCCWRP pilot CEC study guidance document concerning CEC monitoring in aquatic environments; 2) completion of an RMP special study consisting of non-targeted broad scan analysis of Bay tissue samples to identify CECs not yet monitored; and 3) completion of an RMP study to develop bioanalytical tools to identify estrogenicity due to contaminants. The potential impact of these larger scale developments on the RMP's CEC strategy requires full revision of the strategy document, as opposed to the revision of specific tables considered emerging contaminants strategy deliverables for 2015.

In addition, as the RMP CEC strategy has expanded and evolved in recent years, a number of process-related questions have come up surrounding the annual procedure for updating the tiered risk and management action framework, as well as the process for making recommendations regarding analyses appropriate for inclusion in RMP Status and Trends monitoring. An updated CEC strategy document will also include clear descriptions of all processes relating to the RMP CEC strategy.

Study Objectives and Applicable RMP Management Questions

Through this Special Study, the RMP has traditionally funded updates to the tiered risk and management framework (element one of the RMP CEC strategy), review of the state of the science concerning CECs and interaction with other monitoring groups (element two), and interpretation of the findings of non-targeted analysis (element three) to determine new monitoring priorities.

Additional demands now placed on the RMP's emerging contaminants team include: a) scientific assistance to the Water Board as agency staff prepare action plans for priority CECs; b) increased engagement with stakeholders (e.g., briefings for the Water Board and the RMP Steering Committee); c) scientific advisory support for the Water Board and other stakeholders concerning relevant policy proposals and actions at the local, state, and federal levels (e.g., USEPA proposed significant new use rules); and d) increasing coordination of pro bono analyses that leverage RMP funds. To assure that the RMP is able to provide cost-effective expertise to address these demands, this proposal requests a higher level of funding for 2016 to assure that the policies that are developed are based on sound science.

As described above, key developments with the potential to impact the core RMP CEC strategy make revision of the strategy document in 2016 a high priority. Periodic revision was anticipated as necessary to maintain the relevance of this document in the face of an evolving science and policy landscape.

Table 1: Study objectives and questions relevant to RMP management questions

Management Question	Study Objective	Example Information Application
1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?	Compare existing occurrence data with new toxicity information reported in the scientific literature. Evaluate future monitoring needs and toxicity data gaps.	Does the latest science suggest a reprioritization of chemicals as we learn more about them? Which newly identified contaminants merit further monitoring?
2) What are the concentrations and masses of contaminants in the Estuary and its segments? 2.1 Are there particular regions of concern?	Does new knowledge including recently published toxicity data and/or source/pathway information suggest different relative risks for any of the five subembayments?	What are the key regional influences on different subembayments that impact concentrations, masses, and potential risk of emerging contaminants?
3) What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary? 3.1. Which sources, pathways, etc. contribute most to impacts?	Does new research in other regions provide insight as to key sources, pathways, loadings, and processes that affect impacts of emerging contaminants?	Are relative levels of contaminants in different matrices or subembayments consistent with our expectations for various contaminant processes?
4) Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased? 4.1. What are the effects of management actions on concentrations and mass?	Does trend data from other regions suggest likely trends in the Bay? Which new management actions are likely to impact contaminant levels?	Are additional or different actions needed to reduce levels below aquatic toxicity thresholds?
5) What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?	Do data on production, use, and source trends in the scientific and trade literature provide a means of prioritizing relative risk of Bay contaminants?	Do production, use, and source trends suggest likely changes in the relative risk of specific emerging contaminants?

Emerging contaminants strategy work most directly addresses questions 1, 3, and 5, by assuring that all manner of relevant new information is brought to bear in evaluating the relative risk of emerging contaminants to Bay wildlife. For example, a new study identifying a lower toxicity threshold for a particular contaminant might suggest that the relative risk tier in which that contaminant had been placed should be revised.

In addition, the study will address the emerging contaminants priority question: What emerging contaminants have the potential to adversely impact beneficial uses of the Bay?

By providing funding for the emerging contaminants strategy, the RMP can be assured it is getting "the most bang for its buck," targeting the highest priority contaminants among the many thousands in commerce and potentially discharged to the Bay. The RMP is a global leader in CEC monitoring, yet it must be efficient and pragmatic in the face of finite

resources. An increase in funding for this task will allow for strategic thinking using the latest science, so that the RMP can continue to generate the information water managers need to effectively address emerging contaminants in the Bay.

Approach

Base funding ($20,000) for this effort has supported the review of key information sources throughout the year. These sources include:

- Abstracts of newly published articles in key peer-reviewed journals (e.g., Environmental Science and Technology, Environmental Toxicology and Chemistry, Environment International)
- Documents produced by other programs (e.g., USEPA, Environment Canada, European Chemicals Agency, Great Lakes CEC Program)
- Abstracts and proceedings from relevant conferences (e.g., Society of Environmental Toxicology and Chemistry, International Symposium on Brominated Flame Retardants)

Additional funding ($13,000) would support staff to provide additional services, such as:

- Additional presentations, briefings, and stakeholder interactions
- Scientific assistance to the Water Board as the agency prepares emerging contaminant action plans
- Scientific assistance to stakeholders engaged in emerging contaminants policy
- Coordination of pro bono analyses including study of pharmaceuticals in WWTP effluent

Finally, a major emerging contaminants deliverable proposed for 2016 is full revision of the RMP CEC Strategy document (Sutton et al. 2013). The estimated cost for this task is $15,000. A number of critical developments have occurred since its original publication in 2013, as detailed previously, and the RMP's overall strategy should evolve to encompass new science and policy. Updates to the tiered risk-management action framework for San Francisco Bay would be included within this larger deliverable, as well as an outline of the general process for future updates and other related activities, such as CEC-related recommendations for expanded Status and Trends analyses.

Budget

The following budget represents estimated costs for 2016 Emerging Contaminants Strategy, including additional deliverables not included in the proposals from previous years.

Table 2. 2016 Emerging Contaminants Strategy budget

Deliverables	**Funds**
Tasks 1-4: Information gathering from a variety of sources throughout the year, including presentations at scientific conferences; Assist Water Board and other stakeholders with science summaries relating to policy including emerging contaminants action plans and comment letters regarding proposed actions of other agencies; Present an update of emerging contaminants strategy, ongoing or completed special and pro bono studies, and new studies to the Steering Committee; Review tiered monitoring and management risk framework, brief the Water Board	$33,000
Task 5: Update RMP CEC Strategy document	$15,000
Total	$48,000

Budget Justification

Essential Emerging Contaminants Strategy Deliverables

In past years, a strategy fund of $20,000 has covered a number of essential tasks to assure that the RMP's monitoring of CECs remains relevant and timely, as described previously. New demands placed on CEC staff indicate a need for a discrete increase in these funds to $33,000. For example, developing a single memo for the Water Board describing the state of science and policy for a particular contaminant for which an action plan is being developed may require 20 hours of senior staff time @ $150/hr, resulting in an expenditure of $3,000.

RMP CEC Strategy document update

To produce a revised CEC strategy document, we estimate 80 hours of senior staff time @ $150/hr ($12,000), 20 hours of junior staff time @ $70/hr ($1,400), and 15 hours of design staff time @ $115/hr ($1,725).

Reporting

Emerging contaminants strategy work would be captured in the updated RMP CEC Strategy document proposed as a major deliverable. A number of RMP CEC Strategy presentations (Emerging Contaminants Workgroup, Steering Committee, and Annual Meeting) and briefings (Water Board, others as needed) provide further opportunities to report on this work.

References

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Priority Margin Unit Conceptual Model Development

Oversight group: PCB Workgroup
Proposed by: Jay Davis, SFEI

Funding Options

1) Funding recommended by TRC for 2016:	**$40,000**
2) Another viable funding option:	$60,000
3) Funding originally proposed by Workgroup for 2016:	$80,000

Proposed Deliverables And Timeline

Deliverable	**Due Date** (Option 1)	**Due Date** (Options 2 and 3)
Updated multi-year plan for RMP PCB studies	June 2016	June 2016
Draft report	Apr 2017	Dec 2016
Final report	Jul 2017	Mar 2017

Summary

The goal of RMP PCB Strategy work over the next few years is to inform the review and possible revision of the PCB TMDL and the reissuance of the Municipal Regional Permit for Stormwater (MRP), both of which are tentatively scheduled to occur in 2020. Conceptual model development for a set of representative priority margin units will provide a foundation for establishing an effective and efficient monitoring plan to track responses to load reductions and also help guide planning of management actions.

Introduction and Background

The RMP PCB Strategy Team formulated a PCB Strategy in 2009. The Team recognized that a wealth of new information had been generated since the PCBs TMDL Staff Report (SFBRWQCB 2008) was prepared. The Strategy articulated management questions to guide a long-term program of studies to support reduction of PCB impairment in the Bay. The PCB Team recommended two studies to begin addressing these questions. The first recommended study was to take advantage of an opportunity to piggyback on the final year of the three-year small fish mercury sampling in 2010 to collect data on PCBs in small fish also. The second study that was recommended was a synthesis and conceptual model update based on the information that had been generated since the writing of the TMDL Staff Report.

The small fish monitoring revealed extremely high concentrations of food web PCBs in several areas on the Bay margins (Greenfield and Allen 2013), and highlighted a need to develop a more detailed conceptual model than the one-box model used as a basis for the TMDL. A model that would support the implementation of actions to reduce loads from small tributaries, a primary focus of the TMDL, would be of particular value. A revised conceptual model was developed that shifted focus from the open Bay to the contaminated areas on the margins where

impairment is greatest, where load reductions are being pursued, and where reductions in impairment in response to load reductions would be most apparent (Davis et al. 2014).

The margins appear to be a collection of distinct local food webs that share some general similarities but are largely functionally discrete from each other. Monitoring, forecasting, and management should therefore treat these margin locations as discrete local-scale units. Local-scale actions within a margin unit, or in upstream watersheds, will likely be needed to reduce exposure within that unit. Better characterization of impairment on the margins through more thorough sampling of sediment and biota would help focus attention on the margin units where the need for action is greatest ("priority margin units" or PMUs), and will also provide an important performance measure for load reduction actions taken in local watersheds. Davis et al. (2014) recommended a focus on assessing the effectiveness of small tributary load reduction actions in priority margin units, and provided an initial foundation for these activities.

The 2014 update of the PCB Strategy called for a multi-year effort to implement the recommendations of the PCB Synthesis Report (Davis et al. 2014) pertaining to:

1. identifying margin units that are high priorities for management and monitoring,
2. development of conceptual models and mass budgets for margin units downstream of watersheds where management actions will occur, and
3. monitoring in these units as a performance measure.

A thorough and thoughtful planning effort is warranted given the large expenditures of funding and effort that will be needed to implement management actions to reduce PCB loads from urban stormwater.

The work being conducted in 2015 has initiated the multi-year PMU effort. The first phase of the 2015 work consisted of a preliminary assessment of margin units downstream of six pilot watersheds that have been prioritized for management actions. In the second phase of the 2015 workplan, to be conducted in the second half of the year, a detailed assessment of one of the six PMUs will be developed.

PCB Strategy Team discussions in 2015 have helped refine the multi-year plan (Table 1). The goal of RMP PCB special studies over the next few years is to inform the review and possible revision of the PCB TMDL and the reissuance of the Municipal Regional Permit for Stormwater (MRP), both of which are tentatively scheduled to occur in 2020. Conceptual model development for the set of PMUs is the element of the PCB workplan that will have the greatest value in informing the consideration of a revised TMDL and MRP. A conceptual understanding of the anticipated response of these PMUs to load reductions, in addition to providing a foundation for establishing an effective and efficient monitoring plan, will also help guide planning of management actions. As conceptual models are developed for these PMUs, consideration will be given to whether a general model or family of models can be developed that could apply to margin units more broadly. The monitoring plans that are produced will be designed to maximize sensitivity to detecting reduced impairment in the margin units.

Study Objective and Applicable RMP Management Questions

The objectives of this study are:

1. to develop a conceptual understanding of the anticipated response of four PMUs to load reductions, and
2. to develop sensitive monitoring strategies to detect the effectiveness of watershed management actions in reducing PCB impairment in PMUs.

PCB Strategy Questions Addressed

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
4. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?
5. What management actions have the greatest potential for accelerating recovery or reducing exposure?
6. What are the near-term effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

RMP Management Questions Addressed

4.Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?

B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

Study Approach

The multi-year plan for studying PCBs in the margins has three components: conceptual model development, field studies to support/confirm the models, and trend monitoring. The funding requested for 2016 would support continued conceptual model development through synthesis and simple modeling based on existing information, potentially supplemented by a small budget for field sampling to address critical information needs related to the conceptual models.

- The revised multi-year plan calls for the development of conceptual models for four PMUs (Emeryville Crescent, Richmond Harbor, Steinberger Slough, and San Leandro Bay) from 2015-2018. Work on this component will begin for Emeryville Crescent in 2015 and is proposed to continue with San Leandro Bay in 2016.

- To support conceptual model development, a budget for field studies ($20K per year) is also included in the multi-year plan. This component would only be included under funding option 3. These studies could include, for example, analysis of spatial patterns in surface sediments or of sampling to determine the presence of indicator species and their PCB concentrations.

- Per the multi-year plan, as the conceptual models are completed, trend monitoring can be phased in. A preliminary estimate of the cost of this monitoring is $30K per unit per year. Monitoring is tentatively planned for one unit in 2017, two in 2018, and all four in 2019.

Given the long-term plan discussed above, the work proposed for 2016 is to develop a conceptual site model for a second PMU (San Leandro Bay). Under funding option 1, development of the conceptual site model for San Leandro Bay would begin in 2016 and would be completed in the first half of 2017. Under funding options 2 and 3, the conceptual site model for San Leandro Bay would be completed in 2016.

The field study budget for 2016 (included for option 3 only) can be used either to address information gaps for the first (Emeryville Crescent) or second (San Leandro Bay) PMUs.

Tasks for 2016

Task 1: Develop a conceptual site model and first order mass budget for the second PMU ($40K: $30K for SFEI labor to synthesize information and conduct modeling). Funding option 2 adds $20K for model development. Funding option 3 adds $20K for field studies.

The second PMU (San Leandro Bay) will be evaluated in detail in 2016. A relatively large Conceptual Site Model Workgroup (CSMW) will be assembled that includes members of the PCB Strategy Team, along with experts on potential biotic indicators, sediment movement from watersheds to margins to the open Bay, and local conditions, and local stakeholders. This CSMW will meet two to three times to develop and document conceptual understanding and a monitoring plan for the PMU. While ideally the site model evaluations will conclude that it is possible to detect reduced concentrations in the Bay, it is also possible that the CSMW will conclude that this is not feasible with a realistic effort given the relative magnitude of the reduced loading, the reservoir of PCBs already in the PMU, and environmental variation. Schedules for CSMW activities will be established with input from workgroup members and interested parties.

The labor required to conduct task 1 is difficult to estimate because this is a pilot effort and the data gathering and analysis to be done will be determined through Strategy Team and CSMW discussions. If funds remain from task 1 after the task is completed, they will be applied to development of the CSM for the third PMU. More detailed budgets will be developed and subject to Strategy Team, TRC, and Steering Committee approval as planning proceeds.

Timing and Deliverables: A draft technical report documenting a conceptual site model and monitoring plans for the second PMU by April 2017. Final report in July 2017. Dates for funding options 2 and 3 would be December 2016 and March 2017.

Task 2: Convene PCB Strategy Team and update multi-year plan in support of the TMDL ($10K)

Funds for this task would enable SFEI to continue to convene the PCB Strategy Team to allow discussions of plans for the next iteration of the TMDL and RMP activities that can inform the TMDL, and for any small-scale synthesis of information that is needed to support these discussions. The plan will include a multi-year plan schedule of budgets and deliverables aimed at providing a technical foundation for the next iteration of the TMDL. Depending on the outcomes of the site model evaluations, this RMP expenditure for continued Strategy Team discussions may need to be augmented or complemented by other forums for discussing TMDL revision.

Timing and Deliverables: An updated PCB multi-year plan in June 2016. The plan will include a multi-year plan schedule of budgets and deliverables.

References

Davis, J.A., L.J. McKee, T. Jabusch, D. Yee, and J.R.M. Ross. 2014. PCBs in San Francisco Bay: Assessment of the Current State of Knowledge and Priority Information Gaps. RMP Contribution No. 727. San Francisco Estuary Institute, Richmond, California.

Table 1. PCB studies and monitoring in the RMP from 2010 to 2019 - $40K funding scenario in 2016. Numbers indicate budget allocations in $1000s.

Element	PCB Questions Addressed	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Food Web Uptake (Small Fish)	1, 4	50									
PCB Conceptual Model Update	1,2,3,4,5,6		53								
Development and updating of multi-year workplan and continued support of PCB Strategy Team meetings							10	10	10	10	10
Prioritize Margin Units	1, 4, 5, 6						30				
Develop Conceptual Site Models and Mass Balances for PMUs (4 PMUs)	1, 4, 5, 6						45	30	70	50	
PMU Field Studies to Support Development of Conceptual Site Models and Monitoring Plans	1, 4, 5, 6								30	20	
PMU Trend Monitoring (5 PMUs)	1, 4, 5, 6									60	120
TOTAL		50	53				85	40	110	140	130

Special Study Proposal: Correlation of Selenium in Sturgeon Tissues - Sturgeon Derby

Summary: The Regional Water Board is currently developing a selenium TMDL for the North San Francisco Bay, which will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. This study proposes the collection of tissues from female sturgeon sacrificed as part of the annual Sturgeon Derby in order to establish relationships between selenium concentrations measured in non-lethally collected tissues (muscle plugs, fin rays) and those more closely tied to, or predictive of, adverse impacts in white sturgeon due to selenium (ovaries, otoliths).

Estimated Cost: $37,000

Oversight Group: RMP Selenium Strategy Team

Proposed by: Jennifer Sun and Jay Davis

Background

In April 2014, the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that can provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation.

The TMDL will establish a target concentration in white sturgeon muscle tissue as the basis for evaluating impairment. White sturgeon is a bottom-feeding species that is considered to be at substantial risk for selenium exposure in the Bay (Beckon and Mauer 2008). White sturgeon are particularly at risk because their diet consists primarily of the overbite clam (*Corbula amurensis*), which are selenium-rich relative to other prey (Stewart et al. 2004). Other increased risk factors for sturgeon include their longevity (they can live over 100 years), their year-round resident status, and long egg maturation times (several years) (Beckon and Mauer 2008). Green sturgeon are also considered to be vulnerable to selenium but their exposure could be limited. Adults and sub-adults spend a large portion of their lives in coastal marine waters outside of the estuary, and are only briefly exposed to high selenium diet during their infrequent spawning migrations through the Bay. In addition, green sturgeon are threatened species and fishing for them is prohibited.

White sturgeon have been routinely sampled (in 1997, 2000, 2003, 2006, 2009, and 2014) as part of RMP sport fish monitoring. The tissue analyzed has been muscle fillets. In recent years, the focus of white sturgeon monitoring has been shifting towards non-lethal sampling methods, which allow for the collection of larger sample numbers.

Sampling of sturgeon ovaries, although logistically more challenging than sampling using non-lethal methods, would provide a more direct metric of the risk to sturgeon reproduction. USEPA recently published draft selenium criteria for freshwater that highlight egg or ovary data as a preferred endpoint most directly tied to adverse effects (USEPA 2014). Data that would allow evaluation of the correlation between concentrations measured in non-lethally collected tissues and ovary concentrations would enhance the application of muscle plugs as an impairment indicator.

The RMP is currently working to establish two non-lethal sampling methods for measuring selenium concentrations in sturgeon tissues. In 2014, the RMP collected muscle plug samples for selenium analysis from 21 white sturgeon, including 12 as part of the sport fish monitoring round and 9 in collaboration with the CDFW during the Selenium in Muscle Plugs Special Study. Similar studies have been approved or are being proposed for future field seasons.

In 2015, the RMP also collaborated with Dr. Vince Palace at Stantec and Dr. Norman Halden with the University of Manitoba, Department of Geological Sciences, to test a second non-lethal sampling method using fin rays using data collected at the annual Sturgeon Derby. In this Sturgeon Derby, held on Super Bowl weekend, anglers attempt to catch sturgeon that come closest to a selected size. Fish that are close to the target size are brought to a central location and sacrificed. For the past several years, the USFWS has collected tissues from these sturgeon and analyzed them for a suite of metals and organics, including selenium, in gonads (including ovaries), liver, and plasma. These data have not yet been published. During the 2015 Sturgeon Derby, the RMP successfully collaborated with USFWS and Stantec to collect muscle plug, fin ray, and otolith samples for selenium analysis as well, for comparison with concentrations measured in ovary samples and other tissues.

Fin rays are taken as a clip and are easy to collect by non-specialists, and fin clips have been shown to be non-harmful to sturgeon (Collins and Smith 1996). Because fin rays have a regular growth pattern similar to growth rings of a tree, a laser ablation MS technique (laser ablation inductively coupled plasma mass spectrometry [LA-ICP-MS]) can be used to allow for the analysis of concentrations of selenium and other elements in each annual ring (i.e., concentrations in the fish tissue over the time). Data showing trends in selenium concentrations in North San Francisco Bay white sturgeon tissue over time will help elucidate the dynamic selenium bioaccumulation patterns in sturgeon, and begin to answer the question of whether or

not changes in selenium water chemistry and prey over time relates to changes in tissue concentrations in sturgeon.

A recent study found that fish otolith selenium measurements are the best predictors of ovary selenium, enhancing data collected from tissues alone (Reash, Friedrich, and Halden 2014). However, otoliths can only be collected from sacrificed fish. Thus, fin ray analysis is being developed as a potential alternative to both muscle plug and otolith sampling. The research team is currently using otolith microchemistry analyses to establish the chemical stability of fin ray samples. Fin ray data will also be compared with muscle and ovary data to develop a model that establishes the relationship between selenium concentrations in these tissues.

The annual sturgeon fishing tournament in the Delta again provides an opportunity to obtain tissue samples from a small number of female sturgeon in 2016. These samples will be used to test the relationships between selenium concentrations measured in tissues collected using lethal and non-lethal methods, and contribute to the development of the fin ray microchemistry analysis technique.

The average number of fish that are sampled during the Derby is about 40, with about half being females. In 2015, sampling conditions were relatively poor during part of the Derby, and only 27 fish were sacrificed, including 8 females. Because sampling conditions and sex ratios may be unpredictable, the proposed target number of female fish sampled during the 2016 Sturgeon Derby will remain at 15. In 2015, the target sample tissues were successfully collected, and the muscle plugs, ovaries, and fin rays have been analyzed for selenium. The full results from the 2015 Sturgeon Derby will be available in August 2015.

This proposal is requesting funds for a second year of sampling at the sturgeon Derby in 2016, which will include measuring selenium in muscle plugs, ovaries, fin rays, and otoliths.

Study Objectives and Applicable RMP Management Questions

The objective of this study is to obtain data to evaluate the correlation between muscle and ovary selenium concentrations through a collaboration with USFWS, local fishermen, and USGS. Together with data collected during the 2015 Sturgeon Derby and other selenium studies, data collected during the 2016 Sturgeon Derby would also contribute to the tracking of temporal trends in selenium impairment over time.

Selenium Strategy questions addressed:

2. Are the beneficial uses of San Francisco Bay impaired by selenium?
4. How do selenium concentrations and loadings change over time?

RMP Management Questions addressed:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
   B. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
   B. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

Approach

This study would be performed in collaboration with USFWS, USGS, and Stantec. RMP staff would plan the study, perform muscle plug sampling, manage the data, and write a brief technical report. USFWS would assist with the collection of ovary samples for the same fish sampled for muscle plugs. USGS (Robin Stewart and her team) would process the muscle plug and ovary samples, perform selenium analyses, and subsequently prepare and ship these samples to UC Davis to perform C, N, and S stable isotope analyses.The stable isotopes will provide information on diet and habitat use by the sturgeon. Stantec would collect fin rays and otoliths and conduct selenium microchemistry analyses.

Tissues would be collected and analyzed from up to 15 female white sturgeon. If fewer than 15 females are euthanized during the Derby, tissues would be collected from all females. The sampling would occur on Super Bowl weekend in 2016.

Budget

The proposed budget for this Special Study is $37,000.

Table 1. Budget for the 2016 Sturgeon Derby Proposal

Task	Estimated Cost
Labor*	
Project Planning & Coordination	$2,500
Field Work	$3,200
Data Management	$9,600
Reporting	$6,000
Subcontracts	
USGS - sample processing, archiving	$200
USGS - 30 selenium analyses (plugs, ovaries) @ $165/sample	$4,950
UCD - 15 C, N, S analyses (plugs only) @ $25/sample	$375
Stantec - Travel ($3,000), instrument set-up ($2,500), 15 fin ray and 15 otolith selenium microchemistry analyses @ 115/sample	$8,950
Direct Costs	
Equipment - biopsy plugs, sample containers, etc.	$200
Shipping - 45 samples to lab, 15 samples from USGS to UCD	$200
Travel - 2 days of travel for 2 RMP staff	$350
Contingency	$525
Grand Total	$37,000

*Project management, contract management, and archiving costs will be included in the RMP base funding

Reporting
A draft technical report describing the results of the study will be prepared by September 30, 2016. The technical report will be reviewed by the Selenium Strategy Team and the TRC and will be finalized by December 31, 2016.

References

Beckon, W. and T. Mauer. 2008. Species at Risk from Selenium Exposure in San Francisco Estuary. Final report to the USEPA. US Department of the Interior, Fish and Wildlife Service. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/northsfbayselenium/Species_at_risk_FINAL.pdf

Collins, M.R., and Smith, T.I.U. 1996. Sturgeon fin ray removal is nondeleterious. North American Journal of Fisheries Management. 16:939-941

DuBois, J. and M.D. Harris. 2013. 2013 Field Season Summary for the Adult Sturgeon Population Study. http://www.dfg.ca.gov/delta/data/sturgeon/bibliography.asp

Reash, R., Friedrich, L., and Halden, N. 2014. Selenium bioaccumulation patterns in tissue and otoliths for fish from wastewater exposure and reference sites. Poster *Society of Environmental toxicology and Chemistry North america 35th Annual Meeting*. Vancouver, BC, Canada. November 9-13, 2014.

Stewart, R.A., S. Luoma, C. Schlekat, M. Doblin, and K. Hieb. 2004. Food web pathway determines how selenium affects aquatic ecosystems: a San Francisco Bay case study. Environ. Sci. Technol. 38. 4519-4526.

United States Environmental Protection Agency. 2014. External Peer Review Draft Aquatic Life Ambient Water Quality Criterion For Selenium - Freshwater 2014. United States Environmental Protection Agency, Washington DC. http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/selenium/upload/External-Peer-Review-Draft-Aquatic-Life-Ambient-Water-Quality-Criterion-For-Selenium-Freshwater-2014.pdf

Special Study Proposal: Selenium Strategy Coordination and Technical Support

Oversight group: Selenium Strategy Team
Proposed by: Jay Davis, SFEI

Funding requested for 2016: $10,000

Introduction and Background

In April 2014 the RMP formed a Selenium Strategy Team to evaluate information needs that can be addressed by the Program in the next several years. The charge given to the Team by the RMP Steering Committee was to focus on low-cost, near-term monitoring elements that could provide information that provides high value in support of policy development and decision-making. A TMDL for the North Bay is in development by the Regional Water Board, with a staff report in preparation. Development of a TMDL for the South Bay will be considered after the North Bay TMDL is completed. In the longer-term, the need for a greater investment in studies in support of managing selenium in the Bay will be considered.

Study Objective and Applicable RMP Management Questions

The objective of this task is to provide coordination and technical support for continuing development of the Selenium Strategy. This task would therefore address all of the questions articulated in the Strategy.

1. What are appropriate thresholds?
2. Are the beneficial uses of San Francisco Bay impaired by selenium?
3. What is the spatial pattern of selenium impairment?
4. How do selenium concentrations and loadings change over time?
5. What are the mechanisms of uptake from water and sediment to biota?
6. What is the relative contribution of each loading pathway as a source of selenium impairment in the Bay?
7. What future impairment is predicted for selenium in the Bay under different management scenarios?
8. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes?

The task would also address many of the overarching RMP management questions.

Tasks for 2016

Funds for this task would enable SFEI to continue to convene the Selenium Strategy Team to allow discussions of plans for the North Bay TMDL and the consideration of a TMDL for South Bay, to develop RMP workplans to support these efforts, and for any small-scale synthesis of information that is needed to support these discussions. The plan will include a multi-year schedule of budgets and deliverables aimed at providing a technical foundation for the

TMDLs.

Timing and Deliverables

An updated selenium multi-year plan will be prepared for June 2016. The plan will include a multi-year schedule of budgets and deliverables.

Special Study Proposal: Assessing the Effects of Clay on the Amphipod *Eohaustorius estuarius*

Summary: This study will confirm results of the 2014 Regional Monitoring Program (RMP) Special Study showing that sediment clay causes size specific effects on the amphipod *Eohaustorius estuarius*. Experiments with field sediments from the San Francisco Estuary will be used to corroborate laboratory experiments conducted in 2014 which showed that larger amphipods were less tolerant of kaolin clay. These results have the potential to inform policy regarding the use of this species in monitoring clay-rich sediments. These experiments may result in a revision of the toxicity testing protocol to use smaller test organisms to minimize the confounding effect of clay on toxicity test results.

Estimated Cost: $30,000

Oversight Group: EEWG

Proposed by: Brian Anderson (UC Davis)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Project Management (write and manage sub-contract, track budgets)	September-November 2015
Task 2. Analyze data, select sites and conduct field sampling	Winter 2015
Task 3. Laboratory analysis; QA/QC	Winter 2015-2016
Task 4. Draft/final report/protocol recommendation	March 2016

Background

The 10 day survival toxicity test with the amphipod *Eohaustorius estuarius* (U.S. EPA, 1994) is the primary sediment test protocol used in the Regional Monitoring Program and the State Water Resources Control Board's Sediment Quality Objective (SQO) program (Beegan, 2009). Historical data have indicated that the mortality of this species correlates with the clay content of sediments. Based on the recommendations of two RMP workshops convened to investigate causes of moderate toxicity in the Estuary, a series of laboratory experiments were completed in 2014 to investigate the effects of kaolin clay on *E. estuarius*. Kaolin is the dominant clay in the Estuary. The results of these experiments showed that smaller amphipods were more tolerant of kaolin than larger amphipods. These results were confounded by the fact that dose-response experiments with sand-spiked kaolin mixtures did not exhibit strict monotonic decreases in amphipod survival. Analyses of clay concentrations suggested that clay was agglomerating (=flocculating) in the kaolin concentrations higher than 70%. This resulted in increasing silt concentrations in the treatments $\geq$70% kaolin (silt = particle sizes >4um to $\leq$63 um), and therefore reduced effects of clay (particles < 4 um). The flocculation phenomenon may have been due to the use of pure kaolin clay in these experiments.

To confirm the size-specific effect of clay on *E. estuarius*, confirmatory experiments are recommended using estuarine reference sediments having high clay content. Appropriate reference sites will be identified using existing RMP data. These will be sites with high clay concentrations, but low concentrations of anthropogenic contaminants. Once identified, high clay sediments from three reference sites will be collected and these will be mixed with reference sand to give a range of clay concentrations using the same procedures described in the 2014 kaolin tests (Anderson et al., 2015). Sediments will then be tested with small, medium and large size classes to confirm whether smaller amphipods are more tolerant of clay than larger animals. If small amphipods are demonstrated to be more tolerant of high clay reference sediments, these results will inform policy regarding use of *E. estuarius* in future RMP monitoring, as well as the use of this species in the SWRCB SQO program.

Study Objectives and Applicable RMP Management Questions

This study will provide confirmatory evidence that high clay in sediment inhibits *E. estuarius* in sediment toxicity tests and that clay effects are more pronounced in larger amphipod individuals. The study will address one RMP Management Question as it relates to one of the RMP and SQO monitoring indicators:

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

1.d. What contaminants are responsible for observed toxic responses?

The objective of the study is to define the tolerance range of three different size classes of *E. estuarius* to sediment clay concentrations, and confirm whether small amphipods are more tolerant of clay than large amphipods.

Approach

Experiments will follow methods used in the 2014 experiments where reference sand was spiked with increasing concentrations of kaolin clay and exposed to three size classes of field caught *E. estuarius* (Anderson et al., 2015). Rather than kaolin, the current experiments will use reference sediments with high clay content. Reference sediments are defined as San Francisco Estuary sediment having low contaminant concentrations based on sediment quality guideline quotient values (e.g., Effects Range Median quotient value (ERMQ) $\leq$0.11). These will be identified through screening of the most recent existing RMP data from sediments monitored by the RMP Status and Trends program. Three sites will be identified based on the following criteria: ERMQ $\leq$ 0.11; sediment clay content $\geq$90%.

The field sediment will then be hand mixed with #60 reference sand (0.25 mm mesh size) at the following ratios: 0% (sand only), 10%, 30%, 50%, 70%, 90%, and 100% field sediment. Sediment from the amphipod collection site (home sediment) will also be tested as a control. All samples will be tested with small, medium, and large size classes of *E. estuarius* collected from the Oregon field site and pre-sorted by the amphipod supplier, Northwest Aquatic Sciences. As in the previous experiments, field animals will be wet sieved onto a 1 mm

screen, then visually sorted into small, medium, and large cohorts for testing. All tests will conducted when sufficient densities of amphipods in each size class are present at the collection site (likely winter 2015-2016).

Analyses of variance with post hoc Dunnett's tests will be used to determine significant differences among amphipod responses in different concentrations of field sediment, and also among different size classes of amphipods ($\alpha = 0.05$). Sediment grain size analyses will be conducted using laser diffraction analysis as well as the pipet method, as described previously (Anderson et al., 2015).

If results of these experiments are consistent with the previous laboratory tests with kaolin, they will provide corroboratory evidence that smaller amphipods are more tolerant of clay than larger animals. If so, this will likely lead to a revision of the standard 10 day test protocol using *E. estuarius* to restrict testing of high-clay sediments using larger animals and recommend using only the smallest individual amphipods (<1 mg) to minimize the confounding effect of clay on test results.

Budget

The proposed budget for the study is $30,000. This includes review of existing RMP data to identify candidate reference sites, collection of sediment from three reference sites, dose-response experiments from each reference sites using three size classes of amphipods, grain size analyses, and data analysis and final reporting.

Table 1. Budget summary.

Task	**Laboratory**	**Cost**
Task 1 Site selection and sampling		
(a) Data screening and site selection	MPSL – Granite Canyon	$350.00
(b) Sediment sampling	MPSL – Granite Canyon	$3,150.00
Task 2 Laboratory Experiments		
(a) Size-specific effects of sand-spiked high clay field sediments	MPSL – Granite Canyon	$19,460.00
Task 3. Grain size analysis	Aiello Moss Landing	$2,400.00
Task 4. Data analysis and reporting	MPSL – Granite Canyon	$4,640.00
Total Costs		**$30,000.00**

Reporting

A draft fact sheet summarizing the approach, analyses and results of the study will be submitted to the EEWG and TRC. Upon receipt and incorporation of comments, a final recommendation for revision of the 10d sediment protocol using *E. estuarius* for high clay sediments will be issued.

References

Anderson, B.S., Phillips, B.M., Voorhees, J.P., 2015. The effects of kaolin clay on the amphipod *Eohaustorius estuarius*. San Francisco Estuary Institute.

Beegan, C., 2009. Water Quality Control Plan for Enclosed Bays and Estuaries - Part 1 Sediment Quality. State Water Resources Control Board. Sacramento, California.

U.S. EPA, 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA/600/R-94/025. Office of Research and Development, Washington D.C.