

## **Regional Monitoring Program for Water Quality in the San Francisco Estuary**

### **Summary of the 2013 Program**

#### **OVERVIEW OF THE 2013 PROGRAM**

In 2013 the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is entering its 21<sup>st</sup> year of monitoring and synthesis. At its inception, the purpose of the Program was to provide ambient water quality data to support management. This continues to be a major goal and is addressed through the annual Status and Trends (S&T) monitoring and special studies on select topics. The S&T program includes long-term water, sediment, and bivalve monitoring; hydrographic and sediment transport studies; triennial bird egg monitoring (cormorant and tern); and sport fish monitoring on a five-year cycle. In 2011, after careful review of the data and information needs, the Technical Review Committee (TRC) and the Steering Committee (SC) approved the reduction of the frequency of water and sediment monitoring to a biennial program. This change was implemented in 2012.

As a result of the reduction in S&T, the Program has been able to expand to address a number of urgent information needs in other areas such as tributary and nutrient monitoring and modeling. Prioritization of information needs has been articulated through the RMP Multi-year Planning meetings. The Program continues to achieve a sharp focus on providing key information to assist in the management of the Bay Area's most precious resource. The planning is continual with guidance from stakeholders and peer reviewers occurring every step of the way. The RMP Multi-year Planning priorities are conveyed to the workgroups and study designs are developed in consultation with Program participants and science advisors. The studies are then reviewed and approved by the TRC and SC. The results of these studies are evaluated to identify further information needs for consideration in the planning process.

In 2013, we will continue to advance our understanding of the potential impacts of emerging contaminants. In 2012, we will complete the emerging contaminant synthesis and will begin to articulate a strategy for addressing these contaminants. In 2013, we will build upon these efforts by allocating funding to keeping the strategy document updated. In addition, we will convene a workshop of local experts on current use pesticides and consider incorporating some of these into our S&T program. We will highlight our substantial progress on emerging contaminants at the Annual Meeting and the Pulse. We are fortunate this year to be able to combine efforts with the State of the Estuary meeting, which will widen our audience and impact.

The Sources, Pathways, and Loading Workgroup, through the Small Tributary Loading Strategy, continues to provide critical information on loads from Bay Area watersheds. This group has developed a spreadsheet model to predict contaminant loads and will continue to update the model with new information as it becomes available. Important for the success of the model is both continued monitoring of different watersheds as well as predicting pollutant concentrations

in stormwater (referred to as event-mean concentrations) based on land use, soil type, and other watershed characteristics. With regard to the former, the RMP will intensively monitor two watersheds in the wet season of 2013 (beginning in late October 2012): Pulgas pump site and the North Richmond site.

Nutrients have become a major focus of the RMP. In 2011, the RMP initiated a stakeholder process to develop a Nutrient Strategy for the Estuary. The RMP sponsored a number of meetings regarding the potential role nutrients may play in the possible eutrophication of the Bay and ways in which indicators may be used to monitor changing conditions. Based on work by the RMP and USGS, we know that suspended sediment concentrations in the Bay are decreasing, phytoplankton concentrations are increasing, and dissolved oxygen concentrations are slowly decreasing. There is much yet to be learned about the complex linkages that have made the Bay resilient to the adverse effects of nutrients. The RMP will devote a significant effort in 2013 to exploring scenarios for the future and their possible effects on nutrients in the Bay. We will evaluate new means for monitoring nutrients through the use of moored sensors and passive sampling devices for algal toxins. In addition to this effort, the RMP will continue to collect information on nutrient loads from Bay Area watersheds. In the Nutrient Strategy, RMP resources are being combined with resources from local dischargers, the State Water Board, USGS, and other organizations to address the significant information needs related to this important issue.

Modeling will also be one of the key elements of the Nutrient Strategy. Given the clear and immediate need for model development in support of the Nutrient Strategy, these Modeling and Nutrient strategies will be closely coordinated, with nutrient model development as a first priority, but with the aim of establishing a modeling framework that can also be used to forecast concentrations of other contaminants such as PCBs and contaminants of emerging concern.

The success of the RMP is in large part due to the active involvement of RMP participants, agency staff, and representatives from academia in reviewing Program elements. Through workshops, workgroup meetings, and committee meetings, these individuals help to assure that the RMP obtains high quality information on the key issues of concern to the Bay. This information is used by managers to make sound decisions to promote the health of the Estuary.

This Program Plan is a summary of activities planned for 2013; a Detailed Workplan and budget are prepared separately and are reviewed and approved by the Technical Review Committee and Steering Committee. A budget summary of the total cost for each program element is included in Table 1. Detailed scopes of work and budgets are presented in the 2013 Detailed Workplan which will be presented to the TRC in December.

## **TASKS**

### **1. Program Management**

The administration and management of the RMP requires a substantial effort from SFEI staff. Costs for this component of the RMP reflect the staff time required to manage finances and

contracts, plan and coordinate internal activities and workgroups, and provide technical oversight of RMP products. A summary of the cost for these activities is included in Table 1.

### **1.1 Internal Coordination**

This category provides SFEI staff time for coordination and liaison to Program participants, Program collaborators, the Regional Water Quality Control Board, and the Steering and Technical Review Committees. This coordination is necessary to prepare for and facilitate critical decisions, outline issues, and to ensure that RMP activities complement and enhance other scientific efforts by Program Participants and the Regional Board. This task also includes the internal coordination of RMP staff (e.g., the coordination and technical oversight of different RMP tasks).

### **1.2 External Coordination**

External coordination promotes a comprehensive and coordinated understanding and monitoring of the Estuary through participation in workgroups and committees outside of the RMP umbrella. Members of RMP staff participate in the Surface Water Ambient Monitoring Program (SWAMP), various Regional Board activities in Regions 2 and 5, Northern California SETAC, the Delta Science Program, BASMAA, BACWA, LTMS, and various TMDL workgroups and committees. In addition to the above, RMP staff are frequently asked to present at stakeholder meetings, universities, national and international working group meetings, and to serve on advisory boards. RMP staff also provide peer review of documents from other relevant non-RMP programs and projects.

### **1.3 Contract and Financial Management**

Tasks in this category include efforts related to tracking progress and expenditures on all budgeted items, including invoicing of Program Participants, tracking incoming and outgoing funds, accounting and working with the SFEI auditor, working with the Fiscal and Administration Subcommittee of the SFEI Board of Directors, providing financial status updates, and communicating with the Steering Committee on financial matters as needed. It also includes preparation of contracts after scopes of work have been negotiated, scientific oversight of products, coordination of field and laboratory components, trouble-shooting, scheduling, and implementing course adjustments as necessary, cost-effectiveness/performance evaluations of existing contractors and identifying potential new subcontractors as needed.

### **1.4 Program Planning**

Program planning for the RMP involves several tasks including Program Plan and workplan development, updating the Multi-year Plan and strategy documents, proposal writing, RFP development, Program reviews, and development of scopes of work, both for in-house staff and subcontractors. We continue to place emphasis on documenting

planning steps and assisting the Steering Committee and the Water Board in prioritizing information needs, and adapting the Program to evolving management priorities.

Since 2008, the RMP has focused considerable attention to develop strategies for high priority needs. Examples of these activities include the modeling strategy, the PCB strategy, mercury strategy, dioxin strategy, small tributary loading strategy and most recently the nutrient strategy. Through strategy team meetings, stakeholders are able to articulate key questions and to identify and prioritize fundamental monitoring and research needs to begin to answer the high priority questions.

These priority questions and the key information needs from RMP stakeholders are articulated in the RMP Multi-year Plan. The Multi-year Plan allows the RMP to prioritize research and monitoring needs over the next five years, to enable long-term financial planning, to assure that the studies are planned and reviewed in close consultation with our external review panels, and to assure that information is being provided for important management decisions in a timely manner (e.g., development of TMDLs, preparation of permits, etc.).

## **2. Information Management and Synthesis**

The overarching goal of the RMP is “to collect data and communicate information about water quality in the San Francisco Estuary to support management decisions.” Information management and synthesis includes all activities relating to data management, RMP web site maintenance, development of newsletters/inserts, the RMP Annual Meeting, presentations, and information transfer to a variety of audiences, including preparation of the RMP Annual Monitoring Results and the “Pulse of the Estuary.” A summary of the cost for these activities is included in Table 1.

### **2.1 Data Management**

The primary objective of this task is to manage, maintain, and improve the RMP database and to enable greater accessibility of data results. The information management and dissemination goals for 2013 are as follows (listed in order of priority):

#### Data Formatting – QA/QC and Upload

- Upload RMP field and analytical results from laboratories into RMP database, which is comparable to the State’s SWAMP v.2.5 database.
- Perform QA/QC review of the data to verify they meet the RMP’s Data Quality Objectives.

#### Database Maintenance and Web Access

- Incorporate updates and corrections to data as needed, including reanalyzed results and updates implemented by the SWAMP/CEDEN DMT.

- Add enhancements and updates to the web-based data access tool to make data easier to access by users (e.g., user-defined queries, data download and printing functionality, maps of sampling locations, and visualization tools).

#### Mapping Assistance (GIS)

- Generate maps of sampling stations for sample collection and display of results.

#### Data Management Efficiencies

- Develop and/or enhance tools to increase the efficiency of data management tasks, including data collection (e.g., data entry forms created in Access database to collect field data and generate electronic forms and electronic data submittal templates), data upload (e.g., web data checker verifies that standard codes are submitted), and QA/QC review (e.g., standard queries for reviewing data quality objectives).

## **2.2 RMP Web Site**

The RMP web site has an important role in making data, technical reports, meeting materials, workshops, Powerpoint presentations, and other documents available to stakeholders and the public.

## **2.3 Information Dissemination**

The RMP produces an annual insert for the ESTUARY magazine, and occasionally factsheets and other documents for wide dissemination. Where possible, RMP staff uses existing publications for information distribution, such as newsletters of participating agencies, the ESTUARY newsletter, and the IEP newsletter. As appropriate, formal presentations to community groups and other organizations, and scientific conferences also provide information about the RMP and its findings. This task also includes work related to planning and executing the RMP Annual Meeting. This year's theme is emerging contaminants and the Annual Meeting will be held in conjunction with the State of the Estuary meeting on October 29<sup>th</sup> and 30<sup>th</sup>.

## **2.4 Annual Reporting**

This task includes preparing the Annual Monitoring Results for distribution on the web and writing, editing, and publishing the "Pulse of the Estuary" and the "RMP Update". It continues to be a goal for the Program to report out data within a one-year time frame.

## **2.5 Quality Assurance and Quality Control**

This task includes three main elements: 1) evaluating the quality of data generated by analytical labs; 2) updating the QAPP and protocol documentation; and 3) coordinating intercomparisons and other efforts to improve the quality of RMP data.

#### **4. Status and Trends Monitoring**

In 2011, the RMP reviewed the Status and Trends monitoring to evaluate the information that Status and Trends is providing and the frequency at which this monitoring needs to occur. Based on this review, the TRC and SC recommended a reduction in the frequency of sediment and water monitoring to a biennial program. In addition, the frequency of organic analyses in water was reduced to a four-year cycle. A summary of the cost for these activities is included in Table 1. A summary of these changes to the program is presented in Table 2.

##### **3.1 Water**

###### *Water Chemistry*

Monitoring for trace elements and water quality parameters will occur at 22 sites in 2013. Organic analyses will be deferred to 2015 (see Table 2). As in prior years, SFEI staff will assist in the collection of water samples. Contracts to conduct the water chemistry work will be with the same laboratories that have performed well in recent years and include: Columbia Analytical Services (TOC, nitrogen, etc.) and Brooks Rand Laboratory (inorganics). Applied Marine Sciences will continue to serve as our logistics coordinator, and will continue to be a sole source of services for us to as a result of their expertise.

##### **3.2 U. S. Geological Survey Studies**

The United States Geological Survey (USGS) has been collaborating in the RMP since the beginning of the Program and has contributed in-kind services through Department of Interior funding, IEP funding, and other sources to enhance the RMP financial contributions designed to address basic hydrographic and sediment transport processes. An understanding of these basic processes is necessary to interpret the spatial and temporal trends that are emerging from the RMP monitoring of chemical indicators of water quality condition, and to understand fundamental ecological processes in the Estuary that affect water quality.

###### **3.2.1 Sediment Dynamics in San Francisco Bay**

This element of the RMP focuses on understanding suspended sediment dynamics in the Estuary. Recent findings suggest that suspended sediment concentrations in the Bay declined sharply in 1999. This work is conducted by Dr. David Schoellhamer of the USGS in Sacramento.

USGS maintains five suspended sediment stations in the Estuary (i.e., Alcatraz, Mallard Island, Benicia, Richmond Bridge, and Dumbarton Bridge) and funding for a temporary site (formerly the Hamilton transfer station). Based on discussions with the TRC and LTMS managers, the USGS used the temporary site funding for 2012 for better understanding the sediment flux at the Golden Gate. We are currently working with USGS to determine how funding for the temporary station will be allocated.

In addition, in 2012, USGS will place oxygen probes at the following sites: Dumbarton Bridge (already deployed); Alviso Slough; San Mateo Bridge (near bottom); mouth of Corte Madera Creek; Benicia Bridge (near-bottom); and Richmond Bridge (near bottom). At this time, it is not clear whether USGS will continue this work.

### 3.2.2 Hydrography and Phytoplankton

This work is conducted by Dr. Jim Cloern of the USGS (Menlo Park). This study will continue its measurement program in support of the RMP, with monthly water sampling to map the spatial distributions and temporal trends of basic water quality parameters along the entire Bay-Delta system. Measurements will include salinity, temperature, and dissolved oxygen, which influence the chemical form and solubility of some trace contaminants; and suspended sediments and phytoplankton biomass, which influence the partitioning of reactive contaminants between dissolved and particulate forms. 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.

## 4. Special Studies

The following studies were reviewed by the TRC and SC and approved for incorporation into the 2013 Program Plan.

### 4.1 PBDE Summary Report

The RMP has monitored for polybrominated diphenyl ethers (PBDEs) since 2002 and has one of the most comprehensive datasets on PBDEs in environmental matrices. The data present a compelling story of the rapid rise of this contaminant in the Bay, followed by a period of dramatic decline in biota after the phase-out of two of the three major formulations (Penta and Octa formulations). (The third formulation, Deca BDE, is on schedule to be phased out at the end of 2013.) At the same time that concentrations are declining, recent benchmarks suggest that PBDEs may be less of a concern than originally believed. RMP-sponsored work on hatching and success of tern bird eggs suggests that concentrations observed in Bay area tern eggs are of low risk. Similarly, the Office of Environmental Health Hazard Assessment has recently established human health thresholds and Bay fish are substantially below these levels.

This task will summarize our current state of understanding of PBDEs in the Bay. In addition, a short summary of the RMP work on alternative flame retardants will be presented.

The funding for this project is \$35,000.

### 4.2 Updating the Emerging Contaminant Strategy

The RMP has just completed a synthesis document summarizing the occurrence of contaminants of emerging concern (CECs) in San Francisco Bay. In addition to RMP funding, many of the CECs studies to date have been the result of pro bono work conducted in collaboration with

universities, government agencies, and commercial laboratories. These opportunities were identified by RMP staff through professional contacts and literature reviews. These studies have allowed for prioritization of these CECs using occurrence and toxicity data to determine the level of concern for individual contaminants in the Bay. The RMP strategy document currently being developed articulates three approaches for identifying CECs for monitoring. These approaches are based on:

- Existing information (known or suspected use, occurrence or toxicity from other locations, best professional judgment),
- Effects (i.e., bioassays), and
- Occurrence (non-target analyses such as the RMP-funded project with NIST or fate modeling).

This will be an iterative process as new information, new analytical methods, and new collaborations become available. The purpose of this task is to keep the CEC Strategy document relevant and timely. A short summary memorandum will be prepared and presented to the Emerging Contaminants Work Group.

The funding for this project is \$20,000.

#### **4.3 Current Use Pesticide Focus Meeting**

The RMP has been monitoring organochlorine and organophosphate pesticides in San Francisco Bay surface waters, sediments, and wildlife since the program started in the 1990s. In 2008, pyrethroids were added to Status and Trends sediment monitoring as a result of high volume urban use and the potential for toxicity at low concentrations in the environment. Over the years other current use pesticides have been monitored in water or sediment, with target compounds largely based on suspected use, analytical method availability, and capability for low-level detection. Several of these compounds have been detected in Bay samples.

The purpose of this task is to evaluate existing information on current use pesticides and to develop a list of current use pesticides to monitor in San Francisco Bay. RMP staff will also convene a meeting with local experts to discuss these recommendations.

The funding for this project is \$15,000.

#### **4.4 Bioanalytical Tools**

The RMP has embarked on a three-pronged approach for identifying contaminants that may have adverse effects on the Bay: reviewing the literature and discussing with other monitoring programs CECs; using new instruments such as the GC-GC-TOF mass spectrometer that NIST is currently using to identify the presence of CECs in Bay seals and mussels; and lastly evaluating biota to see which CECs may be causing cellular and organism effects. With regard to the latter, the RMP has a unique opportunity to partner with researchers at the University of Florida and at SCCWRP to evaluate the effects of endocrine disrupting compounds on an estuarine fish (Mississippi silverside). In the first



year of this two year study, researchers will evaluate the effects of four endocrine disrupting compounds on cellular functions and will develop simple bioassays. The presence of biomarkers associated with growth, sexual differentiation, brain development, and reproduction (e.g., vitellogenin) will be correlated with exposure to endocrine disruptors. One of the unique and important points of this research is that it will link cellular effects to whole organism endpoints such as reproduction, growth, and mortality. In the second year, field samples from San Francisco Bay will be used to validate the laboratory work. Fish will be exposed to effluent from several Bay Area wastewater treatment plants as well as receiving waters.

This is a two-year study. The 2013 funding level for the first year of study is \$70,000. Funding for the second year (\$56,000) is contingent upon satisfactory progress in the first year.

#### **4.5 Developing Benthic Indices for Mesohaline Environments**

The Sediment Quality Objectives (SQOs) were recently promulgated and evaluate the health of an ecosystem based on sediment chemistry, sediment toxicity and benthic community. Benthic assessments are important because they are a fundamental link in the food chain. The RMP has been collecting sediment triad data since 2009. To date, benthic indices for polyhaline central bay have been developed; however, no indices exist for the low salinity (mesohaline) or tidal fresh environments.

Project will develop three indices for the San Francisco Bay. The first two indices are based on species composition of large numbers of species: the Benthic Response Index (BRI) and the River Invertebrate Prediction and Classification System (RIVPACs). The third index will be a multi-metric index (MMI) based on community measures and indicator species such as the index of biotic integrity (IBI).

This is a two-year study. In 2012, the project will standardize the existing taxonomic data bases with recently collected benthic data and associated habitat (salinity, depth, sediment grain size distribution, and total organic carbon), chemical contaminant, and sediment toxicity data. It will also refine the habitat definitions and conduct calibration and validation exercises.

In 2013, the project will develop the benthic indices, assure independence of the variables and conduct calibration and validation exercise. The final report will consist of a manuscript.

The 2013 funding for this study is \$75,800.

#### **4.6 Modeling**

Modeling is a key element of the Nutrient Strategy. In recent years, the RMP has also been developing a Modeling Strategy and laying the groundwork for development of contaminant fate models for the Bay that can be used to forecast conditions under different management scenarios. Given the clear and immediate need for model

development in support of the Nutrient Strategy, these two strategies will be closely coordinated, with nutrient model developing as a first priority. Further model development to develop predictive capacity for other pollutants will build upon a foundation established for nutrient modeling. RMP stakeholders (i.e., BACWA) are already exploring the role that modeling can play as a means for informing nutrient management decisions in the Bay.

In the last quarter of 2012, RMP staff will develop a tactical modeling plan that will clearly articulate the management questions that we expect to answer using the model, the strengths and weakness of the model selected, the cost and time associated with developing and maintaining the model, the institutional agreements that may be needed, and a draft schedule for nutrient and contaminant fate modeling.

Building upon this effort, in 2013, we will develop the base hydrodynamic and sediment transport model (e.g., defining the grid, boundary conditions, model resolution, etc.). RMP staff will work with a team of modeling experts and RMP stakeholders to construct the model. Once the hydrodynamic/sediment model is developed, a basic water quality model for Suisun and South Bay will be added on to the base model to assist in understanding the system, to test hypotheses, and to inform data collection and future modeling efforts. This model will be used to synthesize nutrient load and concentration data (i.e., mass budgets); to assess relative importance of processes affecting phytoplankton productivity and nutrient cycling and to perform sensitivity analyses. Lastly, the 3D model will be used to develop forecasts for particle-reactive and bioaccumulative contaminants.

The funding for this task is \$100,000.

#### **4.7 Small Tributary Loading Strategy (STLS): Load Monitoring in Representative Watersheds**

There is an urgent need for estimates of stormwater loads by watershed and by region. The recently adopted Municipal Regional Permit (MRP) specifically requires additional information on the loads of sediment and contaminants. In addition, the Mercury and PCB TMDLs require reductions in watershed loads by 50 and 90 percent, respectively. Understanding the loads from representative watersheds will be critical for addressing these information needs and achieving these load reductions.

The RMP Small Tributary Loading Strategy (STLS) outlines four priority management questions:

- Which are the “high leverage” small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?

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

Monitoring in representative watersheds will provide information to assist in answering these questions.

The STLS team conducted a statistical analysis of watersheds and developed an optimal sampling plan for watersheds. Based on this work and the reconnaissance work at 16 watersheds, the STLS team decided to focus intensively on six Bay Area watersheds. The stormwater project is a multi-year effort under the Municipal Regional Permit, studying six watersheds for four storms each in 2012-2013 (e.g., two watersheds monitored by RMP staff and the remaining four by consultants). The two RMP sites, Pulgas Pump station and North Richmond, will be sampled over four storms (16 samples for each event). These watersheds will be monitored for a variety of constituents including: PCBs, PAHs, PBDEs, pyrethroids, mercury, copper, selenium, suspended sediment, nitrate, and toxicity. A report summarizing these results will be prepared.

The funding level for this study is \$343,000.

#### **4.8 STLS: Regional Watershed Spreadsheet Model – Year 4**

A high priority for the Small Tributary Loading Strategy (STLS) is to develop models to estimate the loads from local watersheds to the Bay and how these loads may be reduced. The STLS resources over the last several years have been directed to address this need through the development of a regional spreadsheet model and the calculation of contaminant emission rates based on land use. The regional spreadsheet model was a significant improvement on the simple rainfall/ runoff model that was developed in 2000 to calculate regional stormwater volumes and contaminants. The improved model can calculate average monthly storm water volumes and better estimates of regional loads through improved spatial and temporal coverage.

In 2012, RMP staff used copper as a pilot for the Regional Watershed Spreadsheet model to test our understanding of sources, build-up, and wash-off processes in relationship to urban land uses. There is a wealth of local land use information and copper event mean concentrations as well substantial calibration data sets for the bottom of the watershed. In 2013, we intend to expand the model to include more refined estimates for mass emissions of PCBs and mercury. As part of this task, contaminant profiles for PCBs and mercury will be developed.

The funding level for this study is \$25,000.

#### **4.9 STLS: Development of Land-use and Source Area Specific Event Mean Concentration**

A critical input parameter for the Regional Watershed Spreadsheet model is the event mean concentration for POCs (EMCs). Although EMCs have been developed for Southern California, these data is not directly applicable to the PCB and mercury emissions in the Bay Area. The proposed framework for EMC development in 2013 is currently being reviewed by the SPLWG. The framework outlines contaminant-specific land use and source areas; present data limitations for Hg, PCB, Cu, Se, and dioxins for each of these land use and/or source areas; and provides conceptual recommendations for the best next steps for EMC development. Key contaminants not covered by the literature review include suspended sediment, PBDEs, and OC pesticides (contaminant profiles and recommendations for these will likely be covered through budget provided by the BASMAA monitoring coalition).

The framework for the development of EMCs will differ by contaminant. In general, the following approach will be used: perform literature review for each contaminant to identify available EMC data and to characterize EMC values based on soil type, land use, etc.; use soil data to calibrate the suspended sediment spreadsheet model; evaluate loadings based on land use/source areas; develop GIS databases for proposed contaminant-specific land use or source area; using literature values and current loads estimate Bay Area specific EMCs; and lastly, monitor specific land use/source areas during wet weather events to confirm EMCs. A short summary of methods and results will be developed for inclusion in the model documentation.

The funding for this task is \$80,000.

#### **4.10 STLS: Management Support**

A substantial amount of coordination is required to assure that the STLS activities are in alignment with other monitoring partners, BASMAA, the Regional Water Quality Control Board, and in accordance with the Municipal Regional Permit. This task will support STLS meetings to collaborate on WY2013 monitoring and to provide updates and solicit input on the spreadsheet model and EMC development.

The funding level for this activity for 2013 is \$20,000.

#### **4.11 Nutrients: Management Support**

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. The published literature 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, in the North Bay, ammonium inhibition of diatom uptake of nitrate. However, evidence is

building that, since the late 1990s, the historic resilience of the Bay to the harmful effects of nutrient enrichment is weakening (Cloern et al., 2007; Dugdale et al, 2007).

In response to the apparent changes in the Bay's resilience to nutrient loading, SFEI has been working with the San Francisco Bay Regional Water Quality Control Board and Bay area stakeholders to develop the San Francisco Bay Nutrient Strategy ([http://www.waterboards.ca.gov/sanfranciscobay/water\\_issues/programs/planningtmdls/amendments/estuaryne.shtml](http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuaryne.shtml)). The goal of the Nutrient Strategy is to lay out a thoughtful and cost-effective program to generate the scientific understanding needed to support major management decisions. The Nutrient Strategy has 6 main goals:

1. Define the problem: develop conceptual models for Bay segments that characterize important processes linking nutrient, biological responses, and indicators of adverse effects of nutrient over-enrichment
2. Establish guidelines (water quality objectives; i.e., assessment framework) for nutrients, including ammonium, focusing on the endpoints of eutrophication and other adverse effects of nutrient overenrichment;
3. Implement a monitoring program that supports regular assessments of the Bay;
4. Develop and utilize nutrient-load response models to support nutrient management decisions;
5. Evaluate control strategies to reduce nutrient inputs from wastewater treatment plants and other sources; and
6. Consider alternative regulatory scenarios for how to move forward with nutrient management in SF Bay.

This project will address both RMP Multi-Year Plan priority questions as well as several of the Nutrient Strategy.

*RMP Multi-Year Plan Priority Questions addressed by study proposal*

1. Is there a problem or are there signs of a problem with respect to nutrient enrichment?
2. What are appropriate guidelines for assessing SF Bay health?
3. What is the relative contribution of nutrient loading pathways and how do loads vary seasonally and between Bay segments?

*Goals of Nutrient Strategy addressed by study proposal*

1. Document our current understanding of nutrient dynamics in the Bay, highlighting what is known and the crucial questions that need to be answered
2. Develop a monitoring program to support regular assessments in the Bay
3. Quantify nutrient loads to and important processes in the Bay

The following four tasks outline specific activities to be undertaken as part of the nutrient strategy (Task 4.12 through 4.15). Given the significant number of stakeholders, agencies, and scientific organizations that are involved with nutrients, a significant amount of coordination will be necessary to assure successful completion of these task. The funding for coordination and project management of all RMP nutrient activities is \$20,000.

**4.12 Nutrients: Moored Sensor Monitoring Program**

The indications of decreased Bay resilience to high nutrient loads described above have come to the fore at a time when the availability of resources to continue assessing the Bay's condition is uncertain. The USGS has monitored the water quality parameters in the Bay since the late 1960s. These data have been critical for determining the effects of nutrients on the Bay and will be essential for future modeling efforts. However, at the present time, the future of the USGS long-term water quality monitoring is uncertain. It will be important for the RMP to begin to evaluate methods for cost-efficient monitoring. One opportunity may be the use of moored sensors.

This project will evaluate a moored sensor that may be suitable for the Bay, select and calibrate the sensor, and then field test for approximately one month the sensor at the Redwood City dock used by the USGS Menlo Park staff. Once the system is deemed reliable, it will be installed at the Dumbarton Bridge at a site at which the USGS is currently maintaining turbidity and dissolved oxygen sensors. This overlap will allow for coordinated maintenance activities to reduce labor costs. A technical memorandum summarizing the results will be developed.

The funding level for this study is \$200,000.

#### **4.13 Nutrients: Algal Biotoxin Monitoring**

Similar to the previous task, this task is related to developing new more cost efficient methods for monitoring the Bay and is focused on the detection of algal toxins produced by harmful algal blooms (HABs). There was broad agreement within the conceptual model technical team that increased concentrations of algal toxins are one likely outcome of elevated nutrient loads to the Bay and Delta. The group further concurred that the development of sensitive tools for measuring phytotoxins should be a high priority for the Bay monitoring program.

Dr. Kudela at University of California at Santa Cruz (UCSC) and his colleagues have been investigating the use of a passive sampling method, Solid Phase Adsorption Toxin Tracking (SPATT), to monitor microcystin (and other toxin) levels in seawater. SPATT was first proposed for HAB monitoring by MacKenzie et al. (2004), who developed this passive sampling device by placing resin, which binds an array of lipophilic algal toxins, within a polyester mesh bag. Over the last several years UCSC researchers have been further developing and applying SPATT for HAB detection in both marine and freshwater environments. Their results indicate that the sensitivity of this system is extremely high, which greatly facilitates source-tracking efforts.

This project will provide continued funding for UCSC to collaborate with USGS on the deployment of SPATT during the USGS monthly cruises of the Bay. In addition, the project will conduct calibration experiments to understand the relationship between the SPATT and ambient concentrations of HABs, develop best practices for handling and analyzing SPATTs, and evaluate optimal deployment times.

A technical memorandum summarizing the results of the study will be prepared upon completion of the project. The funding level for this study is \$65,000.

#### **4.14 Nutrients: Augmenting 2013 Storm Water Monitoring**

As described above in Task 4.8, in 2013, the RMP is funding storm water monitoring to quantify concentrations and loads of priority pollutants to the Bay from watersheds. Study watersheds have been selected to represent the range of land use and land cover characteristics of the diverse watersheds draining to the Bay. This work is a multi-year effort, studying six watersheds for four storms in the wet season 2012-2013 (e.g., two watersheds monitored by SFEI, two by consultants and two by municipalities). Although nutrients are not the main focus of the POC study, three nutrient parameters (nitrate, total phosphorous, dissolved P) are among the current list of analytes. However, other important nutrient parameters that are needed to create a full picture of nutrient loads to the Bay are not being measured (total Kjeldahl nitrogen, ammonium, ortho-phosphate, and urea).

This task will fund the collection and analyses of additional nutrient parameters at the two watersheds being sampled by SFEI staff during the 2012-2013 wet weather season. The additional analytes are ammonium, total Kjeldahl nitrogen, ortho-phosphate, and urea. The combined suite of nutrient analytes matches the type of information being collected in the USGS monthly Bay surveys, and data may be collected in the near future at some regional POTWs. Results of the storm water sampling will be summarized in a memorandum.

The total cost for this work is \$40,000.

#### **4.15 Nutrients: Loads and Data Gaps**

A high priority need identified by the Nutrient Strategy stakeholders is quantifying external loads of nutrients to San Francisco Bay. In 2012, RMP staff have begun the process to develop spatially- and temporally-explicit estimates of nutrient loads to the Bay, and to identify critical data gaps that contribute most to current uncertainty in total loads, speciation of those loads, and the relative importance of various sources. Because this project began late in the year, it will continue into 2013.

A summary of external loads to the South Bay has already estimated by SFEI through funding from BACWA (McKee and Gluchowski, 2011). This project expands that loading work into the Central, San Pablo, and Suisun Bays, developing monthly, seasonal and annual load estimates, and exploring the importance of uncertainties in loading and nutrient speciation. The nutrient sources considered will include: POTW discharges; stormwater discharges; flows from the San Joaquin and Sacramento Rivers entering through the Delta; exchange across the Golden Gate; and direct atmospheric deposition. Unlike the South Bay, where loads from POTWs appear to dominate input of nutrients, other sources (e.g., flux through the Golden Gate; discharge through the Delta) likely contribute substantial proportions of the overall loads in the Central and North Bay. Loads from the Delta to the North Bay may be reasonably well-constrained, due to intensive monitoring in the region. Some of the funding in 2013 can be applied toward incorporating the historic and new discharge effluent data required under the Regional

Water Board's March 2012 13267 Order to wastewater dischargers; that data will begin becoming available in the second half of 2012.

A report summarizing the loads will be prepared. The total cost for this work is \$30,000.

#### **4.16 Copper and Olfaction in Salmon**

Copper has been a priority concern due to its acute toxicity to aquatic life. As a result of significant research demonstrating that much of the copper in the Bay is not bioavailable and the on-going observations of concentrations below water quality objectives, the Bay was delisted for copper. A copper site-specific objective was developed in 2007 that establishes water quality criteria for various segments within the Bay. The site-specific objectives specifically called for further study on the potential toxicity of copper to the olfactory system of salmonids.

Exposure to dissolved copper has been shown to cause olfactory impairment at relatively low concentrations in freshwater (e.g., 3 ug/L), resulting in an impaired avoidance respond to predators. However, preliminary research conducted by the Northwest Fisheries Science Center/ NOAA has demonstrated relatively little effects of copper in saltwater. The goal of this study is to vary salinity to understand when toxic effects begin to occur. The work will be conducted by NOAA and summarized in a report.

The funding level for this study is \$38,000 for 2013.



**Table 1**  
**Cost Summary of Program Elements**

A budget summary for each of the program elements is listed below.

	<b>Labor</b>	<b>Direct Costs/ Subcontractors</b>	<b>Total</b>
1. Program Management	\$545,000	\$71,000	\$616,000
2. Information Management and Synthesis	\$437,000	\$67,000	\$504,000
3. S&T Monitoring	\$212,000	\$577,500	\$789,500
4. Special Studies			
4.1 PBDE Summary	\$35,000		\$35,000
4.2 Update EC Strategy	\$20,000		\$20,000
4.3 CUP Focus Meeting	\$15,000		\$15,000
4.4 Developing Bioanalytical Tools		\$70,000	\$70,000
4.5 Developing Mesohaline Index		\$75,800	\$75,800
4.6 Modeling	\$30,000	\$70,000	\$100,000
4.7 Stormwater Loads Monitoring	\$192,000	\$151,000	\$343,000
4.8 Update RWS Model	\$25,000		\$25,000
4.9 Develop Land Use Event Mean Conc.	\$80,000		\$80,000
4.10 STLS Management	\$20,000		\$20,000
4.11 Nutrients Management	\$20,000		\$20,000
4.12 Nutrients Moored Sensors	\$120,000	\$80,000	\$200,000
4.13 Algal Biotoxins		\$65,000	\$65,000
4.14 Nutrient Storm Water Monitoring	\$20,000	\$20,000	\$40,000
4.15 Nutrient Loads	\$30,000		\$30,000
4.16 Cu and Fish Olfactory Nerves		\$38,000	\$38,000
5. Set Asides			\$333,450
<b>Totals</b>	<b>\$1,801,000</b>	<b>\$1,285,300</b>	<b>\$3,419,750</b>

**Table 2 Revised Status and Trends Schedule**

	2012	2013	2014	2015	2016	2017	2018	2019
Bivalve	X		X		X		X	
Water		TE		Org, TE		TE		Org, TE
Sediment	Org, TE, wet		Org, TE, dry		Org, TE, wet		Org, TE, dry	
Bird Egg	X			X			X	
Sport Fish			X					X
USGS WQ	X	X	X	X	X	X	X	X

Org - Organics  
 TE - Trace elements  
 Wet - 27 sites  
 Dry - 47 sites