Regional Monitoring Program

2012 Detailed Workplan

DRAFT

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Regional Monitoring Program (RMP) for Water Quality in the San Francisco Estuary

2012 Detailed Workplan

Overview

This document is the detailed workplan that describes the major RMP elements and tasks to be completed in 2012. It is the guiding document for planning and allocating funds for 2012. The workplan is divided into Program areas or tasks. For each task, the following information is provided: a description of the task and how it relates to the RMP objectives and management questions; identification of subtasks; a schedule of deliverables; and an estimate of SFEI labor costs. All major tasks and associated costs to complete these tasks are presented on Table 1.

The SFEI labor costs are our best estimate at present as to the level of effort we anticipate that it will take to complete each of the proposed tasks for 2012. It is likely that as the year progresses, adjustments will be made to the individual labor cost and/or subcontractor and direct cost estimates for each task; however, the total budget for 2012 will remain fixed.

The RMP objectives were revised in 2008 to reflect improved understanding and to respond to new priorities. The overarching goal of the Program is to collect data and communicate information about water quality in the San Francisco Estuary to support management decisions. The management questions are in three levels. The core management questions (level 1) are presented below. Level 2 and 3 questions address specific elements of the level 1 questions.

1. Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
2. What are the concentrations and masses of contaminants in the Estuary and its segments?
3. What are sources, pathways, loadings, and processes leading to contaminant-related impacts to the Estuary?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

This document is divided into four chapters that describe the major task areas within the RMP. Task 1 explains the overall management of the Program and the efforts made to coordinate the Program both internally with SFEI staff and stakeholders and externally with the many agencies and organizations that are responsible for stewardship of the Estuary. Task 2 describes how the results of the RMP studies are reviewed, validated,

synthesized, and disseminated to researchers, regulators, and the public at large. The long-term monitoring component of the Program, Status and Trends monitoring, is presented in Task 3. Task 4 describes special studies that will be performed in 2012.

Task 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; track deliverables and project status; coordinate SFEI staff; and plan and coordinate activities among external agencies and organizations that have a vested interest in the RMP. This task is divided into four subtasks that are described below: internal coordination; external coordination; contract and financial management; and Program planning.

1.1 Internal Coordination

The purpose of this task is to coordinate and facilitate among Program participants, subcontractors, collaborators, Regional Water Quality Control Board staff, and members of the Steering and Technical Review Committees. This coordination is essential to enhance the exchange of information, to avoid duplication of efforts, to identify and inform members of critical decisions and important issues, and to ensure that RMP activities complement and improve other scientific efforts by RMP participants, the Regional Board, and others. This task also includes the internal coordination of RMP staff (e.g., the coordination and technical oversight of different RMP tasks).

Internal coordination also includes all of the activities associated with the workgroups. Currently, the RMP has four workgroups: Sources Pathways and Loadings; Contaminant Fate; Exposure and Effects; and Emerging Contaminants. All of these workgroups have advisory panels composed of prominent outside experts which provide peer review to assure that the projects developed and implemented are technically sound.

In addition to these four workgroups, select teams from the workgroup and the RMP stakeholders have been formed to implement strategies for select topics including: mercury, small tributary loading, modeling, dioxins, nutrients and PCBs.

1.2 External Coordination

External coordination promotes comprehensive and coordinated understanding and monitoring of the Estuary through participation in committees outside of the RMP umbrella.

Members of RMP staff participate in the Surface Water Ambient Monitoring Program (SWAMP), Northern California Society for Environmental Toxicology and Chemistry (NorCal SETAC), BASMAA, BACWA, LTMS, IEP, refineries, and various Total Maximum Daily Load (TMDL) work groups and committees. In addition, RMP staff are

frequently asked to present guest lectures at universities and national and international meetings and to serve on advisory boards.

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. It also includes development 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 the development of the Program Plan and the Detailed Workplan and development of scopes of work, both internally and externally for contracts. In 2010, an RMP Multi-Year Plan was developed based on information needs of our stakeholders. The plan articulates key studies to be undertaken in the next five years. The RMP Multi-Year Plan will be updated annually to reflect new knowledge gained and changes in priorities of our stakeholders. Part of the RMP Planning process is conducting an annual workshop in which priorities are articulated. This meeting is scheduled for the Fall of 2012.

1.5 Schedule, Deliverables, and Budget

Program management activities are implemented year round. Deliverables for these tasks also occur year round and correspond to the RMP activities at hand (e.g., contracts are negotiated at the beginning of the fiscal year, invoicing of stakeholders occurs in the summer, and preparation for the quarterly TRC and SC meetings occurs throughout the year). Both technical and administrative staff are involved with project management as this encompasses a wide variety of activities (e.g., negotiation of contracts, preparation of invoices, coordination with external groups, and coordination internally among staff members).

Estimated labor costs for each subtask are presented below.

Subtask	Estimated Cost 2012
Internal Coordination	$327,000
External Coordination	$25,000
Contract and Financial Management	$160,200
Program Planning	$12,500
Total	$524,700

Task 2 Information Management and Dissemination

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. It is critical that the important findings from the Program are disseminated to managers and the scientific community. The RMP disseminates information using a variety of means including the web query tool, newsletters, technical reports, annual reports such as the Pulse and Annual Monitoring Results, workshops, and conferences.

2.1 Data Management

The primary objectives of this task are to manage, maintain, and improve the RMP database, to enable easy access to RMP data, and to share RMP data with the California Environmental Data Exchange Network (CEDEN). In addition to the formatting and reporting of the current year's monitoring data, it is also necessary to periodically update and standardize data from prior years to ensure comparabilty. In accordance with these objectives, our information management and dissemination goals for 2012 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 CEDEN/SWAMP v.2.5 database.
- Perform QA/QC review of the data to verify they meet the RMP's Data Quality Objectives outlined in the RMP QAPP, which is comparable to the State's SWAMP Quality Assurance Management Plan.

Database Maintenance and Web Access

- Incorporate updates and corrections to data as needed, including reanalyzed results and updates implemented by the SWAMP/CEDEN data management team.
- 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 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 COC forms and EDD 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).

A description of each of these subtasks is presented below.

SUBTASK DESCRIPTIONS

Subtask 1 Data Formatting, QA/QC, and Upload

The data formatting process consists of several steps:

1) Verifying accuracy and completeness of each data submission from the sub-contract laboratories;
2) Transferring the electronic data submittals to the SFEI's relational database;
3) Conducting a complete QA/QC review of each data submission to ensure data are appropriately qualified according to RMP data quality objectives and consistent with historic data;
4) Contacting laboratories regarding questionable or missing data and ways to improve data quality; and
5) Tracking the various data management and QA/QC procedures for each dataset.

All results are reviewed according to the data quality requirements outlined in the 1999 QAPP and validated before being publicly released on the Institute's website.

Subtask 2 Database Maintenance and Web Access

In addition to managing data for the current monitoring year, data updates and routine maintenance tasks are performed in order to provide reliable and standardized data for all years of the Program. Data are continually updated to comply with reporting requirements. Inconsistencies are identified, qualifiers are updated, and reanalyzed results are added to the database as they are received from the laboratories. This subtask involves contacting laboratory representatives, updating data records and tracking data management processes, and archiving work files.

Subtask 2.1 Update Web Query Tool

The web-based data access tool will be updated as needed and new enhancements added to better meet the needs of the users.

Subtask 2.2 Update and Maintain RMP Database

The RMP Status and Trends database is comparable to the State's Surface Water Ambient Monitoring Program (SWAMP) database (version 2.5). By using the same standardized data format required by SWAMP and all State-funded grant projects, RMP data are more accessible to regulators, researchers, and the public. SFEI is one of the State's Regional Data Centers and exchanges data with CEDEN on a weekly basis.

The SWAMP database design is extremely detailed and must be updated as the SWAMP/CEDEN data management team continues to develop and update their database standards. The RMP will incorporate new changes to the database in order to maintain comparability with SWAMP/CEDEN database.

Subtask 2.3 Develop and maintain a database of samples archived through the National Institute of Standards and Technology (NIST)

The RMP is collaborating with NIST to house RMP biological samples in long-term state of the art facilities. A database has been developed to track these samples. This database will be maintained as samples are added, removed, and modified.

Subtask 3 Data Management Efficiencies

This task will continue the process of developing standards and tools for RMP laboratories to submit their data electronically in standard electronic data deliverable formats (EDDs) and tools for staff to evaluate completeness and accuracy of those data submissions. The tools will perform a preliminary review of the EDDs to ensure that data are submitted in current database formats prior to being parsed into the many relational tables of the RMP database. Additional review queries will evaluate datasets for completeness and provide preliminary QA/QC review summaries.

Several routine calculations and procedures (e.g., summing of organics totals, QA/QC validation procedures, and assignment of QA qualifiers, etc.) could be made more efficient through additional programming. The goal of this subtask is to build additional efficiencies into the RMP QA/QC process and to eventually link these tools to a web-based data submission process as opportunities arise.

Staff Involved
Staff leads for Data Management are Cristina Grosso, John Ross, Amy Franz, Adam Wong, and Donald Yee. Other key staff include: Susan Klosterhaus, Shira Bezalel, and Todd Featherston.

Schedule and Deliverables
Data management tasks are ongoing and updates are made available as soon as they are deemed complete. Data are made available for report production and meeting deadlines.

Budget
The estimated labor budget for data management for 2012 is presented on the table below.

Subtask	**Estimated Labor Cost 2012**
Data Formatting, QA/QC, and Upload	$246,000
Database Maintenance, GIS, and Web Access	$98,900
Data Management Efficiencies	$25,000
Total	$370,000

2.2 RMP Web Site

OVERVIEW
The RMP web site has an important role in making data, technical reports, newsletters, bibliographies, Powerpoint presentations, and other documentation available to stakeholders. This task includes: publication of RMP *Annual Monitoring Results* and uploading new documents to the web site (e.g, reports, SC and TRC meeting packages, etc.); maintenance of web directories; updating the RMP program page; and improving the overall design of the RMP web site.

SUBTASK DESCRIPTIONS

Subtask 1 2011 Annual Monitoring Results

The RMP *Annual Monitoring Results* is published only on the RMP website. The graphics group prepares the web layout.

Subtask 2 General Report Formatting for the Web

RMP reports are formatted for access on the RMP web site. Appropriate links are added to the RMP reports page to provide access to the report.

Subtask 3 Maintenance of RMP Data Access Page

Data Access via the Web Query Tool, csv files (e.g. pilot studies), and the QA Summary Tables

The graphics group is responsible for maintaining the data access homepage and making sure it effectively provides access to the data associated with RMP reports including the Status and Trends data, Pilot and Special Study data, and QA/QC summary reports. The Data Access Page also has links to associated reports, provides contacts for assistance, and links to additional information.

Subtask 4 Overall RMP Web Site Maintenance

Overall maintenance of the RMP directory includes:

1) updating the RMP Homepage for calendar items and other “new” elements;
2) updating the data query pages and source database;
3) maintaining the links in the site;
4) generating new graphics as needed;
5) updating content and adding pages as necessary;
6) reviewing overall site architecture and maintaining an intuitive hierarchy; and
7) reviewing "like-minded" web sites for improvement ideas.

Subtask 5 Development of a Web Page to Upload Metals Effluent

NPDES dischargers have requested that the RMP develop a method for uploading the metals effluent data electronically through an RMP web site.

Staff Involved

Key staff involved with this task include: Jeff Mueller, Linda Wanczyk, Joanne Cabling, Meg Sedlak, Cristina Grosso, Adam Wong, and Rachel Allen.

Schedule and Deliverables

Maintenance of the web site is an on-going activity. The site is updated as new reports become available and new events are planned.

Budget

The cost for web-site maintenance in 2012 is estimated to be $10,000.

2.3 Information Dissemination

The primary purpose of this task is to communicate information about water quality in the San Francisco Estuary to scientists and managers. RMP results are synthesized and disseminated by a variety of means including inserts and factsheets, conferences, guest presentations, and journal publications.

The RMP will continue to take advantage of existing venues for information distribution, such as the *ESTUARY* newsletter. As appropriate, press outreach, formal presentations to community groups and other organizations, and scientific conferences will also provide information about the RMP and its findings. This task also includes work related to planning and executing the RMP Annual Meeting.

Subtask 1 Newsletters/Inserts

Subtask 1.1 ESTUARY Insert

The *ESTUARY* Insert is produced in the late Fall as a four-page supplement to *ESTUARY* newsletter and is essentially a "mini" issue of *RMP News*. These inserts are used to provide updates on the Program. *ESTUARY's* audience is broader than *RMP News*, thus providing the Program with an opportunity to reach new readers. Insert production consists of planning, writing, editing, layout of articles and pre-press collaboration with *ESTUARY* staff.

Subtask 1.2 Other Media Opportunities

RMP staff assist other organizations and news services with articles about the RMP and RMP data. When feasible, the Production Department may provide assistance in writing, editing, and layout of article submissions.

Subtask 2 Record of Publications

The RMP keeps track of all publications that use mainly RMP data. Each publication is assigned an SFEI Contribution number and entered into an EndNote database in full bibliographic format. Though the contribution list also includes other SFEI programs and will be used as a means of presenting SFEI reports on the SFEI web site, RMP publications will be independently tracked by means of a “profit center” field in EndNote. SFEI's Production/Graphics team is responsible for assigning contribution numbers and maintaining the publications list in EndNote.

Subtask 3 Posters

The RMP produces posters for display at poster sessions at various conferences (e.g., SETAC, State of the Estuary, etc.). Staff members involved include RMP technical staff and the graphic design group.

Subtask 4 Presentations

RMP staff present technical and non-technical talks at various venues (e.g., conferences, lectures, and meetings).

Subtask 5 RMP Annual Meeting

The RMP Annual Meeting is an important means of describing the latest findings from the Program to stakeholders. The Annual Meeting requires preparation by RMP technical and administrative staff. RMP technical staff members are responsible for developing a variety of presentations; the Art Director is responsible for flyers, postcards, photos, and web site announcements; and administration is responsible for meeting logistics (e.g., venue, food, setup, etc.) and for mailings of printed matter.

Subtask 6 Press Outreach

The RMP will seek appropriate opportunities for disseminating RMP information through the media. The RMP Annual Meeting/ Pulse typically receive extensive coverage on the radio, television and in numerous newspapers (e.g., San Francisco Chronicle and San Jose Mercury News). In addition, individual staff members frequently serve as technical resources for reporters for stories of both local and national significance.

Staff Involved

Most SFEI staff are involved in some aspect of Information Dissemination. Technical staff write articles for the Pulse, newsletter, and Estuary insert. Graphics staff are critical for the production of inserts, posters, and presentations. Senior staff and the Executive Director are involved in conducting media outreach.

Schedule and Deliverables
Key deliverables for this task are presented below.

Deliverable	Target Date
ESTUARY insert	October
RMP Record of Publications	On-going
Posters and Presentations	On-going
Annual Meeting	September
Press Outreach	On-going

Budget
The estimated budget for information dissemination for 2012 is presented below.

Subtask	Estimated Labor Cost 2012
General Information Dissemination (e.g., presentations, RMP News, *ESTUARY* insert, posters, factsheets, press outreach, etc.)	$80,000
RMP Annual Meeting	$48,000
Total	$128,000

2.4 Annual Reporting

Annual reporting consists of the preparation and production of the *Annual Monitoring Results* and the *Pulse of the Estuary*. The *Pulse of the Estuary* is also published in hardcopy.

Subtask 1 ***2011 Annual Monitoring Results***
This report will present nine years of randomized sampling for water and sediment. It will follow a format similar to the *2010 RMP Annual Monitoring Results*. Data will be presented in the form of maps with bubble plots of contaminant concentrations at each site. Box plots and cumulative distribution frequency plots, by segment, will also be reported. The *Annual Monitoring Results* is a web-based report with downloadable maps and figures.

Subtask 1.1 Preparation of the Annual Monitoring Results

Web-ready graphics and various tables, including analyte lists, will be reviewed and updated. Introduction, water, sediment, tissue and QA/QC chapters will be updated to reflect the 2011 data.

Subtask 1.2 2011 Annual Monitoring Results Distribution
The *Annual Monitoring Results* document will be made available through the RMP website *Documents and Reports* link. The 2011 data and QA/QC summaries will be made available on the RMP website through the *Data Access* link. Additional tasks include public outreach and mailings.

Subtask 2 *2012 Pulse of the Estuary*
The theme of this year's *Pulse* will be "Chemicals of Emerging Concern". The 2012 *Pulse of the Estuary* will be finished in time for the Annual Meeting (typically the first week in October).

A more detailed outline will be developed under guidance of TRC and SC. First drafts of articles will be sent out for review in April. The articles will be revised in response to comments. A laid-out version of the report will be distributed to the SC and TRC for a second review in June. The report will be printed by early September, and distributed at the Annual Meeting. An electronic PDF file will be posted on SFEI's web site.

Staff Involved
The production of the *Annual Monitoring Results* will include: Amy Franz, Meg Sedlak, John Ross, Cristina Grosso, Jennifer Hunt, and Nicole David. Leads on the *Pulse* will include: Jay Davis, Meg Sedlak, and Linda Wanczyk.

Schedule and Deliverables
A detailed schedule of tasks is presented below.

Deliverable	**Target Date**
2011 RMP Annual Monitoring Results – Final on web	December 2012
2012 Pulse of the Estuary	September 2012

Budget
The estimated SFEI labor budget for the *Annual Monitoring Results* and the *Pulse of the Estuary* for 2012 is presented on the table below.

Subtask	**Estimated Labor Cost 2012**
Annual Monitoring Results 2011	$40,000
Pulse of the Estuary 2012	$87,000
Total	$127,00

2.5 Quality Assurance

OVERVIEW
Planned tasks for 2011 include:

- completing the update of the Quality Assurance Program Plan (QAPP);
- analyzing data from special QA studies; and
- optimizing metal analyses.

BACKGROUND
The RMP QA program ensures the consistency and reliability of data generated by various subcontractor laboratories and among different facets of RMP estuarine monitoring. The requirements presented in the RMP QAPP are intended to ensure data comparability among different laboratories and different years.

The RMP quality assurance component has been recognized as one of the most thorough and systematic efforts of any ambient monitoring program. The RMP has been involved with method development since its inception in the early 1990s. At that time, the RMP supported trace metal analyses in academic settings; these methods have now become standard methods in commercial laboratories. Similarly, the RMP is working with AXYS Analytical to develop new organic methods for analyzing pharmaceuticals and chemicals of emerging concern (e.g. the CEC analyses sediment, water and biota as part of a pro bono exercise). Where possible, the RMP supports continuous performance evaluation exercises. Most of the RMP contract laboratories participate in NIST intercomparison exercises.

The QA element includes the following tasks:

1. Routine data verification and validation procedures to determine if laboratories are able to meet data quality guidelines specified in the current RMP QAPP and to determine if the data quality meets the expectations of the data users.

2. Updates of the QAPP to meet evolving management priorities and incorporate new components (e.g., new analytes, or new data acceptability criteria).

3. Special QA projects that are limited in scope and that may assist in the evaluation of data accuracy among different laboratories, or in the development of new field collection or analytical methods (e.g., evaluation of samples split among labs or intercalibration exercises).

This section outlines the annual data quality assurance procedures to be conducted in 2012, the periodic review of RMP contract laboratories to ensure high quality performance, and the general evaluation of factors contributing to analytical variation and other causes of measurement uncertainty.

SUBTASK DESCRIPTIONS

Subtask 1 QA Management and Revision of the QAPP

This task includes review and updating of the Field Operations Manual (FOM) and QAPP to reflect new measurements added to the RMP. A number of improvements in analytical techniques have occurred since the 1997 QAPP was prepared. In 2008, we began the process of revising the QAPP by convening meetings with both the organics and inorganics laboratories. In addition, revisions were made to the RMP QAPP to make it more consistent with the SWAMP QAPP, starting with the dioxin studies QAPP written in the SWAMP style. We will build on the dioxin QAPP adding tables and text for remaining analytes and study components as needed. While the revision of the QAPP began in 2011, this task will be completed in 2012.

Subtask 2 Laboratory/Sample Intercomparisons (RMP Status and Trends)

The RMP conducts periodic QA studies such as blind field samples, duplicate field samples collected by different methods, and inter-comparison studies among laboratories to evaluate data quality. These samples are included in the Status and Trends sub-contracts and reported, validated, and reviewed as part of the Status and Trends task. We plan to continue these exercises in 2012.

Results for dissolved copper concentrations in the first year of analysis (2007) with a new contract laboratory (BRL) raised some concerns about comparability to previous results, with average concentrations in the Lower South Bay 20 to 25 percent higher than in previous years and higher than results reported by City of San Jose (CSJ) laboratory. An extensive QA review was conducted; however the cause of the variation was not determined. Results in 2008 were more comparable between labs (~5% difference) and 2009 and 2010 results were similar (average 13% and 10% difference, respectively), with

no consistent bias (some results higher from CSJ and others higher from BRL). A portion of the QA budget will be set aside to continue the comparison.

Subtask 3 Optimizing Trace Element Methods (RMP Status and Trends)

In 2010, a few water samples potentially showed matrix interference problems with the current lab method (reductive precipitation, followed by ICP-MS) for Cd and Cu (despite typically good results with Cu on average), and the lab has migrated to an in-line column chelation ICP-MS instrument for most clients' water metals analysis. Although the next water sampling is not scheduled until 2013, we will continue discussions with the lab on the comparability of, their experiences with, and developments in the new analytical procedures. We will continue to work with the lab on comparing alternative methods for these and other analytes as needed.

Staff Involved
The leads on the QA task will include: Don Yee, Susan Klosterhaus, Meg Sedlak, and Cristina Grosso. Other staff members involved in this task will include: John Ross, Jen Hunt, Amy Franz, and Adam Wong.

SCHEDULE AND DELIVERABLES

The main QA task for 2012 will be updating the QAPP; we anticipate completing this by June 2012.

BUDGET

The estimated SFEI labor budget for QA is approximately $29,000.

Task 3 Status and Trends Monitoring

The Status and Trends (S&T) Program is composed of four elements: long-term water, sediment, and bivalve monitoring; sport fish bioaccumulation; bird egg monitoring; and the USGS hydrographic and sediment transport studies. In 2007, the S&T monitoring program underwent a significant redesign in which each aspect of the monitoring program was evaluated by the TRC and SC to determine how well it answered the priority management questions. In response to this exercise, several modifications were made to S&T including reducing the number of water sites and adding in benthic sampling and bird egg monitoring.

In 2011, the S&T element was again evaluated to determine the information needs of participants and the necessary frequency of analyses. Based on discussions with stakeholders and an evaluation of Water Board needs, it was determined that the program could reduce the frequency of the water and sediment sampling from annual to biennially. These findings are summarized in a memorandum to the TRC and SC in the fall of 2011. With the exception of sportfish monitoring, all other elements remain the same as in prior years. At the writing of this report, the fish committee is evaluating a recommendation to reduce the frequency from every three years to every five years.

The 2012 RMP sampling will mark the 10th year of using a randomized sampling design. The S&T monitoring program switched from a fixed sampling design to a randomized design in 2002. A long-term plan for this design, including a 24-year cycle of rotating panels, is being implemented. The design follows the EMAP example of a randomized design capable of addressing questions related to a representative characterization of contaminant concentrations in water and sediment. In 2010, the program switched from a five-year rotating panel to a six-year rotating panel to address wet weather sediment sampling which occurs every other year (e.g., next wet weather sampling event will be 2012). The bivalve program uses a fixed station, rather than random, sampling design.

The S&T monitoring component of the RMP addresses elements of all of the Level 1 management questions:

- Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
- What are the concentrations and masses of contaminants in the Estuary and its segments?
- What are sources, pathways, loadings, and processes leading to contaminant-related impacts to the Estuary?
- Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
- What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

Randomized sampling provides representative characterization of contamination within each Bay segment to determine whether chemicals are at levels of concern for human health and biota. These data are also used to track trends and to develop models to estimate current and future loadings and concentrations in the Bay.

Beginning in 2002, water, sediment, and bivalve bioaccumulation sampling for the S&T monitoring program were conducted in the summer. Summer was selected for sampling because inter-annual variation due to natural variables, primarily freshwater inflow, is minimized during this period. However, significant toxicity is observed in the winter in sediments. To better understand the causes of toxicity and the variability that may be observed in the rainy season, the TRC and SC recommended as part of the redesign of S&T that sediment be sampled in alternating years in the summer and winter. Winter sediment sampling was conducted in 2010 at a reduced number of sites (i.e., 27 vs. 47 for dry weather sampling), and all samples were analyzed for the full sediment triad of chemistry, toxicity, and benthos.

Five historical water stations and seven historical sediment stations are sampled to maintain time series for long term trend analyses. The Annual Monitoring Results reports further describe the scope of work, analytes measured, and the analytical and reporting expectations for the S&T monitoring program.

Much of the S&T monitoring effort consists of sample collection and laboratory analysis that is undertaken by subcontractors (e.g., AXYS Analytical, and Applied Marine Sciences). SFEI provides oversight, coordination with the laboratories, sample collection, and field assistance.

3.1 Status and Trends: Long Term Monitoring of Water, Sediment, Bivalves, Benthos, and Toxicity

In 2005, the RMP began a process to redesign the Status and Trends program element. This was completed in 2007 and a summary report documenting these changes was prepared in 2008 (http://www.sfei.org/sites/default/files/Report555_Power_Analysis_FINAL.pdf). A number of changes were implemented in 2008 and 2009 including the reduction of organic analyses in water and inclusion of benthic community assessments. A much smaller effort was undertaken in 2011 to address the frequency of sediment and water analyses. Based on discussions with stakeholders and a review of the power analyses conducted by Melwani et al. 2008, the TRC and SC recommended that the program switch to biennial sampling of sediment and water.

Subtask 1 Water Chemistry

In 2012, water samples will not be collected.

Subtask 2 Sediment Chemistry
Beginning in 2010, sediment sampling will alternate wet and dry seasons. In 2012, the sediment samples will be collected in the wet season at 20 random sites and 7 fixed sites. The sediment analysis will consist of organic (e.g., PCBs, PAHs, PBDEs, and pesticides) and inorganic contaminants.

Subtask 3 Sediment Benthos
Promulgated by the State in 2009 for marine waters in enclosed bays and estuaries, sediment quality objectives (SQOs) are based on sediment chemistry, toxicity, and benthic assessments. To provide the data needed for sediment triad evaluation, the RMP began collecting samples for benthic community analysis in 2008. This will continue in 2012.

Subtask 4 Bivalve Bioaccumulation
The bivalve monitoring component maintains the long-term database started by the State Mussel Watch Program in the early 1980s. Because of logistical complexities, a randomized design is not economically feasible, nor is it technically desirable for this long-term trend monitoring tool. Bivalves are excellent trend indicators particularly for organic contaminants. The redesign workgroup recommended that a biennial plan be implemented. In 2008, bivalves were sampled for organics and inorganics; in 2012, bivalves will be sampled for organics. Inorganics are being analyzed on a longer-term five year cycle and were most recently analyzed in 2008.

Subtask 5 Toxicity (Aquatic and Sediment)
After the RMP S&T aquatic toxicity monitoring showed little toxicity over several years, aquatic toxicity sampling was scaled back to a screening effort every five years. At the request of the dischargers, in 2011, aquatic toxicity was conducted at 9 sites throughout the estuary using mysid shrimp (*Americamysis bahia)* as the test organism (survival and growth as end points). Toxicity was only observed at one site (BG20 Sacramento River). Aquatic toxicity is not planned for 2012.

Sediment toxicity measurements will be made at 27 sites (20 randomly allocated sediment chemistry stations and seven historical RMP sampling sites). Toxicity tests will be conducted with *Eohaustorius* (a solid phase test with survival as the endpoint) and *Mytilus* (a sediment-water interface test with normal larval development as the endpoint). In 2008, the Program switched to the sediment-water interface test from the elutriate test to be consistent with the SQOs. If needed, TIEs will be conducted in samples that show significant toxicity; however, contingency funding for TIEs will need to be requested.

STAFF INVOLVED
The S&T staff members will include: Meg Sedlak, Susan Klosterhaus, Amy Franz, and Don Yee. Other staff members involved in this task will include: Nicole David, Jen Hunt, and Rachel Allen.

SCHEDULE AND DELIVERABLES
The S&T sediment sampling cruise will occur in the first quarter of 2012; and transplanted bivalves will occur in the summer.

BUDGET
The estimated SFEI labor budget for S&T long-term monitoring task is presented below.

Subtask	**Estimated Labor Cost 2012**
S&T Field Sampling and Oversight	$30,000
S&T Benthos fieldwork/ Data review	$10,000
Total	$40,000

3.2 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a three-year cycle. In 2009, sport fish were successfully collected from five popular fishing locations within the Estuary. The trend assessment species included shiner surfperch, white croaker, striped bass, and white sturgeon. Additional species targeted included anchovies, jacksmelt, leopard sharks, and halibut. Samples were analyzed for mercury, PCBs, organochlorine pesticides, PBDEs, dioxins, and perfluorinated compounds.

At the present time, the fish committee is evaluating the frequency of sampling. Based on the initial responses, it appears that this element of the program will move from a three-year cycle to a five-year cycle.

3.3 Bird Egg Monitoring

The Exposure and Effects Pilot Study (EEPS) conducted monitoring of bird eggs from 2002 through 2006. Two species have been monitored. Cormorant eggs provide a valuable regional indicator of contamination on the open waters of the Bay and Forster's tern eggs are indicators of more localized contamination in shallow water habitats around the margins of the Bay. Forster's terns are also more sensitive to contamination. As part of the Status and Trends redesign, it was recommended that bird egg monitoring be included as a triennial element.

Under EEPS, cormorant eggs were collected in 2002, 2004, and 2006. At three locations in the Bay, two composites from ten eggs were analyzed for PCBs, PBDEs, musks, phthalates, mercury, selenium, pesticides, nonylphenol, and dioxins. Starting in 2006, eggs were also analyzed for perfluorinated compounds. In 2009, cormorant eggs were

collected at the following three sites (consisting of three composites from each site): Wheeler Island; Richmond Bridge and Pond AB2 located in the South Bay. The eggs have been analyzed for PCBs, PBDEs, Hg, Se, pesticides, and perfluorinated compounds. The dioxin strategy team recommended deferring bird egg dioxin analysis to 2012.

EEPS monitored tern eggs for mercury in 2002 and 2003. Recent work, in part funded by the RMP, has shown that levels of mercury in Forster's terns are sufficiently high that they appear to be significantly affecting the reproductive success of the birds. Tern eggs have been analyzed for mercury, selenium, and PBDEs. Except for mercury, the eggs were composited with three composites per site and seven eggs per composite. Six tern colonies were sampled successfully in 2009: Eden Landing, Napa Marsh, Napa Marsh, Hayward Shoreline and Ponds A2W, AB2, and A16 in the South Bay.

The results of this study will be summarized in 2012 in a technical report.

STAFF INVOLVED
SFEI staff involved include: Jennifer Hunt, Jay Davis, Cristina Grosso and John Ross.

SCHEDULE AND DELIVERABLES

Deliverable	**Target Date**
Draft Technical Report	March 2013
Final Technical Report	May 2013

SFEI LABOR BUDGET

Subtask	**Estimated Cost**
Project Management, Coordination, Data Analysis, and Reporting (SFEI labor)	$20,000
Total	$20,000

3.4 RMP-Sponsored United States Geological Survey Studies

The United States Geological Survey (USGS) has been a collaborating agency 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 water quality and sediment transport processes. An understanding of these basic processes is essential to interpreting patterns in data on chemical indicators of water quality condition. The funds contributed by the RMP are generally less than half of the overall USGS costs to conduct both monitoring components outlined below. Because these tasks are undertaken entirely by the USGS, no SFEI labor costs are associated.

Subtask 1 Factors Controlling Suspended Sediment in San Francisco Bay
Since 1993, this element of the RMP has focused understanding suspended sediment dynamics in the Estuary through the monitoring of suspended sediments at key locations in the Estuary. This work has yielded many insights into sediment and contaminant dynamics in the Estuary, as summarized in articles by Dr. Schoellhamer in the 2003, 2005, and 2010 editions of the *Pulse of the Estuary.*

In 2005, faced with a significant funding shortfall, USGS reduced the number of sites at which it measured suspended sediment concentrations from ten to six (five fixed sites and one temporary site in the vicinity of the aquatic transfer station for Hamilton Air Force base). The sites for 2012 are: Alcatraz, Mallard, Benicia, Richmond Bridge, and Dumbarton Bridge. Based on meetings with the TRC and LTMS project managers late in 2011, it was decided that funding for the sixth site would be used to calculate sediment flux out the Golden Gate based on prior collection events.

In a separate non-RMP funded project, USGS will also install dissolved oxygen probes at the following stations: Dumbarton Bridge, near -bottom (already deployed, will add a chlorophyll probe near-surface); Alviso Slough (backwater slough); San Mateo Bridge near-bottom; Corte Madera Creek mouth; Benicia Bridge near-bottom; and Richmond Bridge near-bottom.

STAFF INVOLVED
Dr. David Schoellhamer of the USGS in Sacramento, California is the lead investigator for this project. SFEI staff members are not directly involved in this task.

Schedule and Deliverables

Deliverable	Target Date
Progress reports	Quarterly
Annual summary report	December 2012

BUDGET
Because this work is entirely conducted by USGS, no SFEI labor hours are allocated to this task. The total budget for this task is $250,000 (provided by the US Army Corps of Engineers).

Subtask 2 Basic Water Quality
The USGS will continue to conduct monthly water quality sampling of basic water quality parameters along the spine of the entire Bay-Delta system. Measurements will include: salinity, temperature and dissolved oxygen (which influence the chemical form and solubility of contaminants); suspended sediments (which influences the transport of contaminants); and phytoplankton biomass (which influences the partitioning of reactive contaminants between dissolved and particulate forms). This information is important for

understanding seasonal changes in water quality and estuarine habitats and their influence on biological communities and the distribution of contaminants.

Highlights from this work were described by Dr. Cloern at the 2009 Annual Meeting as well as an article in the 2006 *Pulse of the Estuary*. In the Pulse article, Dr. Cloern and Dr. Alan Jassby documented the dramatic change that has occurred in the Estuary with the advent of a fall phytoplankton bloom and larger spring blooms. We will continue to monitor these important changes in the Estuary.

STAFF INVOLVED

Dr. Jim Cloern of the USGS in Menlo Park, California is the lead investigator for this project. SFEI staff is not involved in this task.

Deliverables

The USGS posts the data from their monthly cruises on their website (http://sfbay.wr.usgs.gov/access/wqdata/) which is also available from the SFEI RMP web site.

BUDGET

Because this work is entirely conducted by USGS, no SFEI labor hours are allocated to this task. The total subcontract budget for this task is $110,000.

Task 4 Special Studies

Each year, the RMP undertakes special studies to complement Status and Trends monitoring. These studies are developed under the guidance of the workgroups and committees and seek to answer high priority management questions that are articulated in the RMP Multi-Year Plan.

4.1 Dioxin Analysis in Bird Eggs, Storm water, and Sediments

OVERVIEW

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

DIOXIN STRATEGY QUESTIONS

Recognizing that there was a dearth of information, RMP stakeholders developed a Dioxin Strategy in 2008 that prioritized the information needs and articulated a series of studies to be undertaken over the next five years. The RMP has conducted analyses of dioxin in sport fish, tributaries, surface water and shallow sediments and sediment cores to begin to address the Dioxin Strategy questions. In 2012, we will focus on analysis of water samples from two urban tributaries, bird eggs (cormorants) and sediments.

The following Dioxin Strategy questions will be addressed through this study of urban tributaries, bird eggs and sediments:

1. Are the beneficial uses of San Francisco Bay impaired by dioxins?
2. What is the spatial pattern of dioxin impairment?
3. What is the dioxin reservoir in Bay sediments and water?
4. Have dioxin loadings/concentrations changed over time?
5. What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?
6. What future impairment is predicted for dioxins in the Bay?

APPROACH

Bird Eggs

Dioxins will be analyzed in nine samples of cormorant eggs collected from three sites (three samples per site) spatially distributed throughout the Bay as part of S&T monitoring described in Section 3.3. Because of their high position in the foodweb and relatively wide foraging ranges, cormorants are valuable indicators of regional contamination in the Bay.

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

Tributaries

Whole water samples from Zone 4 Line A (urban), Guadalupe River (mixed ag/urban), and Mallard Island (Delta inflow) were collected in 2010. In the Dioxin Strategy, data from two more urban tributaries are planned. In 2012, the dioxin study will augment the efforts being undertaken to characterize urban tributary loads from San Leandro Creek and Sunnyvale Channel East (as described in Section 4.5).

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

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

Sediments

At present, the need for dioxin analysis of sediments is being evaluated. The strategy team felt that there was sufficient surface sediment dioxin data; however, that there may be a need for dioxin analyses of cores or shallow Bay margin sediments.

SCHEDULE AND DELIVERABLES
Tributary samples will be collected in the winter of 2012 and sent to AXYS Analytical for analyses in the Spring/Summer. Bird eggs will be collected in the Spring and sent to AXYS Analytical for analyses in the Summer/ Fall of 2012. A plan for the collection of sediment samples will need to be developed early in 2012.

STAFF INVOLVED
This task will be led by Susan Klosterhaus and Don Yee with assistance from the RMP wet weather staff.

SCHEDULE AND DELIVERABLES

Deliverable	**Date**
Collect and ship tributary samples to AXYS	January-March 2012
Collect and ship bird egg samples to AXYS	Spring 2012
Data validation	Fall/Winter 2012
Summary presentation to TRC	December 2012

BUDGET
The budget for this task is $95,550 including subcontractors and direct costs:

Element	**Budget**
Bird eggs (analytical)	$9,600
Tributary (analytical and shipping)	$33,300
Sediment (analytical)	$24,300
SFEI labor (data management, analysis and reporting)	$28,350
Total	$95,550

WORKGROUP OVERSIGHT
The TRC will review this work.

4.2 CEC Synthesis Report (Year 2) and Strategy

OVERVIEW

Since 2006, the RMP has been collecting data on contaminants of emerging concern (CECs) to proactively identify unregulated chemicals that have the greatest potential to adversely affect the health of San Francisco Bay wildlife and humans that are linked to the Bay food chain. With guidance from the Emerging Contaminants Work Group (ECWG), RMP pilot and special studies have focused on preliminary monitoring of pharmaceuticals, perfluorinated chemicals (PFCs), and flame retardants in Bay samples. Pro bono analyses of a variety of CECs by other laboratories have substantially augmented this work. In early 2012, other information generated by the State Water Board, and the NOAA Mussel Watch Program will be available that is expected to influence the management of CECs in San Francisco Bay and the entire state. A summary document that synthesizes these data and other information in the context of CECs management in San Francisco Bay is needed to guide future monitoring efforts by the RMP.

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

APPLICABLE RMP MANAGEMENT QUESTIONS
This study would address the following RMP management question (MQ):

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

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

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

RMP Preliminary Monitoring Studies

- South Bay surface water pharmaceutical study (2006)

- PFCs in mussels (2010), small fish (2009), sportfish (2009), harbor seals (2006-2008), and bird eggs (2006-2009)
- Non-PBDE, current-use flame retardants in sediments and wildlife (2008-2009)
- Triclosan in sediments (2008)
- Chlorinated paraffins in wildlife (2008)
- Nonylphenol in small fish (2009)
- PFCs in tributary waters, ambient surface water, sediment, and wastewater effluent
- PPCPs, alkylphenols, and PFCs in mussels, water, sediment (2010)
- Single-walled carbon nanotubes in sediment (2010)
- Screening of biological tissues for CECs (2010-2011)

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

NOAA Mussel Watch California CEC Pilot Study
A pilot study is being conducted by state and federal agencies to determine which CECs should be added to the list of target analytes for the national NOAA Mussel Watch Program. Pharmaceuticals and personal care products (PPCPs), PBDEs, polybrominated biphenyls (PBBs), alternative flame retardants, PFCs, alkylphenols, and pesticides (pyrethroids, organochlorines, organophosphates, other current use pesticides) were analyzed in resident mussels throughout the State. In San Francisco Bay, resident mussels were collected from the four core Mussel Watch sites (Yerba Buena Island, Dumbarton Bridge, San Mateo Bridge, and Emeryville). Resident mussels, caged mussels and/or passive samplers were deployed near three wastewater treatment plant outfalls and three agriculturally influenced sites in the Bay and analyzed for CECs. These data are currently being reviewed with a report available in early 2012.

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

SCHEDULE AND DELIVERABLES
This project is a two-year project that commenced late in 2011 and will finish in March 2012. Upon completion of the synthesis, SFEI staff will develop a strategy for how the RMP will address CECs. The strategy document will be completed in the Fall of 2012.

BUDGET
The budget for this CEC synthesis task is $45,000 (all SFEI labor hours) with $30,000 being allocated in 2011 and $15,000 for 2012. The budget for the CEC strategy is $15,000 (all SFEI labor).

WORKGROUP OVERSIGHT
The Emerging Contaminant Workgroup will review this element.

4.3 Monitoring of Perfluorinated Compounds in SF Bay Biota

OVERVIEW

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

APPLICABLE RMP MANAGEMENT QUESTIONS

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

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

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

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

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

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

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

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

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

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

APPROACH

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

Small fish
Seals are omnivores and will commonly consume fish such as herring, flounder and perch as well as crustaceans, mollusk, squid and octopus (http://www.palomar.edu/oceanography/harbor_seals/facts.htm). In prior studies, variation in small fish PFOS concentrations were observed both spatially and by species. PFOS was the major PFC detected in this matrix. Interestingly, PFCs were largely not detected in mollusks which are consumed by seals. In San Francisco Bay, yellow fin gobies were observed to comprise 54% of the harbor seals diet (Torok 1994). Cormorants, which are diving birds, also feed on small fish. The RMP is currently undertaking a small fish study in 2011 at two sites in the South Bay to evaluate uptake of

mercury into the food web. Ten composite fish samples from this project will be analyzed for PFCs to determine the potential for uptake and to identify potential hot spots. Small fish samples will be collocated with the sediment samples.

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

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

STAFF INVOLVED
SFEI staff will Meg Sedlak, Rachel Allen and the data management team.

BUDGET
The budget for this task is $87,000.

Task	**Estimated Cost**
Analysis of seal blood (40 samples), data management and reporting	$31,000
Analysis of small fish samples (10 composites), data management and reporting	$36,000
Analysis of collocated sediment (10 samples), data management, and reporting	$20,000
Total	**$87,000**

SCHEDULE AND DELIVERABLES

Deliverable	**Target Date**
Draft Report	December 2012
Final Report	March 2013

WORKGROUP
The Emerging Contaminant Workgroup will review this element.

4.4 Regional Loading Spreadsheet Model – Year 3

OVERVIEW

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

"Spreadsheet models" of storm water quality provide a useful and cheap tool for estimating regional scale watershed loads. These models are based on the simplifying factor that unit area runoff for homogeneous sub-catchments have constant concentrations, and thus have advantages over models such as HSPF and SWMM that require large calibration data sets which take money and time to collect. Such a model was developed for the Bay Area previously (Davis et al., 2000); however, at that time, there was only local land use specific data on pollutants of concern (POCs) for a drought period late 80s and early 90s, and there was no local data on Hg and PCBs. More recently, a spreadsheet model was developed for a watershed in Los Angeles that was able to predict mass emissions to within 8% of measured Zn loads and described options for loads reduction through a focus on "high leverage" areas (Ha and Stenstrom, 2008). Locally Lewicki and McKee (2009) used a combination of methods to make new watershed specific suspended sediment loads estimates. In watershed areas where there were empirical observations, these were used to estimate long-term average loads. The empirical data were also used to calculate regional regression equations that were then applied to larger watersheds dominated by non-urban land use. For urban areas, a spreadsheet model was used that combined delivery ratios calculated from watershed area and erosion estimates for specific land use classes (natural, agricultural, low density and high density urban and industrial). These estimates are presently deemed to be the best and will need to be taken into account during year 2 and year 3 of the development of a spreadsheet model.

During the RMP 2010 calendar year (year 1 of this project), the GIS-based simple model was developed to calculate storm water volumes and POC loads on a long-term average annual basis. (Ideally the model should operate on a storm event basis, but a massive

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

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

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

APPLICABLE RMP MANAGEMENT QUESTIONS
The following RMP management questions will be addressed in this project.

- Level I RMP, Q3: What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- Level II RMP, Q3C: What is the effect of management actions on loads from the most important sources, pathways, and processes?

- Level III SPL Q2: What is the watershed-specific and regional total water flow, load of sediment, and load contaminants entering the Bay from the urbanized small tributaries and non-urban areas draining to the Bay from the nine-county Bay Area and are there trends through time?
- Level IV STLS Q1: Impairment: Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- Level IV STLS Q2: Loads: What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- Level IV STLS Q4: Support management actions: What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries and where should management actions be implemented in the region to have the greatest impact?

APPROACH

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

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

SCHEDULE AND DELIVERABLES

This project will commence in January with the refinement of the runoff model and the extension of the model to new pollutants. The results of this project will be presented to the SPLWG and TRC in the Fall of 2012.

BUDGET

The budget for this task is $20,000 (all SFEI labor hours).

WORKGROUP OVERSIGHT

The SPLWG will review this element.

4.5 Load Monitoring in Representative Watersheds

OVERVIEW

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) (Provision C.8.e.) calls for better quantification of loads of sediments and trace contaminants on a watershed basis and regionally (SFRWQCB, 2009).

Better quantifications of loads has been a priority for the Sources Pathways and Loading Work Group (SPLWG). Davis et al. (2000; 2001) recommended that six observation watersheds be picked on the basis of land use and climate. This recommendation was reiterated by the SPLWG during Five-year planning (McKee et al., 2008). As such, the Regional Monitoring Program for Water Quality in San Francisco Estuary (RMP), through the SPLWG, has been conducting tributary loading studies for nine years. The focus has been to provide information on sediment and pollutant transport processes in urban watersheds around the Bay (McKee et al., 2004; 2005; 2006a; 2006b; Davis et al. 2007; Oram et al. 2008; David et al. 2009; McKee and Gilbreath, 2009; David et al., in review; Gilbreath et al., in review). Most of the sampling effort has been focused on three SPLWG identified priority locations using a turbidity surrogate methodology recommended by McKee et al. (2001) and McKee et al. (2003): Mallard Island on the Sacramento River; Guadalupe River in San Jose; and the Zone 4 Line A flood control channel in Hayward.

During 2010, the STLS carried out two tasks to support the development of a multi-year watershed loading sampling plan version 2011 (MYPv11). The first of these tasks "develop criteria and rank watersheds" used GIS to support a statistical classification of watersheds in the Bay Area. Preliminary results provided evidence that there are at least four distinct classes. The second task "Optimize sampling for loads and trends" took advantage of existing temporally resolute (5-15min) data available in Guadalupe River and Z4LA. These data were statistically resampled using a range of sampling designs and loads estimators (mathematical formula for loads calculations). The outcomes supported the logical notion that more samples covering a greater number of storms or the use of the turbidity surrogate method provide loads with the greatest accuracy and the least bias. At the March 29th STLS meeting, a draft monitoring method was outlined as follows:

1. A minimum of six watersheds would ultimately be monitored with four watersheds beginning October 1st 2011. Guadalupe River and Marsh Creek were identified as likely candidates; the final two watersheds were named after the WY 2011 reconnaissance data review in June; San Leandro Creek and Sunnyvale Channel East.
2. The turbidity surrogate methodology will be the preferred monitoring method employing continuous (5-15 minute interval) turbidity records calibrated for

sediments and contaminants using both discretely analyzed and composited water samples (depending on contaminant).

3. Discrete and composited samples will be collected using automated techniques for most contaminants. Per MRP requirements, total methylmercury will be collected manually. Despite automated sampling being the chosen method, there remains some concern about Hg sample contamination using this sampling technique. Careful diligence and further evaluation was recommended as part of the WY 2012 sampling program.
4. Using the MRP as a guide, the STLS workgroup collaborated to find a balance between the total number of samples achievable for the season and the total number of autosamplers required, and made contaminant-specific decisions on total sample number. Sample numbers for all the contaminants range between 2 - 4 composite samples and 8 – 16 discrete samples (32 samples for SSC).
5. Each year data management would be completed and preliminary data interpretations would be presented to the workgroups and in short memo style progress reports
6. At the end of a 3 year sampling period, finalized loads analysis and other interpretations would be completed

This methodology was endorsed at the May 2011 SPLWG meeting and subsequent meetings of the STLS local team were used to work up further details on site logistics, sample numbers, priorities for analytes, laboratory choices, and other issues. The MYPv11 (STLS, 2011) contains recommendations for sampling location, sampling design (frequency), and analytes, and linkages between bottom of the watershed loads sampling and other elements (spreadsheet model and land use/source area specific sampling) based on these outcomes.

APPLICABLE RMP MANAGEMENT QUESTIONS

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

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

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

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

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

Level IV STLS Q3: Trends: How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?

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

APPROACH

This study will implement a small tributaries loadings sampling following the MYP in two watersheds.

Following the MYPv11 methods, gauging locations will be implemented in two watersheds, San Leandro Creek and Sunnyvale Channel East. Automated sampling will occur during four storms, with manual sampling for total methylmercury and discharge measurement also occurring during two of those storms. Methylmercury will additionally be collected during two events in dry weather conditions.

STAFF INVOLVED

The project will be led by Lester McKee, with field work, project management, and reporting by Alicia Gilbreath, Jen Hunt, Rachel Allen, David Gluchowski, and Don Yee.

SCHEDULE AND DELIVERABLES

Deliverable	**Estimated cost (spread across 2 watersheds)**
Task 1. Project Management (write and manage sub-contracts, track budgets)	$22,000
Task 2. Equipment purchase and prefabrication	$48,000 [1]
Task 3. Fieldwork	$76,000
Task 4. Laboratory analysis	$115,000 [2]
Task 5. QAQC / data management	$30,000
Task 6. Interim reporting	$20,000
Shipping and Travel	$17,000

1. Cost assumes set up of turbidity probes at 2 sampling stations and maintenance by SFEI. Note that the cost for USGS gauging stations is $40 K per station (2 USGS stations would be $80K)
2. Amount reflects a reduction in effort for analysis of legacy pesticides and pyrethroids

BUDGET

The budget for this project is $328,000, of which $157,300 is for SFEI labor, $170,700 is for laboratory analyses, equipment and direct costs.

WORKGROUP

This project will be overseen by the Small Tributaries Loading Strategy Team, as part of the Sources, Pathways, and Loadings Workgroup.

4.6 POC Loads Monitoring – Land Use/ Source Area Specific EMC Development

OVERVIEW

The PCB and Hg TMDLs for San Francisco Bay call for improved stormwater loading information and increased application of urban Best Management Practices (BMPs) for reducing pollutant loads and impacts. Since it is impossible to monitor all stormwater inputs to San Francisco Bay (there are more than 250 urban watersheds presently identified), the first report of the SPLWG recommended a combination of monitoring and extrapolation using modeling to develop regional loads estimates (Davis et al., 2001).

To estimate regional loads, the STLS documents the consensus recommendation to develop a spreadsheet model using the methods of Ha and Stenstrom (2008). Data inputs for such a model include rainfall, runoff coefficients, and land use based contaminant event mean concentrations (EMCs). In 2010, the TRC funded the first year of development of that modeling platform (Lent and McKee, 2011). The outcomes of the first year included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds. Preliminary loads of copper and sediment were also generated but confidence was low. In 2011, the TRC provided another $20,000 to further the development of the model to finalize the hydrological and sediment transport components and further test contaminant data inputs from literature review. In parallel, a literature review is being completed to evaluate land use or source specific strata, to evaluate information from literature to determine local empirical EMC data development needs and to do reconnaissance of monitoring sites.

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

Unfortunately these Southern California data are not directly applicable to the Bay Area, where PCBs and Hg are the pollutants of highest concern. In the Bay Area, older industrial areas are hypothesized to be more polluted with PCBs than other urban landscapes, whereas for mercury, a broader distribution is hypothesized that includes industrial and commercial areas with higher imperviousness, and older urban areas.

Beyond land use, the literature review being completed presently is considering condition of development (e.g. roads cracked under the pressure of heavy vehicles, poorly maintained facilities, or the existence of bare earth or gravel on roads and industrial lots) and source areas (e.g. electrical facilities for PCBs or reprocessing facilities for Hg and PCBs).

APPLICABLE RMP MANAGEMENT QUESTIONS

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

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

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

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

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

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

APPROACH

The proposed framework for EMC development 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 the EMC 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 data bases for proposed contaminant specific land use or source area; using literature values and current loads estimate Bay Area specific EMC and lastly, monitor specific land use/source areas during wet weather events to confirm EMCs.

At present, field work to confirm desktop EMC values is not recommended for 2012; however, it is possible that the development of the EMCs will not require the full budget currently allocated. If it is possible, the remaining funds will be used to begin to scope EMC field work for 2013. The development of the EMCs and future field work will be conducted in consultation with STLS team and the SPLWG and the development of approved workplans. This work plan will be coordinated with the BASMAA contaminant profile development for suspended sediment, PBDEs, and OC pesticides.

STAFF INVOLVED

The project will be led by Lester McKee with assistance from Alicia Gilbreath, Jen Hunt, and David Gluchowski.

SCHEDULE AND DELIVERABLES

A report summarizing the literature review will be available in the second quarter of 2012. The literature review will be used to inform EMC monitoring activities for 2012.

BUDGET

The budget for this project is $80,000.

WORKGROUP

This project will be overseen by the Sources Pathways and Loading Workgroup.

4.7 Sediment Quality Assessment of Toxic Hot Spots in SF Bay – Year 2

OVERVIEW

In 2009, the State Water Resources Control Board adopted the Sediment Quality Objectives for marine waters in Enclosed Bays and Estuaries (SQOs). The SQOs are based on a triad evaluation of sediment chemistry, benthos, and sediment toxicity. A fundamental challenge in SQO implementation has been the interpretation of the results of these assessments. In 2011, the RMP sampled along gradients at two previously identified hotspots within San Francisco Bay: Mission Creek, and San Leandro Bay. These sites are located in areas with polyhaline benthic assemblages which allows for application of the current SQO guidance. In 2012, the results will become available and will be compared to the similar evaluations of the 27 RMP sites for which there are similar data.

This study will address RMP management questions (listed below) related to pollutant effects on benthic organisms including: evaluating the long-term persistence of benthic impacts at hotspots, which pollutants are responsible for potential impacts, and the utility of the SQO approach in evaluating sediment condition. This study will provide the Water

Board with SQO assessments of important estuary margin sites of concern in the Central and South Bay regions of the San Francisco Estuary in support of managing contaminated sites and 303(d) listing decisions.

APPLICABLE RMP MANAGEMENT QUESTIONS

This study will aid in understanding the following EEWG benthic effects management questions:

What are the spatial and temporal patterns of impacts of sediment contamination on benthic biota?
This study will employ the SQO methods for Enclosed Bays and Estuaries to assess ecological condition, and if there is a potential concern of degraded conditions due to pollution. This study will focus on impaired sites located in the Estuary margins and SQO assessment scores will be compared to the RMP Status and Trends scores from the ambient survey design.

Are the toxicity tests, benthic community assessment approaches, and the overall SQO assessment framework we are using reliable indicators of impacts on benthic biota?
The SQO methods for Enclosed Bays and Estuaries will be implemented to investigate sediment conditions at sites that are the most impaired in the Estuary which will help to inform us on how sensitive these tools are and if they can detect changes in sediment conditions over time or after remediation efforts have been completed.

APPROACH

Sediment assessment scores will be compared among sites and to the scores of sites collected through the RMP Status and Trends program. The Status and Trends program began conducting SQO assessments in 2008 at a subset of the long-term sediment monitoring sites, which are located throughout the Estuary and represent ambient conditions. Comparing the study sites to those representing ambient conditions will provide perspective about the respective ecological condition of sediments in the Estuary as a whole and near pollution sources.

A report detailing the SQO assessment results and the conclusions from these comparative analyses will be prepared.

STAFF INVOLVED

The data management team will review and QA the data. Susan Klosterhaus will manage this project and summarize the findings of this work. Given the current lack of benthic expertise at the institute, SFEI will likely work with SCCWRP to conduct the SQO evaluation.

SCHEDULE AND DELIVERABLES

Deliverable	Target Date
Draft and Final reports	Aug 2012, Oct 2012

BUDGET

This is the second year of a two-year project. Funding for this project in 2012 is $30,000 with half being allocated to SFEI labor to write the report and half to SCCWRP to conduct the SQO analyses.

WORKGROUP

This project will be overseen by the Benthic Workgroup and the Exposure and Effects Workgroup.

4.8 Nutrient Strategy

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. 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., 2006; Cloern et al., 2007).

In response to the apparent changes in the Bay's resilience to nutrient loading, and recognizing the need for both an assessment framework for nutrients (McKee et al, 2011) and a long-term monitoring strategy to assess impairment of the Bay, the San Francisco Bay Regional Water Quality Control Board, in collaboration with Bay stakeholders, are developing a San Francisco Bay Nutrient Strategy. The goal of the Nutrient Strategy is to lay out a well-reasoned and cost-effective program to generate the scientific understanding needed to fully support major management decisions and questions.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?
Answering these questions requires a clear understanding of processes/drivers in the Bay. The Bay's health with respect to nutrients is influenced by a number of strong forcings

(anthropogenic nutrient loadings, biota and top down controls on productivity, natural climate variability). These need to be clearly laid out, the potential for future changes identified, and the potential impacts of those changes explored, which are the goals of Tasks 1.1, 1.2, and 1.3, respectively. Task 2 also addresses this question by identifying nutrient loadings under current conditions.

2. Which nutrient sources, pathways, (and transformation processes) contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

As described below, Tasks 1.1. and 1.3 work toward answering these questions by developing conceptual models for the system and identifying key knowledge/data gaps. Task 2 directly addresses the loading pathway questions by calculating external loads to the Bay using best available information.

APPROACH

In consultation with the Nutrient Workgroup, the following three tasks have been identified.

Task 1. Nutrient/Water Quality Conceptual Model and Scenario Building

The Nutrient Workgroup identified a fundamental need for developing a consensus statement on nutrient science in San Francisco Bay that documents current concerns related to maintaining and protecting Bay beneficial uses. Despite the high nutrient loads to and concentrations within the Bay, it is not obvious that beneficial uses in the Bay are currently impaired by nutrients. Instead, most of the current nutrient-related concerns are focused on future conditions in the Bay, and the possibility that alterations to one or more of the drivers (natural or anthropogenic) that influence the Bay's biological responses to nutrients could result in an alternate and potentially impaired state for the Bay.

The Nutrient Numeric Endpoint (NNE) assessment framework being developed for San Francisco Bay recommends the use of models to assist with determining sustainable nutrient loads based on beneficial use protection. There was broad consensus among Nutrient Workgroup participants (dischargers, regional scientists, regulators) that Task 1 is needed to help frame the questions that may eventually be explored through modeling efforts employing varying degrees of complexity, and to identify the key drivers/factors that need to be incorporated into models.

There was also broad agreement among Workgroup participants that San Francisco Bay needs a sustained monitoring program to provide the key information to support management decisions. Since 1969, a USGS research program has supported water-quality sampling in San Francisco Bay, providing monthly data on salinity, temperature, turbidity, suspended sediments, nutrients, dissolved oxygen and chlorophyll a. The

USGS program, along with sampling conducted by the Interagency Ecological Program, covers the entire San Francisco Bay and Delta system, and the observations generated from these long-term data sets have contributed immensely to the current understanding of nutrient dynamics in the Bay. However, the USGS is not mandated to do this monitoring, and future funding is uncertain. The recommended monitoring program elements that will be generated through Task 1 are an important early step in establishing the necessary structure of a locally-supported program.

Task 1 has the following main goals:

1) Develop spatially-explicit (Bay compartments and habitats) conceptual models of nutrient dynamics in the Bay, with clear linkages to indicators of Bay beneficial uses;
2) Develop scenarios for future changes to key drivers/factors that influence biological responses to nutrient loads;
3) Prioritize scenarios that could be investigated through future modeling efforts, and additional scientific investigations to address critical knowledge gaps; and
4) Determine the key elements of a monitoring program that are needed to assess the Bay's current status and to detect changes in that status over time.

Task 1 will be carried out from November 2011 to December 2012, and is divided below into four main sub-tasks.

Task 1.1 Develop Spatially- and Temporally-Explicit Conceptual Models

The first step in Task 1 is to develop a set of conceptual models for the Bay that characterizes important processes linking nutrient loading, biological responses, and indicators of adverse effects of nutrient over-enrichment. Because of the large differences in hydrography and nutrient dynamics between regions of the Bay, the Bay will be divided into a manageable number of segments and habitat-types, and individual conceptual models will be developed for each. These conceptual models will be developed collaboratively with input from regional scientists and stakeholders.

Task 1.2 Conceptualize Scenarios for the Bay under Future Conditions

With input from stakeholders and regional scientists, a list of plausible future scenarios for the Bay will be developed. Three broad categories of scenarios are envisioned:

- Management scenarios (increases or decreases in nutrient loading via various sources, changes in timing and quantity of waters, removal of suspended sediments, etc.)
- Scenarios that involve changes in environmental factors/drivers (temperature, benthic invertebrate population size, climate change, etc.)
- Scenarios that depict an altered state of the Bay resulting from a combination of factors

A preliminary list of example scenarios has been developed based on initial feedback from the Nutrient Workgroup. Through further consultation with the Nutrient Workgroup, the list will be revised and narrowed to a manageable number of high-

priority scenarios that will receive detailed consideration within this task. Some of these scenarios may consist of two or more scenarios acting in parallel (e.g., continuing decrease of suspended sediment loads and low abundance of filter-feeding clams).

These scenarios will be explored within the context of the conceptual models for Bay segments and habitats developed in Task 1.1. Some scenarios will be more relevant in certain segments/habitats than others (e.g., changes in NH_4^+ loading and inhibition of primary production in Suisun Bay). Scenarios will be evaluated and, if possible, ranked based on their potential impact on beneficial uses of the Bay and risk of occurrence. Throughout Tasks 1.1 and 1.2, major uncertainties and data/knowledge gaps will be identified.

Task 1.3 Consensus Statement on Nutrients Impacts on Bay Beneficial Uses, and Summary of Knowledge/Data Gaps

Based on the evaluation of scenarios in Task 1.2, a consensus statement will be developed about the present or future state of the estuary and concerns regarding nutrients and beneficial uses. Task 1.3 will also identify major data and knowledge gaps, and will identify priorities for additional scientific investigation (e.g., Special Studies) that will be required in order to adapt conceptual models into quantitative models that can address the related priority management questions.

Task 1.4 Recommended Elements of a Monitoring Program

Based on the concepts developed in Tasks 1.1-1.3, Task 1.4 will make preliminary recommendations for key elements of a locally-supported monitoring program to assess status and trends related to eutrophication and other adverse effects of nutrients. Recommendations will prioritize indicators to assess Bay health with respect to nutrients, including the candidate NNE indicators and co-factors identified in McKee et al. (2011). This task is intended to be only an initial identification of monitoring program elements, and will need to be followed by more thorough study and discussion to develop the detailed approach.

Task 2 Quantifying External Nutrient Loads and Data Gaps Analysis

Quantifying external nutrient loads to San Francisco Bay was identified as another high-priority funding item by the Nutrient Workgroup. Given that nitrogen (and to a lesser extent phosphorous) can experience multiple potential fates once entering an estuary, accurate load estimates are a pre-requisite for eventually developing reliable mass budgets and quantifying internal-Bay processes.

Task 2 will develop spatially- and temporally-explicit estimates of nutrient loads to the Bay, and identify critical data gaps that contribute most to current uncertainty in total loads, speciation of those loads, and the relative importance of various sources. A conceptual model for external loads will first be developed. A summary of external loads to the South Bay has already estimated by SFEI through funding from BACWA (McKee and Gluchowski, 2011). Task 2 will expand that loading work into the Central and North Bay, develop daily, monthly, and annual load estimates, and explore 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, along with other smaller downstream tributaries; 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 (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. However, fluxes through the Golden Gate to the Central Bay will be more uncertain, and will need to be based on physical exchange data from a limited number of studies (e.g., Fram et al., 2007; Martin et al., 2007) that were not necessarily designed to quantify nutrient exchange.

While there may be some data on inorganic nutrient concentrations in POTW effluent (McKee et al., 2011), there is quite limited data on total nitrogen and total phosphorous loads to and concentrations within the Bay. To the extent possible, potential loads of organic nutrients will also be constrained, using relationships from the literature and through consultation with local wastewater experts.

Within the process of noting major uncertainties and data gaps, Task 2 will identify high-priority monitoring activities and special studies designed to better constrain nutrient load estimates. Task 2 will also point out high-leverage opportunities for decreasing nutrient loads.

Funding is being sought to fund 40% of Task 2 in 2012, and the remaining 60% in 2013.

Task 3 Management of Nutrient Strategy Development Activities
The RMP will ultimately fund only a portion of the overall work envisaged in the Nutrient Strategy. Nonetheless RMP-funded nutrient work, if carried out in close cooperation with other nutrient activities in the Bay (e.g, NNE framework), can play a critical role in shaping the overall future direction of the Nutrient Strategy. Task 3 seeks limited funding to support the coordination of RMP-funded work with other nutrient-related investigations in the Bay. This may include coordinating stakeholder and expert panel meetings for Nutrient Strategy development, revisions of the Nutrient Strategy to address new input, and preparing research proposals to fund Nutrient Strategy projects through other funding mechanisms. This funding will help leverage the RMP investment in the Nutrient Strategy.

STAFF INVOLVED

The project will be led by David Senn with assistance from SFEI staff as needed.

SCHEDULE AND DELIVERABLES
Proposed Deliverables and Time Line

Deliverable		Due Date
Task 1:	***Nutrient/Water Quality Conceptual Model and Scenario Building***	
	Draft conceptual model and scenarios to be considered, outline, and powerpoint presentation to Nutrient Workgroup	1a) March 2012
	Revised conceptual model (including analysis of scenarios) distributed as draft partial report for review by Workgroup	1b) July 2012
	Complete draft report	1c) October 2012
	Final report	1d) December 2012
Task 2:	***Quantifying External Nutrient Loads***	
	Data gathering, initial estimates, identification of data gaps, discussed in powerpoint presentation to Nutrient Workgroup	2a) June 2012
	Incorporation of new data and updated estimates, discussed in powerpoint presentation to Nutrient Workgroup	2b) November 2012
	Complete draft report	2c) February 2013
	Final report	2d) May 2013
Task 3:	***Management of Nutrient Strategy Development Activities***	
	Powerpoint presentation discussing progress and next steps	October 2012

BUDGET

The budget for this project is $110,000, which is exclusively SFEI labor.

WORKGROUP

This project will be overseen by the Nutrient Strategy Team.

4.9 Nutrient Storm Water Sampling

OVERVIEW

Over the last year, the potential for adverse effects of nutrient loads to San Francisco Bay has become a topic of increasing concern. In recent months, work has commenced to develop a nutrient strategy for the Bay (see Section 4.8). A main goal of the strategy is to develop a well-reasoned and cost-effective program to generate the scientific understanding needed to fully support nutrient management decisions. Among the key objectives outlined in the strategy is quantification of nutrient loads from main potential sources. For urban watershed runoff and riverine inputs, there are currently limited data to support developing such estimates. Developing accurate estimates for regional watershed loads to the Bay requires both acquiring empirical data from representative watersheds (for calibration/validation) and developing models to quantify loads across the region.

The small tributaries loadings strategy was first implemented in 2010 and aims to quantify concentrations and loads of priority pollutants to the Bay from watersheds during wet weather events (see detailed description Task 4.5). Study watersheds have been selected to represent the range of land use and land cover characteristics of the diverse watersheds draining to the Bay. The loads monitoring project is a multi-year effort, studying 4 watersheds for 4 storms in 2011-2012 (3 watersheds monitored by SFEI, one by consultant), and up to 2 additional watersheds in 2012-2013. Empirical data on flow and concentration will be collected and used to compute loads, and to calibrate spreadsheet models to estimate loads across the region. Although nutrients are not the main focus of this study, three nutrient parameters (nitrate, total phosphorous, dissolved orthophosphate) 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 (ammonium, total Kjeldahl nitrogen). At the October RMP *Sources, Pathways, and Loadings Workgroup* meeting there was general agreement that the current suite of analytes should be augmented to include a full set of nutrient analytes, funds permitting. Adding these nutrient analytes now, when teams are already mobilizing for the other contaminant sampling, would be a wise investment, leveraging current funds being invested in this effort.

APPLICABLE RMP MANAGEMENT QUESTIONS

1. Is there a problem or are there signs of a problem in the Bay? What future nutrient-related impairments are predicted for the Bay?

Understanding current loads to the Bay will be important for answering this question.

2. Which nutrient sources, pathways, (and transformation processes) contribute most to concern? What is the relative contribution of each loading pathway (POTW, Delta, NPS, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?

Calculating loads directly addresses the loading pathway questions by calculating external loads to the Bay using best available information.

APPROACH

Samples will be collected for additional nutrient parameters at the four watersheds being sampled during the 2011-2012 rainy season (see Section 4.5). The additional analytes to be monitored are ammonium and total Kjeldahl nitrogen. 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.

STAFF INVOLVED

The project will be led by David Senn, with additional support from Lester McKee, Alicia Gilbreath, Jen Hunt, Rachel Allen, David Gluchowski, and Don Yee.

SCHEDULE AND DELIVERABLES

The results of this study will be summarized a technical memo on all the nutrient data (including those already being measured by POC project) and will describe initial findings and make recommendations for field work in 2012-2013 and beyond.

BUDGET

The budget for this project is $29,600. Approximately $19,000 is for SFEI labor; the remaining amount is for laboratory analyses and direct costs.

WORKGROUP

This project will be overseen by the Nutrient Strategy team.

4.10 Modeling

OVERVIEW

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.

A plan for moving forward with modeling will be developed under the guidance of the Nutrient Workgroup and the Contaminant Fate Workgroup. The plan will be coordinated with BACWA and with other groups that are active in modeling water and sediment fate in the Bay.

The funding level for this study is $100,000 for 2012.

4.11 EEWG Moderate Toxicity and Benthic Assessment for Mesohaline Regions

Two study ideas for 2012 were suggested at the October Exposure and Effects workgroup meeting: understanding causes of moderate toxicity and development of a mesohaline

index for the Bay. At the October RMP planning meeting, the group recommended that funding be set aside for these study ideas and that scopes of work be developed in consultation with the work group, TRC and SC.

Moderate toxicity has been consistently observed in the Bay and the causes of this toxicity are not well understood. The workgroup recommended convening a workshop of national experts to address this issue, suggesting that a SETAC Pellston workshop might be an appropriate forum. It was suggested that approximately $50,000 be set aside for this task.

The workgroup also recommended developing a mesohaline index because there is no clear methodology to interpret the benthos data collected in mesohaline regions. It was suggested that approximately $50,000 should be set aside for this task.

Table 1 Projected 2012 Budget

Task	Labor Cost	Subcontracts and Direct Costs
Program management	$524,700	$74,800
Data management	$370,000	
RMP website	$10,000	
Information dissemination	$128,000	$24,500
Annual reporting	$127,000	$32,500
QA/QC	$30,000	
Status & Trends (S&T) Fieldwork/Archive/Logistics	$40,000	$177,500
S&T Chemistry (sediment)		$110,000
S&T Benthos	$10,000	$50,000
S&T Sediment Toxicity		$50,000
S&T Bird Egg	$20,000	$100,000
S&T Bivalve		50,000
S&T USGS Monitoring		$360,000
SS: Dioxin	$28,400	$67,200
SS: CEC Synthesis Yr 2	$15,000	
SS: CEC Strategy	$15,000	
SS: Monitoring PFCs in Bay Biota	$40,000	$47,000
SS: Updating Spreadsheet Model	$20,000	
SS: Watershed Monitoring	$157,300	$170,700
SS: EMC Development	$80,000	
SS: Followup on Sediment Hotspots	$15,000	$15,000
SS: Nutrient Strategy	$110,000	
SS: Nutrient Stormwater Monitoring	$19,300	$10,300
SS: Moderate Toxicity and Mesohaline Index	$50,000	$50,000
Set Asides (e.g., sportfish, bird eggs, and bivalves) and Contingency		$137,000
Total Budget (SC Approved)	**$1,869,650**	**$1,429,600**