Regional Monitoring Program for Water Quality in the San Francisco Estuary

2010 Program Plan

OVERVIEW OF THE 2010 PROGRAM

(At the writing of this Program Plan, the Technical Review Committee has reviewed and approved program elements; however, the Steering Committee has not yet had an opportunity to formally comment on the elements. A final Program Plan will be issued in early November that reflects the recommendation of the Steering Committee.)

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is entering its 18th year of monitoring and synthesis. As the Program matures, it is important that Program elements are periodically reviewed to assure that they are providing relevant information on the major issues of concern to the management of the Estuary. In 2009, this review was in part conducted through the development of strategy documents that articulated the priority questions to be answered and the longer-term information needs. Strategy documents have been developed for a number of topics including: small tributaries, modeling, mercury, polychlorinated biphenyls (PCBs), and dioxin. RMP Workgroups have also developed long-term plans for studies of emerging contaminants and contaminant exposure and effects. These strategy documents and workplans lay the foundation for the 2010 Program Plan.

The priority questions that are articulated in the planning documents will be answered through pilot and special studies and the Status and Trends program. The nexus of the planning documents, RMP stakeholder information needs, and the workgroup five-year plans will be outlined in the RMP Master Plan. This document will be drafted in 2009 and completed in 2010.

In 2009, the Sources Pathways and Loading Workgroup and the Small Tributary Loading Strategy (STLS) Team were very active in developing the STLS strategy and assuring that the strategy was integrated with the requirements in the Municipal Regional Stormwater Permit (MRP). The STLS identifies four key questions:

- Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
- What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
- How are the loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?
- What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries and where should management actions be implemented in the region to have the greatest impact?

In 2010, we will address these questions through monitoring of two small tributaries in Hayward (Zone 4 Line A) and San Jose (Guadalupe). Both tributaries are specifically identified as tributaries to be monitored as part of the MRP. In addition, we will continue to build our understanding of large river fluxes into the Estuary from the Delta through monitoring at the confluence of the Sacramento and San Joaquin rivers. All of these studies will be overseen by the Sources Pathways and Loading workgroup and STLS team.

In 2009, the Modeling Strategy Team and the Contaminant Fate Workgroup identified the following priority questions.

- What is the contribution of contaminated Bay margins to Bay impairment and what are the projected impacts of management actions to Bay recovery?
- What patterns of exposure are forecast for major segments of the Bay under various management scenarios?
- What are the projected impacts of management action on loads or concentrations of pollutants of concern from high-leverage small tributaries?

We will begin to address the first question through the Bay Margins conceptual model that will be completed in last quarter of 2009. In 2010, we will begin to address the second and third questions through the development of a three-dimensional model referred to as SUNTANS. This open-source model was developed by researchers at UC-Berkeley and Stanford to address circulation and sediment movement in the South Bay as part of the South Bay Salt Ponds restoration project. It represents a great opportunity to collaborate with some of the best modelers in the country. One of the first aspects that the RMP will work on in 2010 is modeling the hydrodynamics of the Bay margins. The modeling team is currently working on developing a workplan for the modeling efforts over the next five years. The Modeling Strategy Team and the Contaminant Fate Workgroup will provide technical oversight for the modeling effort.

The first strategy implemented was the Mercury Strategy and we are beginning to see significant results from the targeted studies that were designed to address the following questions:

- Where is mercury entering the food web?
- Which processes, sources, and pathways contribute disproportionately to food web accumulation?

The first question is being addressed through an expanded small fish monitoring program that commenced in 2008 and built upon a smaller pilot effort conducted under the Exposure and Effects Workgroup (2005 through 2007). This year, 2010, represents the last year of the larger three-year effort. The second question is being addressed through two two-year studies that began in 2008 and are being closely coordinated with the small fish project. The first, led by researchers at University of Michigan, is evaluating the suitability of mercury isotopes as a means for identifying sources of mercury to the aquatic food web. The second, led by researchers at Trent University in Canada, is evaluating the use of thin films to serve as proxies for biotic methylmercury uptake. The small fish project is reviewed jointly by the Exposure and Effects workgroup and the Contaminant Fate Workgroup. The remaining two projects will be reviewed by Contaminant Fate Workgroup. All three studies will be discussed at the

Contaminant Fate Workgroup meeting and the Annual Mercury Meeting which are being held on January 26th and 27th, respectively.

The RMP has observed persistent sediment toxicity in the Estuary, particularly in the wet season. In recent years, the RMP has made a number of changes to improve our ability to assess sediment quality and identify the causes of toxicity. In 2008, the Program began monitoring benthos to facilitate sediment triad assessments of the ecological health of the Bay (i.e., sediment chemistry, sediment toxicity, and benthos). In 2010, we will add back into the Program the collection of wet weather sediment samples after a hiatus of eight years. Also in 2010, we will evaluate additional tools to identify causes of toxicity. Researchers at the University of California at Berkeley and the Southern California Coastal Water Research Project will evaluate changes in the gene expression of test species as a result of exposure to contaminants (referred to as a molecular TIE). The RMP will continue to develop benthic assessment methods for the mesohaline and oligohaline portions of the Estuary as part of the SQO and to convene workshops to provide expert guidance and communicate new findings.

Understanding which emerging chemicals have the greatest potential to adversely impact beneficial uses in the Bay remains the priority question for the Emerging Contaminant workgroup. In 2010, we will address this question through the use of powerful new analytical techniques to conduct non-specific scans of contaminants in Bay Area biota. The National Institute for Standards and Technology has recently developed several screening methods to do broad screens to identify previously unknown contaminants in tissue samples. We will use these methods to evaluate bivalve and seal samples from Bay Area and reference locations to determine which previously unidentified contaminants are accumulating in Bay area food webs.

Through the RMP Status and Trends monitoring, we do know that several chemicals of emerging concern such as the perfluorinated compounds and the flame retardants are accumulating in biota. One of the key questions is whether these detected concentrations are having adverse impacts. Preliminary work by the USGS Pauxtent Research Center has shown that concentrations of polybrominated diphenyl ethers (PBDEs) in the upper range of those observed in Bay Area terns have adverse effects on the hatching success for kestrels. A pilot study evaluating effects on PBDEs on terns has been proposed for 2010 to assess the sensitivity of terns to these ubiquitous contaminants and to provide a context for interpreting the tern data collected as part of Status and Trends monitoring.

Part of the key for successfully managing the Bay is providing data and information in a timely manner. In 2009, the RMP was able to collect, format, and report the S&T data within our goal of one year. Improving our timeliness of reporting continues to remain a major goal for the Program. In addition to providing data, the RMP also sponsors meetings and workshops to provide an opportunity for regulators, managers, and the public to: learn about recent scientific advances; engage in dialogues on select technical topics; and foster collaboration and communication among different groups. In 2009, we redesigned the RMP web site and we will continue to make improvements to the site in 2010.

The success of the RMP is in part due to the active participation of RMP participants, government staff, and representatives from academia in reviewing Program elements. Through

workshops, workgroup meetings and committee meetings, these individuals help to assure that the RMP obtains high quality information on the key issues of concern to the Bay. This information is used by managers to make sound scientific decisions regarding the health of the Estuary. We look forward to continued collaborations in 2010.

TASKS

1. Program Management

The administration and management of the RMP requires a substantial effort from SFEI staff. Costs for this component of the RMP reflect the staff time required to manage finances and contracts, plan and coordinate internal activities and workgroups, and technical oversight of RMP products.

1.1 Internal Coordination

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

1.2 External Coordination

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

1.3 Contract and Financial Management

Tasks in this category include efforts related to tracking progress and expenditures on all budgeted items, including invoicing of Program Participants, tracking incoming and outgoing funds, accounting and working with the SFEI auditor, working with the Fiscal and Administration Subcommittee of the SFEI Board of Directors, providing financial status updates, and communicating with the Steering Committee on financial matters as

needed. It also includes preparation of contracts after scopes of work have been negotiated, scientific oversight of products, coordination of field and laboratory components, trouble-shooting, scheduling, and implementing course adjustments as necessary, cost-effectiveness/performance evaluations of existing contractors and identifying potential new subcontractors as needed.

1.4 Program Planning

Program planning for the RMP involves several tasks including Program Plan and workplan development, updating five-year plans, proposal writing, RFP development, and development of scopes of work, both for in-house staff and subcontractors. With procedures in place for Pilot and Special Study selection and data interpretation, we continue to place emphasis on documenting planning steps and assisting the Steering Committee and the Water Board in prioritizing information needs, and adapting the Program to evolving management priorities.

Since 2008, the RMP has focused considerable attention to develop strategies for high priority needs. Examples of these activities include the modeling strategy, the PCB strategy, mercury strategy, dioxin strategy, and small tributary loading strategy. Through the strategy team meetings, stakeholders were able to articulate key questions and to identify and prioritize fundamental monitoring and research needs to begin to answer the high priority questions. In addition, the five-year plans for each of the following four workgroups were completed: Contaminant Fate workgroup, Sources, Pathways, and Loadings workgroup, Exposure and Effects workgroup and the Emerging Contaminants workgroup. As part of this process each workgroup developed a list of prioritized questions to be answered and the work plans outlined a strategy for answering these questions.

The purpose of these five-year plans is to develop a coherent strategy to address the management questions and objectives that guide the RMP. The five-year plans will allow the RMP to prioritize research and monitoring needs, to coordinate with other research/monitoring activities that are being undertaken in the Estuary, to solicit input from experts on a longer term, and to enable long-term financial planning. A master plan for the RMP summarizing all of the workgroup five-year plans will be completed in late 2009/early 2010 that will integrate the information needs from the strategy documents, five-year plans, and the RMP stakeholders.

The workgroups will continue to be very active in 2010 reviewing and recommending pilot studies and providing technical oversight for existing pilot and special studies and Status and Trends elements. As an example, the 2010 Annual Mercury Coordination Meeting will be held jointly with a Contaminant Fate Workgroup meeting to optimize the interactions and collaborations between the two groups.

2. Information Management and Dissemination

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." Therefore, all activities related to data management, RMP web-site maintenance, development of newsletters, the RMP Annual Meeting, presentations, and information transfer to a variety of audiences, including preparation of the RMP Annual Monitoring Results and the "Pulse of the Estuary", are included in this category.

2.1 Data Management

The primary objective of this task is to manage, maintain, and improve the RMP database and to enable greater accessibility of data results. The information management and dissemination goals for 2010 are as follows (listed in order of priority):

- Upload RMP analytical results from laboratories into the new database format (the State SWAMP database format) and continue to QA/QC these data to assure they are of high caliber;
- Continue maintenance of the web-based data access tool that was developed in 2004;
- Develop tools to increase the efficiency of QA/QC review; and
- Upload select datasets from RMP Pilot & Special Studies (or other studies) into the new RMP SWAMP database.

2.2 RMP Web Site

The RMP web site has an important role in making data, technical reports, newsletters, workshops, bibliographies, Powerpoint presentations, and other documents available to stakeholders and the public. In 2009, we revamped our web-site and the web query tool to provide easier access to our data and reports. In 2010, we look forward to continued improvement of the web site.

2.3 Information Dissemination

The RMP produces newsletters, inserts, and other documents for dissemination. We will continue to take advantage of existing publications for information distribution, such as newsletters of participating agencies, the NEP newsletter, ESTUARY, and the IEP newsletter. In 2010, RMP staff will make an effort to develop factsheets on recently completed projects that may be of interest to a wider community. As appropriate, 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 which occurs in early fall.

2.4 Annual Reporting

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

2.5 Quality Assurance and Quality Control

This task includes three main elements: 1) evaluating the quality of data generated by analytical labs; 2) updating the QAPP and protocol documentation; and 3) coordinating intercomparisons and other efforts to improve the quality of RMP data. In 2008, the QA officer began revising the QAPP to incorporate revisions made to state-wide QAPPs. Two meetings were held in 2008 with the RMP organic and inorganic laboratories. This effort will continue in 2009. At present, we are envisioning two meetings with RMP subcontracting laboratories and SWAMP personnel to finish the final modifications to the QAPP.

2.6 Data Integration

In 2009, data integration tasks were included in the pilot and special study pool and were reviewed by the appropriate workgroup, TRC and SC for inclusion into the program.

3. Status and Trends Monitoring

In years past, the Status and Trends (S&T) monitoring program was composed primarily of four program elements: long-term water, sediment, and bivalve monitoring; episodic toxicity monitoring; sport fish monitoring; and the USGS hydrographic and sediment transport studies. In 2007 as part of the redesign process, the S&T monitoring program was expanded to include the following elements: triennial bird egg monitoring (cormorant and tern); annual small fish monitoring; annual small tributary loading; triennial large tributary loading; and triennial studies of the Guadalupe River.

As part of an optimization and redesign of the program, portions of the core Status and Trends program were modified in 2007. The number of water sites and the frequency of the bivalve monitoring program were both reduced. The goal of the episodic toxicity program was refined to address the question of what is causing the sediment toxicity in the Bay; the element renamed to identifying the Cause of Toxicity; and the frequency reduced to a biennial program.

The S&T monitoring program for water and sediment was last revised in 2002 to include a randomized design suited to addressing questions related to a representative characterization of contaminant concentrations in water and sediment. The bivalve bioaccumulation component of the S&T, however, does not use a randomized design but rather continues to sample 11 historical sites.

Water sampling for the S&T monitoring program occurs once a year in the summer. In 2007, the number of stations was reduced from 31 to 22. Summer has been selected for sampling because inter-annual variation due to natural variables, primarily freshwater inflow, is minimized during

this period. Based on discussions with the RWQCB, it is not necessary for the RMP to conduct wet weather water sampling in 2010 so none is planned.
In 2007, as part of the redesign process, a recommendation was made to alternate seasons in which sediment is sampled. A primary goal of the sediment sampling is to begin to understand what is causing the sediments to be toxic. In addition, there appears to be a seasonal aspect with winter sampling exhibiting higher toxicity. In 2010, we will collect wet weather samples at a reduced number of sites (i.e., 27 instead of the 47 that are collected in the dry season). As part of the 47 sites that are sampled in the summer, 27 are sediment sites in which toxicity is evaluated. The winter sampling will include these 27 sites. Sediment will be analyzed for benthos in addition to sediment chemistry and toxicity. With all three lines of evidence (i.e., benthos, sediment chemistry and sediment toxicity), it will be possible to conduct sediment assessments in accordance with the Sediment Quality Objectives (SQOs) protocols, which were promulgated in 2008.

The number of S&T monitoring stations varies by segment for water and sediment measurements based on Water Board management priorities, statistical power achieved for key contaminants, and fiscal considerations. In addition, five historical water stations and seven historical sediment stations are sampled to maintain time series for long-term trend analyses. In 2007, as part of the RMP redesign, statistical power analyses were conducted to determine the optimal number of stations to detect trends and exceedances of water quality objectives.

3.1 Water and Sediment Chemistry and Bivalve Bioaccumulation

Water Chemistry
Conventional water quality, trace metals, and trace organics sampling in water will occur during the dry season at 22 stations throughout the Estuary. Based on a recommendation from the redesign process, water samples will be analyzed for PBDEs annually and all other parameters (e.g., pesticides, PAHs, and PCBs) will be analyzed every other year (a biennial basis). In 2009, pesticides and PCBs were analyzed; in 2008, as a result of the oil spill, PAH analyses were conducted. In 2010, only PBDEs will be analyzed.

Sediment Chemistry
Sediment samples will be collected during the wet season at 27 sites (20 random sites and 7 fixed sites). The 2010 analyte list for sediment will remain unchanged from prior years.

Bivalve Bioaccumulation
The bivalve monitoring component maintains the long-term time series started by the State Mussel Watch Program in the early 1980s. Because of logistical complexities, a randomized design is not feasible. Transplanted bivalves will be deployed at nine stations, using the mussel species, *Mytilus californianus*. As has been done since 1999, resident *Corbula* will be collected from the Sacramento and San Joaquin River stations (BG20 and BG30). Based on the results of the redesign process, tissue concentrations in bivalves will be analyzed once every two years during the dry season when Estuary conditions are more consistent on an interannual basis, to meet the trend evaluation objective of this element. Bivalves will be analyzed for organics in 2010. The organics

analyte list remains unchanged from 2005. Trace element analysis has been reduced to a five-year interval and was most recently conducted in 2008.

Toxicity
Because the RMP S&T aquatic toxicity monitoring in the Estuary has shown little toxicity over the past several years, aquatic toxicity sampling has been scaled back to a screening effort approximately every five years. Aquatic toxicity sampling was not observed in the 2007 samples and therefore, aquatic toxicity will not be conducted again until 2012.

RMP S&T sediment toxicity monitoring will continue as in previous years. Sediment toxicity measurements will be made at 27 sites in the Estuary (20 randomly allocated sediment chemistry stations and seven historical RMP sampling sites). Toxicity tests will be conducted with amphipods *Eohaustorius* (a solid phase test with survival as the endpoint) and mussel larvae *Mytilus* (an elutriate test with normal larval development as the endpoint). Toxicity Identification Evaluations (TIEs) will be conducted in samples that show significant toxicity. In 2008, the TRC recommended that the Program switch from an elutriate method for the bivalve development test to the sediment-water interface method (SWIC method). The rationale for this switch was to be consistent with methods used for the Sediment Quality Objectives. This change was implemented in 2008.

3.2 Causes of Sediment Toxicity Monitoring

In 2007, the RMP began a study to determine the causes of the persistent sediment toxicity that is observed in the Bay. Since the Program began, we have consistently seen toxicity to bivalves and amphipods in the Bay. Toxicity to amphipods exhibits seasonal variation with samples collected in the winter exhibiting a much higher mortality; toxicity to bivalves is unaffected by seasons.

Effective management of factors contributing to toxicity depends on determining which specific pollutants or other factors are responsible. Stressor identification is a key element of the State Water Resources Control Board's Sediment Quality Objectives (SQOs) program for enclosed bays and estuaries. While planned SQO assessments will provide information about sediment condition in the Estuary, they are not designed to identify causes of the observed toxicity or benthic community impacts. In 2009, the following three tasks were proposed to improve our understanding of sediment toxicity: (1) provide new thresholds of effects (LC50s) for the RMP test organism *Eohautorius etuarius* for key contaminants of concern to the Estuary; (2) further develop toxicity identification evaluation (TIE) methods to identify organic contaminant stressors in sediments; and (3) develop a work group process to coordinate scientists around the state to develop and evaluate new TIE tools. Task 1is primarily being conducted by the UC-Davis Granite Canyon laboratory. This work commenced late in 2009 and will continue in 2010.

Task 2 is being addressed through a collaboration with UC-Berkeley and the Southern Californian Coastal Water Research Project to evaluate the use of gene micro-arrays to

identify toxicity. This project will examine changes in the gene expression of individual organisms (*Eohautorius etuarius*) to contaminants.

Task 3 is being conducted by the toxicity workgroup (a subcommittee of the EEWG). The toxicity workgroup will also articulate a long-term strategy for the Causes of Toxicity monitoring element.

3.3 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a triennial basis. The most recent sampling event was in 2009; this work will be written up in 2010 in collaboration with the SWAMP coastal monitoring effort that was also undertaken in 2009. Funding for the report will be provided by SWAMP.

The next triennial sampling event is scheduled for 2012. Resources for the 2012 fish tissue monitoring component will be set aside in 2010 and 2011 to lessen the budgetary impact in the 2012 monitoring year.

3.4 U. S. 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 hydrographic and sediment transport processes. An understanding of these basic processes is necessary to interpret the patterns and dynamics that are emerging from the RMP database 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.

3.4.1 Sediment Dynamics in San Francisco Bay

This work is conducted by the USGS in Sacramento. The principal investigator is Dr. David Schoellhamer.

From 1993 to 2005, this element of the RMP focused on monitoring and understanding suspended sediment dynamics in the Estuary. This work has yielded many insights into sediment and contaminant dynamics in the Estuary. In 2006, in part in response to funding cuts, the USGS reduced the number of stations from ten to six. The RMP, USGS, and the US Army Corps of Engineers convened a meeting in the summer of 2005 to discuss the optimal locations of suspended sediment stations in the Estuary. It was agreed to fund five fixed stations (i.e., Alcatraz, Mallard, Benicia, Point San Pablo, and Dumbarton) and one temporary station located near the Hamilton Army Airfield (San Pablo Bay). In 2007, the Point San Pablo site was replaced with a Richmond Bridge site as a result of the deterioration of a pier at the Point San Pablo site. The five fixed stations

provide suspended sediment information at four embayments. The temporary site at Hamilton provides the US Army Corps with information needed to evaluate the impact of the aquatic transfer station. Sediment flux measurements at the Dumbarton Bridge are currently being funded by the USGS as a result of the RMP's participation in the National Water Quality Monitoring Pilot Study.

3.4.2 Hydrography and Phytoplankton

This work is conducted by the USGS in Menlo Park. The principal investigator is Dr. Jim Cloern.

This study will continue its measurement program in support of the RMP, with monthly water sampling to map the spatial distributions and temporal trends of basic water quality parameters along the entire Bay-Delta system. Measurements will include salinity, temperature and dissolved oxygen, which influence the chemical form and solubility of some trace contaminants; suspended sediments and phytoplankton biomass, which influence the partitioning of reactive contaminants between dissolved and particulate forms. This basic information is required to follow the seasonal changes in water quality and estuarine habitat as they influence biological communities and the distribution and reactivity of trace contaminants. Highlights from this work were described by Dr. Cloern at the 2009 Annual Meeting. Hydrographic and phytoplankton sampling will be coordinated with other elements of RMP sampling.

Approximately 15,000 acres of salt ponds in the South Bay will be converted into wetlands. As part of this process, salt pond levees will be breached and water from the ponds released. Information on basic water quality parameters, such as salinity and dissolved oxygen, will be very important for understanding the impact of this wetland restoration on the Estuary.

3.5 Status and Trends Monitoring Field Work

This work element includes SFEI staff involvement in Status and Trends Monitoring on board ship and general sampling support. SFEI staff collect water and sediment samples for analysis of trace organics and trace elements and assist with bivalve retrieval operations.

3.6 Small Fish Monitoring

Small fish have been analyzed in the RMP Exposure and Effects Pilot Study since 2005. Small fish are excellent indicators of biological uptake of contaminants, particularly mercury. Small fish have high site fidelity and are prey for higher trophic level organisms such as piscivorous birds, mammals, and fish. In 2009, this element was incorporated into an annual sampling effort as part of Status and Trends.

The small fish element initiated in 2008 is planned as a three-year intensive study with this year 2010 being the last year. The goal of the project is to determine hotspots of methylmercury bioavailability by monitoring mercury concentrations in small fish. For a variety of reasons, fish are considered to be appropriate monitoring tools. Monitoring of small fish will be coordinated with the pilot study examining concentrations of PCBs in small fish (see description under pilot and special studies).

Using a randomized design, the small fish program is interested in answering the following questions: (1) What factors (i.e., site characteristics) appear to be important for causing increased mercury concentrations in Bay biota? and (2) Where are the highest mercury concentrations found in the nearshore portions of the system? Each year, 12 sites will be selected based on site characteristics such as enclosed embayments, open bay sites, wetlands with differing mercury concentrations, sites in close proximity to mercury mines, and sites near wastewater treatment facilities.

3.7 Bird Egg monitoring

As part of the redesign of Status and Trends, bird egg monitoring of cormorants and terns will be included in the RMP on a triennial basis. This work was conducted most recently in 2009 and will not be conducted again until 2012.

3.8 Tributary Loading

As part of the redesign of the S&T program in 2006/2007, the following tributary loading studies were included in the S&T program: studies of small tributary loading (annually); large tributary loading (Mallard Island studies, triennial); and Guadalupe River loading studies (triennial). The small tributary site for 2010 is a small tributary in Hayward, referred to as Zone 4. In 2010, we will also monitor Mallard and Guadalupe.

Small tributaries are a major pathway for loads of contaminants that enter the Bay each year. Present load estimates for this pathway are uncertain. Since 2007, the RMP has monitored a small tributary located in an industrialized area of Hayward (referred to as the Zone 4 project). Preliminary data from this study suggest that when the contaminant loads are normalized for area of the watershed that small industrial watersheds such as Zone 4 may provide higher concentrations of some contaminants.

Monitoring of this industrial watershed will provide valuable information on loads derived from small, low rainfall, but highly impervious, commercial and industrialized "storm drain watersheds" on the Bay margin. This is particularly important for updating regional estimates of Hg and PCBs loads derived from urban runoff. In addition, loadings studies will provide baseline data for trend analysis and input parameters for modeling efforts. A primary rationale for continued monitoring at this site is that the data collected to date has been for below-average rainfall years.

The Guadalupe River was monitored intensively for a four-year period beginning in WY 2003 through 2006. As part of the redesign, Guadalupe River was scheduled to be sampled triennially commencing in 2011; however, funding external to the RMP was obtained to monitor Guadalupe River for mercury in 2010. The TRC and SC recommended that the RMP augment this existing work by providing funding for the analysis of polychlorinated biphenyls. In addition, as a result of the dioxin strategy, the Guadalupe River will also be monitored for dioxin (see description in pilot and special studies section).

Two locations will be monitored at Guadalupe; an upstream site (Foxworthy Bridge) and downstream site (Highway 101). With the addition of the upstream site this year, we will be able to characterize the contribution of urban sources to the mercury, PCB, and dioxin load which we were unable to do previously. In addition, data from this year will be useful in the development of the Guadalupe model and in ascertaining whether there are trends.

Sampling at the confluence of the Sacramento and San Joaquin Rivers at the Mallard Island station occurred in WY 2002 through 2004 with limited first flush sampling in 2005 and 2006. Sampling occurs at Mallard Island when the flow exceeds 40,000 cubic feet per second (cfs). The 2006 sampling occurred using contingency funding to sample the extremely large flow event (greater than 370,000 cfs) when water was diverted through the Yolo Bypass. We have very limited information on high flow events and are hoping that 2010 will provide us with another opportunity to sample a large storm event.

In 2010, water samples from the Mallard Island station will be monitored for mercury, PCBs, and dioxin (as part of the dioxin pilot study, see description below). In addition to total mercury, this year will be the first year samples will be analyzed for methylmercury. Sampling at Mallard Island this year will provide important information on trends and loads.

4. Pilot and Special Studies

At the writing of this Program Plan, the workgroups and the Technical Review Committee have recommended approval of the studies described below; however, the Steering Committee will meet on October 26th to discuss these studies and make the final recommendation. This document will be revised after the meeting to reflect the recommendations made by the Steering Committee.

In addition, at the last Technical Review Committee meeting, it was requested that RMP staff develop a strategy for assessing atmospheric loads to the Estuary. Interest in atmospheric loads is driven by recent studies that suggest atmospheric loads of some contaminants such as mercury can be significant. Because it is difficult to accurately measure atmospheric deposition, the Committee recommended that a strategy be developed that articulates which contaminants should be included and how the loading will be measured. At present, $10,000 has been set aside in 2010 to develop this document.

4.1 Development of Polybrominated Dipheny Ether Toxicity Thresholds in Common Terns

San Francisco Bay is critical habitat for many birds including several rare and endangered species such as the Least Tern. Some of the highest polybrominanted diphenyl ether (PBDEs) concentrations identified to date have been measured in Bay Area terns. At present, we have very little information to determine whether these concentrations are causing significant effects. Recent research by the USGS Patuxent Wildlife Research Center suggests that significant effects on the hatching success of American Kestrels can occur at concentrations as low as 1.8 ug/g (wet weight). In contrast, mallards were relatively insensitive to exposure to PBDEs. A number of uncertainties exist with these studies as they are egg injection studies where contaminant is injected into the egg rather than a maternally-derived exposure. Nonetheless, maximum concentration in tern eggs from the Lower San Francisco Bay are in the range of this effect level.

This egg injection study will develop thresholds for hatching, pipping and survival for the east coast common tern, a surrogate for the San Francisco Bay area Least, Caspian and Forster's terns.

The funding for this project is $48,500.

4.2 SQO Assessments for the San Francisco Estuary

In 2009, the State of California adopted Sediment Quality Objectives that incorporate multiple lines of evidence to assess the health of the Estuary's sediment (i.e., sediment chemistry, sediment toxicity and benthos). At that same time, the RMP began monitoring benthos assuring that the RMP was providing all three lines of evidence to assess the sediment quality of the Estuary.

Although SQO for bays and estuaries has been adopted, staff from the RMP, SCCWRP, the State Water Resources Control Board, Regional Water Quality Control Board, the USGS, and Department of Water Resources have been meeting to determine how additional SQO assessments will be conducted. The RMP has convened a number of benthic workshops to discuss the development of benthic indices for the oligohaline (freshwater) and mesohaline (moderately saline) portions of the Estuary.

In 2010, we will complete the mesohaline index for the Estuary and develop a chemical score index for San Francisco Bay (a correlation between chemistry and benthos). At present, the chemical score index has been developed for Southern California and it has a poor correlation for San Francisco Bay.

The funding for this project is $30,000.

4.3 Scoping Needs for Land-use Specific Monitoring

A critical need for prioritizing watersheds to monitor and model is an evaluation of land use characteristics that influence stormwater loads to the Estuary. Eight land use types have been identified as important for Southern California; however, the geology, contaminants of concern, and land use for the San Francisco Bay region are sufficiently different that it is not possible to use this classification system for our watershed.

This project will develop land use classifications (e.g., urban, open space, industrial, etc.) for the Bay area. In addition to land use, consideration of age and condition of the development (e.g., cracked pavement, poorly maintained facilities, gravel or dirt roads, etc.) will be included in the assessment. The project will identify the highest priority land use types to be monitored in the future.

The funding for this project is $30,000.

4.4 Develop and Update Spreadsheet Model

One of the priority questions for the Small Tributary Loading Strategy and the Municipal Regional Stormwater Permit is:

- What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?

This project will begin to answer this question by using a model to estimate the mass loadings from Bay Area watersheds. A simple spreadsheet model will be developed using information on such factors as rainfall, land use, and soil type. Because the model assumes that unit area runoff values remain constant for homogenous sub-catchments, the data needs for model are relatively easy to obtain. The model will help evaluate which watersheds are priority watersheds to monitor and to model. It is anticipated that the model will be updated annually to reflect changes in our understanding.

The funding for this project is $35,000.

4.5 Reconnaissance of Representative Watersheds Sites

The Small Tributary Loading Strategy (STLS) team is currently stratifying watersheds in broad categories in which one or two of the watersheds could be sampled to categorize the loads from the watersheds. Once this list is developed and prioritized, it will be important to assess the watersheds to determine how logistically feasible it is to sample the tributaries (e.g., channel form, access, lighting, safety, etc.)

The funding for this project is $12,000.

4.6 Development of a 3-D Model of South Bay

A high priority for the modeling strategy and the Contaminant Fate workgroup is the development of a numerical flexible grid model of the Estuary. The RMP has a unique opportunity to build off of the substantial efforts that are underway to model the hydrology of the South Bay as part of the South Bay Salt Ponds restoration activities. Researchers from the University of California – Berkeley and Stanford University have developed a three-dimensional model of the South Bay (referred to as SUNTANS). This project would further develop the model to include tributaries and Bay margins.

The modeling strategy team is currently developing a workplan for this project that will be reviewed by the team, the CFWG, TRC, and SC.

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

4.7 Development of a Conceptual Model for Bioaccumulation

The Estuary is listed as impaired for many contaminants as a result of elevated concentrations observed in biota. As such, being able to model the impact of contaminants on biota is critical to successfully managing the Bay. Contaminant uptake into the food web is often the last component to be considered when developing large-scale models of Bay. Because the scale of the model will be governed in part by the biological processes we are interested in, it is important that we consider biology early on as we develop our models. For example, the scale of the biological process may influence the spatial or temporal resolution of the model: different spatial and temporal resolution will be needed for tidal mixing of phytoplankton within the Bay versus the migration of salmon through the Bay.

This project will develop a conceptual model of contaminant uptake by biota. The model will emphasize the roles of sediment and biota movement, drivers of spatial and temporal variation in contaminant exposure, variability in food web uptake, and attributes of local organisms (e.g., lipid and body size).

The funding level for this study is $40,600.

4.8 PCBs in Small Fish

As demonstrated through the fish mercury project described above, small fish are an ideal indicator of short term uptake of contaminants into the food web. Small fish integrate contaminant exposure over a one-year period and have high site fidelity. In 2010, we will begin our last year of a three-year intensive monitoring of small fish for mercury. This sampling exercise presents a unique opportunity to augment the analyses of these small fish for PCBs. Although the RMP routinely monitors sportfish for organics

including PCBs (every three years), very little contaminant information is available for prey fish.

A small number of small fish were analyzed as part of an RMP pilot study in 2007 (six composite samples) and surprisingly high concentrations of PCBs were observed in these fish (198 ng/g well above the TMDL target of 10 ng/g). These concentrations were on par with concentrations that we have observed in much higher level trophic fish.

This project would provide funding for analyzing PCBs in small fish that will collected at 42 sites as part of the small fish mercury project.

The funding level for this study is $50,000.

4.9 Screening San Francisco Biota for Anthropogenic Pollutants

Significant advances in analytical instrument techniques present a great opportunity for the RMP to conduct broad non-targeted scans of San Francisco Bay biota to potentially identify chemicals of emerging concern. Recent advancement in GC-GC time of flight and GC-LC time of flight at the National Institute for Standards and Technology (NIST) has allowed NIST to screen human samples to determine which contaminants are accumulating in humans. NIST will apply a similar broad scan approach to San Francisco Estuary samples to identify previously unmonitored anthropogenic chemicals. While labor intensive, this approach has the potential to direct our monitoring efforts to the chemicals that are accumulating in biota, rather than conducting extensive and expensive monitoring of biota without an indication that the contaminants are bioaccumulating.

Because different organisms have different potentials to bioaccumulate and to metabolize contaminants, we will collect pooled samples of bivalves as part of the RMP 2010 bivalve monitoring effort and pooled harbor seal samples as part of our collaborations with The Marine Mammal Center and Environment Canada. In addition, because contaminants have different physical and chemical properties, they will different affinities for lipids, blood, and tissue. As a result, all three matrices will be analyzed for in seals.

This is a two-year project. The funding for the first year is $55,000.

4.10 Monitoring Tributaries for Dioxin

The San Francisco Bay was listed in 1998 as an impaired water body for dioxin as a result of elevated fish dioxin concentrations. Based on the most recent sampling of sportfish in 2006, dioxin concentrations have remained unchanged. Relatively little information exists characterizing the sources, pathways and loadings of dioxin. One of the most significant areas of uncertainty is the load from the tributaries. In the Dioxin

Conceptual Model/ Impairment Assessment the highest load by a factor of five is storm water from tributaries, but this was based on monitoring of a single storm event.

2010 presents a unique opportunity to sample two major tributaries to the Estuary, the San Joaquin/Sacramento River and the Guadalupe River, for dioxin. Whole water samples will be collected for dioxin analysis during four storm events per year. 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 the Central Valley watershed and small tributaries that receive primarily urban runoff.

The funding level for this study is $68,000.