

Regional Monitoring Program for Water Quality in the San Francisco Estuary

2009 Program Plan

OVERVIEW OF THE 2009 PROGRAM

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is entering its 17th 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 2008, this review was in part conducted through the completion of five-year plans for workgroups and the development of strategies on select topics of concern. In 2009, a five-year master program plan will be written that integrates the workgroup priorities as articulated through the five-year plans, strategy documents developed for high priority pollutants and topics, and the stated needs of Program participants.

In 2008, strategy teams of interested RMP participants, regulators and scientists were convened to develop lists of priority questions and means for answering these questions. The RMP completed strategies for mercury and dioxin, and made significant progress on developing strategies for small tributary loads and modeling. These strategy documents have laid the foundation for the 2009 Program Plan.

The Mercury Strategy places a priority on answering the following two questions in the next few years:

- 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 through the Exposure and Effects workgroup (2005 through 2007). The second question is being addressed through two two-year studies that began last year 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.

Other priorities for the Contaminant Fate workgroup include understanding contaminant depth profiles in the Bay. The results of the analysis of the sediment coring project, available in 2009,

will be important in forecasting future loads to the Bay. These findings and the Mercury Strategy projects will be a major focus of the annual Mercury Meeting which will be held in early February.

Understanding watershed loads to the Estuary, particularly from small tributaries, will continue to be an important part of the 2009 Program. The Small Tributary Loading Strategy that is currently in development will articulate the important loading information needs and prioritize studies to fill these data gaps. Based on the discussions to date, a priority will be classifying watersheds into categories that can be targeted for monitoring and modeling purposes. The Hayward study (Zone 4 Line A) is monitoring loads from a small highly urbanized watershed; characterizing loads from this common type of watershed is important. Depending on the outcome of the Strategy, the Hayward study may be augmented with additional monitoring at other priority watersheds. Another important part of the Strategy will be the development of models to further our understanding of the potential impacts of management actions. In 2009, we will continue the development of a model of the Guadalupe watershed that synthesizes existing information on sediment, water and biota.

A dioxin strategy has been developed that outlines the important information gaps in our understanding of dioxin loads and reservoirs. At present, there are very few data available to characterize the reservoir of dioxin, the spatial and temporal patterns of dioxin, and the relative contributions of sources of dioxin. Some of the largest uncertainties are associated with watershed loads and atmospheric deposition. In 2009, there will be a major effort to collect dioxin data by augmenting existing elements. Dioxin will be added as an analyte to the following elements: the 2009 annual Status and Trends sediment and water sampling; the triennial sport fish sampling; and the Hayward small tributary study. In 2009, an estimate of dioxin loading from direct atmospheric deposition will be modeled using ambient air data and known physico-chemical parameters for dioxins.

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 sediment benthos). The RMP has observed persistent sediment toxicity; a focus for 2009 will be understanding the causes of this sediment toxicity. Work to be performed in 2009 will include sediment triad assessments conducted as part of Status and Trends, benthic workshops to develop consensus on how to interpret benthic assessments, and the causes of toxicity element.

Understanding which chemicals to focus on remains an important issue for the Program. Through the Emerging Contaminant workgroup (ECWG), the RMP is developing a white paper to evaluate which chemicals are of concern from wastewater treatment facilities. Based on the continued presence of elevated levels of perfluorinated compounds in apex predators, the ECWG will evaluate sources of these compounds to the Estuary.

Part of the key for successfully managing the Bay is providing data and information in a timely manner. In 2008, 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, in an effort to increase our information dissemination activities, we will be redesigning the RMP web site.

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 2009.

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 external workgroup, 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 work groups 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.

In 2008, the RMP focused considerable attention to develop strategies for high priority needs. Examples of these activities include the 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, in 2008, the five-year plans for each of the following four workgroups were largely 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. In 2009, a master plan for the RMP summarizing all of the workgroup five-year plans will be prepared.

The workgroups will be very active in 2009 reviewing and recommending pilot studies and providing technical oversight for existing pilot and special studies and Status and Trends elements. As an example, the 2009 Annual Mercury coordination meeting will be held jointly with the Contaminant Fate workgroup 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 2009 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. As presented in the 2008 Annual Meeting, we are looking towards new ways of presenting our data and facilitating access to our reports.

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. As appropriate, fact sheets, briefing papers, and 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

This category provides resources for staff activities that focus on integration of data from the RMP and non-RMP studies of contaminants in the Bay, and on synthesis of all of this information in evaluations of past trends, present status, and projected future trends. Other sources of information on Bay contamination include USGS studies, SWAMP, CALFED, EMAP, and NOAA’s Status and Trends Program. Data integration plans are currently still in development, in consultation with the workgroups and the TRC.

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. The RWQCB is reviewing its needs for seasonal sampling (i.e., wet weather sampling); for 2009, no wet weather water sampling 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 2008, sediment will be collected in summer as in prior years; in 2009, it was envisioned that the program would begin sampling in alternate years in the winter. However, pending discussions with Dr. Don Stevens who has developed the statistical design for the program, it is possible that wet weather sampling will be deferred to 2010. It was also recommended by the Exposure and Effects workgroup that sediment 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). An exception was made to this in 2008 as a result of the oil spill. Water samples were analyzed for PAHs to determine whether there were residual effects of the spill. The data will be reviewed in the winter of 2008/2009 and, assuming no identifiable impacts from the oil spill, the analysis of PAHs will be deferred and only PBDEs, pesticides and PCBs analyzed in 2009.

Sediment Chemistry

Sediment samples will be collected during the dry season. Assuming that wet weather sampling is deferred, sediment chemistry will be analyzed at 40 random sites and seven fixed sites (dry weather sampling). The 2009 analyte list for sediment will remain unchanged from 2008.

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 *Corbicula* 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 were analyzed for organics and inorganics in 2008. No collection will occur in 2009. 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 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 remains unaffected by seasons.

In 2007, the RMP began a study to identify toxic sediments and to elucidate the underlying causes of toxicity. A goal of this study was to develop better methods to assess toxicity to amphipods. Based on a review of historical data and reports, twelve sites were recommended as being sufficiently contaminated to elicit a toxic response. Of the 14 samples collected from the 12 sites, only one site (Mission Creek) was identified as sufficiently toxic to perform a toxicity identification evaluation (TIE) test. The results

of the TIE suggested the toxicity was caused by a mixture of contaminants. The reasons for the lack of toxicity at 11 of 12 of these contaminated sites is not clear; however, it does suggest the variable and sometimes potentially ephemeral nature of toxicity. A draft report has been prepared and will be reviewed in early November by the workgroup. At that time, the work for 2009 will be articulated.

3.3 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a triennial basis. The next sampling event is scheduled for 2009. In preparation for this event, the RMP Fish Committee will convene in early November to determine the study design. It is anticipated that popular sport fish species, including striped bass, white croaker, and halibut will be analyzed for mercury, PCBs, organochlorine pesticides, PBDEs, and dioxins. Resources for the 2009 fish tissue monitoring component were set aside in 2007 and 2008 to lessen the budgetary impact in the 2006 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). The five fixed stations will 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. There was discussion in 2006 that it would be useful to conduct sediment flux calculations at the

Dumbarton Bridge site in lieu of sampling at Alcatraz; however, the dredging community is particularly interested in the results from Alcatraz.

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. In addition, at the writing of this report, it is not clear whether the temporary station will remain at the Hamilton Army Airfield or whether these funds may be reallocated.

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 in the 2006 Pulse of the Estuary. 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 samples for analysis of trace organics and trace elements and assist with sediment collection and 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 cormorants, harbor seals, and fish. In 2008, this element was funded by the Exposure and Effects Pilot Study; in 2009, this will be 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. The goal of the project is to determine hotspots of methylmercury bioavailability by monitoring mercury concentrations in small fish and sediments. For a variety of reasons, fish and sediments are considered to be appropriate monitoring tools. Monitoring will also be performed on Hg isotopes in fish and with Diffusive Gradient in Thinfilm (DGT) Devices, in coordination with this program. These elements are discussed under the Special Study section.

Using a randomized design, the small fish program is interesting 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. Initially this was scheduled to begin in 2008; however, a collection permit for tern eggs was deferred to 2009 and insufficient eggs were collected from cormorant nests in 2008. After payment for collection efforts, the remaining funds allocated to this element were transferred to 2009. Substantial monitoring of eggs was conducted through EEPS pilot studies.

Cormorants

Cormorants are excellent indicators long-term trends and regional spatial patterns of contaminants in open waters of the Bay. Cormorant eggs have been sampled at three locations (Wheeler Island, Richmond Bridge, and Don Edwards) in 2002, 2004, and 2006 as part of the EEPS. As part of the redesign process, it was recommended to collect three composites of seven eggs (previously the RMP collected two composites of ten eggs) at each of the three stations on a triennial basis. The eggs will be analyzed for mercury, selenium, PBDEs, perfluorinated compounds, PCBs, and pesticides. The dioxin strategy team in late 2008 recommended omitting analysis of dioxins in bird eggs in 2009, but resuming this in 2012.

Terns

Terns are valuable indicators of long-term trends and regional spatial patterns in contaminants in the shallow margins of the Bay. As part of the EEPS program, terns eggs were collected in 2002 and 2003 and analyzed for mercury. Terns have also been very extensively studied by USGS in work funded by CALFED. The results of these studies suggest that terns are at an elevated risk. The sampling plan for terns is to collect three composites of seven eggs at six locations on a triennial basis. The precise locations will be selected based on tern nesting in 2009. The eggs will be analyzed for mercury, selenium, and PBDEs.

3.8 Tributary Loading

As part of the redesign of the S&T program in 2006/2007, it was decided to include the following tributary loading studies in the S&T program: studies of small tributary loading (annual); large tributary loading (Mallard Island studies, triennial); and Guadalupe river loading studies (triennial).

Small tributaries form a major pathway for loads of contaminants that enter the Bay each year. Present load estimates for this pathway are uncertain. In 2007, the RMP conducted a special study of 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. For example, total concentrations of mercury were statistically higher for the Guadalupe watershed; however, the Hayward watershed provided statistically higher concentrations of methyl mercury.

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 TMDL 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.

4. Pilot and Special Studies

The Exposure and Effects Pilot Study was initiated in 2002 to understand the biological effects of the chemical contamination observed in the Estuary. This pilot study completed its last year of earmarked funding (at level of \$200,000 per year) in 2008. No pilot studies are scheduled for 2009.

At the writing of this Program plan, the small tributary loading strategy team is preparing a list of priority questions and needed monitoring studies to answer these questions. Approximately \$100,000 has been allocated for this activity. It is anticipated that the small tributary loading strategy will be completed in November. In early December, the Sources Pathways and Loading workgroup will meet to review and approve this plan.

A dioxin strategy team was convened in September to discuss information gaps. At that time, a dioxin strategy plan was prepared including priority questions and a five-year plan. In 2008, approximately \$121,000 was approved by the TRC and SC for dioxin studies. The strategy team recommended that \$114,000 to be allocated in 2008 for dioxin analyses of surface sediment samples from the 2008 RMP S&T collection effort and for dioxin analyses of the 2006 sediment cores. In 2009, approximately \$178,000 was allocated to fund analysis of sport fish, surface sediment, surface water, small tributaries, and atmospheric sampling. Approximately \$20,000 of

the \$178,000 will be paid by the Bay Area Clean Water Agencies (BACWA); it is anticipated that this funding will be used for developing laboratory QA/QC protocols and intercomparisons.

In addition to the \$178,000 for dioxin and \$100,000 for small tributaries, the TRC and SC have recommended that approximately \$360,000 of special studies be approved for 2009. These studies are discussed in more detail below.

4.1 Year 2: Guadalupe River Watershed Model

High levels of PCBs and mercury have been detected in the Guadalupe River. The RWQCB, SFEI and other agencies have developed an extensive database of concentrations of contaminants in water, sediment, and fish tissues in the Guadalupe River watershed. In part based on these data, the Guadalupe River Watershed TMDL identifies fish mercury targets, bed and suspended sediment targets for runoff from mining areas, and load allocations from urban areas. The Bay Hg TMDL calls for Guadalupe River watershed load reductions of 98% and the Bay PCB TMDL calls for load reductions of >95% for urban areas. In response, managers in the Guadalupe River have already started implementing management actions to mitigate contaminant effects including experimenting with aeration in the reservoirs to reduce mercury methylation and removal of contaminated sediment from drainage lines.

The aim of this project is to begin the development of a numeric model to assist in estimating mass loads of mercury and PCBs; to extrapolate the data to determine long-term average loads for the period of extensive rainfall data collection (1973-present); and to determine the proportional sources in the watershed and refine the assumptions of the Guadalupe River Hg TMDL. Ultimately the model will be used to assess the effects of best management practices and impacts of wetland restoration (e.g., effects of South Bay Salt Pond restoration).

This multi-year project began in 2008. In 2008, a model was developed based on land use maps, precipitation, topography, and runoff. In 2009 information on sediment and contaminants will be incorporated into the model (this was not accomplished in 2008). In year two, continued testing of the model will occur and the model will be updated to include sediment transport. A draft report of the model will be prepared and distributed for review.

The funding for year 2 is \$75,000.

4.2 Small Tributary Loading Study

The Small Tributary Loading Strategy team is currently developing a list of priority questions and monitoring needs. It is anticipated that a small tributary loading study will be developed upon completion of the strategy.

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

4.3 Continued Development of Mercury Toxicity Thresholds for Egg Hatchability in Forster's Terns

The RMP has partnered with the USGS to conduct a number of studies of the effects of mercury on terns. In 2009, the RMP will work with USGS to collect tern eggs as part of the Status and Trends bird egg monitoring element. To evaluate the RMP S&T bird egg data, it will be valuable to have egg toxicity thresholds. To date, mercury effect thresholds for wild birds in the Bay area do not exist.

The goal of this project is to develop egg thresholds for mercury. The USGS has developed a method in which a small amount of the individual egg albumen is sampled for mercury using micro-techniques. The amount of albumen is so small that the egg remains viable. The egg is then tracked to determine the success of the hatch and chick. USGS began this technique in 2007 and will build upon the information collected to date. USGS will donate in-kind services to complete this project. The RMP contribution is \$54,000.

4.4 Year 2: Impacts of PAH-contaminated Sediment on Early Life History Stages of Benthic Fish

This is the second year of funding for a two-year project evaluating the effects of PAH-contaminated sediments on the development of juvenile flatfish. The impacts of pyrogenic PAHs (like those detected in San Francisco Bay) on juvenile flatfish development are largely unknown. In the first year, the effects of pyrogenic (higher molecular weight) PAHs on a model fish such as zebra fish are being determined. An update on the first year activities will be presented at the November Exposure and Effects workgroup meeting.

After the identification of biological endpoints with a model fish species, in the second year, the study will examine a native species. In addition, environmental sediment samples with a PAH signature similar to San Francisco Bay will be used.

The funding for this project is \$51,000.

4.5 Year 2: Mercury Strategy Special Studies

In early 2008, the RMP formed a mercury strategy team to identify priority questions and studies to address these key questions. The mercury strategy team issued a Request for Proposals to address the first two key questions:

- Q1 Where is mercury entering the food web?
- Q2 Which processes, sources, and pathways contribute disproportionately to food web accumulation?

Of the number of meritorious proposals received, two were selected: a study of the use of mercury isotopes to identify potential sources and the use of diffusive gradient in thin films (DGTs) to assess uptake of methylmercury into the foodweb.

Use of Mercury Isotopes to Determine Sources

The University of Michigan group led by Dr. Joel Blum is evaluating whether mercury isotopes can be used to identify sources of mercury to the aquatic foodweb. Working in conjunction with the diffusive gradient in thin film project discussed below and the small fish mercury project, these researchers will collect sediment, water, small fish and atmospheric samples from a number of Bay Area locations to ascertain whether certain sources are contributing more to the uptake of methylmercury in biota. Preliminary results from year one will be presented at the Annual Mercury meeting in February of 2009.

The funding for this project in 2009 is \$58,000.

Use of Diffusive Gradient in Thin Films (DGTs) to Determine Sources of Bioavailable Methylmercury

The Trent University group led by Dr. Holger Hintelmann is working in conjunction with the University of Michigan group and the RMP small fish project to assess the uptake of methylmercury using diffusive gradient in thin films (DGTs). This study will also assess whether DGTs can be used as a proxy for biosentinels such as small fish. Preliminary results from year one will be presented at the Annual Mercury meeting in February of 2009.

The funding for this project in 2009 is \$40,000.

4.6 Identification of Sources of Perfluorinated Compounds to San Francisco Bay

The preliminary results of the RMP pilot study evaluating perfluorinated compounds in Pacific Harbor Seals indicates that concentrations of these compounds are an order of magnitude higher in San Francisco Bay seals than those seals sampled at the reference site (Tomales Bay approximately 45 miles to the north of San Francisco Bay). This study will provide data on several of the pathways to the Bay in attempt to understand what are the causes of significant concentrations observed in San Francisco Bay biota.

San Francisco Bay and small fish will be sampled to determine the reservoir of perfluorinated compounds in the Bay and concentrations in prey animals, respectively. In addition, small fish have high site fidelity and may indicate potential source areas. Wastewater treatment facilities will be sampled as they are believed to be a potentially significant source to surface waters. Lastly, this study will collaborate with the tributary loading studies to collect information on tributary loads.

The funding level for this study in 2009 is \$52,000.

4.7 White Paper on Contaminants of Concern in Wastewater Effluent

This special study will evaluate emerging contaminants from wastewater treatment facilities (e.g., pharmaceuticals, personal care products, nano-particles, and alkylphenol ethoxylates) to determine which compounds may, or may not, pose a concern for the Bay. This study will review the literature to obtain ranges of concentrations likely to be observed in effluents and evaluate these data in the context of literature values and effects thresholds. The white paper will then prioritize these contaminants and make recommendations for future monitoring projects. The scope of this project will be further refined at the October Emerging Contaminants workgroup meeting.

The funding level for this study in 2009 is \$40,000.