

Regional Monitoring Program for Water Quality in the San Francisco Estuary

2007 Program Plan

OVERVIEW OF THE 2007 PROGRAM

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is entering its 15th year of monitoring and synthesis. As the Program matures, it is important that Program elements are periodically evaluated to assure that they are answering the important questions in a cost-effective manner. Some of the Program elements are evaluated annually, such as the Pilot Studies and Special Studies (PS/SSs); others, such as elements included in Status and Trends (S&T) monitoring, are not. In 2006, the RMP embarked on a process to begin evaluating S&T using the recently revised RMP Objectives and Management Questions (see the Pulse of the Estuary 2005).

It is timely to conduct this evaluation for several reasons. First, the focus of the San Francisco Regional Water Quality Control Board (RWQCB) has changed from the water to the impacts contaminants are having on biota. An example of this change in focus is the Mercury Total Maximum Daily Load (TMDL) released in August 2006 (RWQCB 2006). The four-day marine mercury water quality objective was vacated and replaced with two numeric mercury objectives for fish (i.e., a 0.2 mg/kg objective for sport fish to protect human health and a 0.03 mg/kg objective for small fish to protect piscivorous fish and wildlife). In addition, the RWQCB has identified bird-eggs as a mercury monitoring target.

Second, several large projects that will dramatically alter the Bay are being undertaken. In 2005, the South Bay Salt Pond Restoration project began restoring 16,500 acres of salt ponds to tidal wetlands; this is the largest wetland restoration project on the west coast. At the same time, the Long Term Management Strategy for the Placement of Dredged Materials in the San Francisco Bay Region (LTMS) is reducing the amount of disposal of sediment in Bay. The long-term goal is to reduce the amount of in-Bay disposal from 3 million cubic yards per year to 1.2 million cubic yards.

Third, our scientific understanding of the Bay and Bay processes has changed significantly since the inception of the Program. A dramatic example of this change is the appearance of a fall phytoplankton bloom, a much larger spring bloom, and a significant increase in the baseline of phytoplankton abundance as described by Dr. Cloern in the 2006 Pulse of the Estuary. Lastly, we have completed several pilot and special studies which are ready to be incorporated into S&T.

The RMP has already begun to address some of the questions associated with these changes through PS/SSs. The Exposure and Effects Pilot Study has been instrumental in addressing the changing regulatory focus to biota and in monitoring the impact of large-scale

management actions on biota. In 2007, EEPS will continue studies of small fish¹, benthos, avian exposure and effects, and fish effects. We will continue with the third year of monitoring mercury in small benthic and pelagic fish throughout the Bay. The preliminary data from 2005 has shown that there are dramatic spatial and species differences in mercury concentrations in small fish. This project has been tremendously successful in collaborating with other programs such as the Interagency Ecological Program, the CalFed Fish Mercury Project and the South Bay Salt Pond Restoration Project.

In 2007, the EEPS benthos study will evaluate effects thresholds for benthic organisms and determine the impact of gradients. It is anticipated that this work will be conducted in conjunction with the Episodic Toxicity element. These projects will help to identify the persistent causes of toxicity to the Bay and the potential impacts to benthic communities. At the writing of this plan, the EEPS studies for avian and fish exposures and effects have not been fully delineated. It is envisioned that the program will include a study of mercury and food web dynamics in clapper rails and continuing investigation of pollutant effects in fish, either through further study of the impact of contaminants on shiner surfperch or of endocrine disruptors in fish.

Understanding the stressors that are causing biological effects is important to developing actions to mitigate the impact. In 2006, the RMP established a new work group to evaluate emerging contaminants and identify those compounds that are important to monitor in the Bay. The work group developed a preliminary list and recommended funding two studies in 2007: an evaluation of pharmaceutical compounds in wastewater influent and effluent and the Bay, and a study of concentrations of perfluorinated compounds and fire retardants in apex predators, Pacific harbor seals, in the Bay. The emerging contaminant workgroup will meet early in 2007 to review these studies and to further develop a strategy for monitoring emerging contaminants in the Bay.

The RMP is expanding the measurement of watershed loadings to the Bay. To date, the RMP has developed a good understanding of loads from the largest source of freshwater to the Bay, the San Joaquin and Sacramento Rivers. Urban runoff is a primary source of pollutants to the Bay and characterizing loads from small urban tributaries is critical to the understanding of the magnitude of this input. The RMP, in collaboration with the Clean Estuary Partnership and the Santa Clara Valley Water District, has collected loading data for the Guadalupe River under normal flow conditions but not under high flow conditions. As part of a long-term strategy for continuing to track inputs from this important pathway, the TRC has tentatively approved contingency funding for analyses should high flow conditions occur in the winter 2006/2007. The Guadalupe River, due in part to its proximity to the New Almaden mercury mining district, is likely not generally representative of small tributaries to the Bay. In 2007, the RMP will begin to characterize a second small tributary that is located in an industrialized area of Hayward to further our understanding of loads from urban runoff.

Part of the key for successfully managing the Bay is providing data and information in a timely manner. In 2006, the RMP was able to collect, format, and report the S&T data within one year – a major milestone for the program. This will continue to be a goal for 2007. In

¹ EEPS funded the small fish project for 2005, 2006, and 2008. In 2007, this monitoring program is funded through the general pool of pilot studies and special studies.

addition to providing data in a timely manner, the RMP also sponsored several 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 2006, workshops were sponsored on mercury, polynuclear aromatic hydrocarbons, benthos, and pyrethroids. In 2007, we will continue to sponsor workshops on key issues, possibly including cyanide, selenium, or the effect of dredged material disposal on fish populations.

In 2007, we will continue the process of optimizing the S&T program. It will be a challenge to balance the long-term information needs with the shorter-term need for focused studies, and to answer the many management questions articulated for the RMP within the existing budget. Through a team effort of the RMP committees and workgroups we will develop a refined Program that makes optimal use of the funds allocated for monitoring water quality in San Francisco Bay.

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 2006, the RMP convened a number of workshops on issues relevant to regulators, RMP participants, and the scientific community in an effort to disseminate

information to those who are making management decisions about the Bay and to identify areas in which additional work is needed. In 2006, workshop topics included: PAHs, benthos, pyrethroids, and the annual mercury conference. It is anticipated in 2007 that the RMP will continue to convene workshops on select topics. In addition to the activities described above, RMP staff is frequently asked to present guest lectures at universities and national 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 all 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 Project Plan development, updating the five-year plan, 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 will continue to place emphasis on documenting planning steps and assisting the Steering Committee and the Regional Board in prioritizing information needs, and adapting the Program to evolving management priorities.

In 2005, we began a process of developing five-year plans for each of the work groups (i.e., Sources, Pathways, and Loading Workgroup; the Contaminant Fate Workgroup; and the Exposure and Effects Pilot Study Workgroup). 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 2007, these plans will be revised to reflect new findings and new research priorities. In 2006, the RMP embarked on a process to redesign the Status and Trends program. As part of this evaluation process, recommendations from the work groups and work plans will be included in the evaluation of Status and Trends. It is anticipated that upon completion of the redesign process, a five-year work plan for all of the RMP will be prepared.

2. Information Management and Dissemination

To meet the RMP Objective 6: “Effectively communicate information from a range of sources to present a more complete picture of the sources, distribution, fate, and effects of contaminants in the Estuary ecosystem”, 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 2007 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 is assuming an ever-increasing role in making data, technical reports, newsletters, workshops, bibliographies, Powerpoint presentations, and other documents available to the public. We will continue the process of improving the website in 2007. The tasks to be conducted include: 1) posting agendas, minutes, and attachments from all workgroups and RMP committees on the web for easy access; 2) posting the RMP Annual Monitoring Results, which is distributed solely via the RMP web site; 3) converting RMP reports into appropriate publication quality formats for quality printing and/or for distribution on the SFEI website, 4) maintaining web directories and updating the RMP publications list to allow easy access; and 5) maintaining and improving the overall design of the RMP 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. 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 September.

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.” In 2006, a major milestone for the program was the reporting of RMP data within one year of collection. The Annual Monitoring Results were released in the Fall of 2006 with two years of data (2004 and 2005). The program will continue to report 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 2006, the QA officer began revising the QAPP to incorporate revisions made to state-wide QAPPs. This effort will continue in 2007.

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, NOAA’s Status and Trends Program, and the Clean Estuary Partnership (CEP).

Multi-box Model

- In 2007, we will continue our efforts to model contaminant fate in the Estuary to better understand the potential impact of management actions on recovery. Models are valuable to summarize the existing state of knowledge, synthesize information from the RMP and other programs on contaminants in San Francisco Bay, predict the response of contaminant concentrations in the Bay to management actions and natural processes, identify and prioritize data gaps, and communicate RMP results. A multi-box model to predict the fate of PCBs in the Estuary will be completed in early 2007. In 2007, another pollutant will be modeled using the same framework. Possible contaminants include mercury, legacy pesticides, or PBDEs.

3. Status and Trends Monitoring

The Status and Trends (S&T) Monitoring Program is comprised of four program elements: long-term water, sediment, and bivalve monitoring; episodic toxicity monitoring; sport fish bioaccumulation; and the USGS hydrographic and sediment transport studies.

In 2006, the RMP embarked on a process to optimize the S&T program. The impetus for this exercise was multi-fold. The regulatory climate has changed substantially since the last redesign effort. The RWQCB has changed its focus, as seen in the recently released Mercury TMDL, from setting objectives for water to establishing thresholds for biota. As we know from the recent USGS data (see the article by Cloern in the 2006 Pulse), the Bay is also changing substantially. Its productivity has increased, potentially as a result of increased light penetration into the water column, decrease sediment loads, increase predation on bivalves, or ocean upwelling. Other major changes are also taking place. As a result of the Long Term Management Strategy (LTMS), there is a decrease in the disposal of sediments in-Bay. At the same time, one of the largest wetland restoration projects on the west coast is being conducted in the South Bay. All of these changes will require the RMP to adapt and change the ways in which the Bay is monitored. In 2006, we began the process of evaluating and optimizing S&T; it is anticipated in 2007 that we will complete this process. Some changes to the program may be implemented in 2007, but the fully optimized program will not be implemented until 2008.

The S&T monitoring program for water and sediment was significantly revised in 2002. A long-term plan for implementing this design, including a 20-year cycle of rotating panels, has been implemented. The new 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. The bivalve bioaccumulation component of the S&T, however, does not use a randomized design but rather continues to sample 11 historical sites.

Water, sediment, and bivalve bioaccumulation sampling for the S&T monitoring program occurs once a year in the summer. Summer has been selected for sampling because inter-annual variation due to natural variables, primarily freshwater inflow, is minimized during this period. It is possible with the redesign that S&T will bring back a wet weather sampling component but it is likely that this will be implemented in 2008.

The number of S&T monitoring stations varies by segment for water and sediment measurements based on current Regional 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. Again with the redesign, it is likely that the number of station and frequency with which they are implemented (e.g., annually, biennially, triennially, etc.) will be changed for 2008. Some of these changes may be implemented in 2007, if desirable and logistically feasible. Therefore, the plans described below are subject to change depending on how the redesign unfolds.

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 31 stations throughout the Estuary. The analyte list for 2007 for trace elements and organics will remain unchanged from 2006. In 2006, the decision was made to eliminate dissolved and particulate organic analyses, in favor of total organic analyses on which the standards are based.

Sediment Chemistry

Sediment samples will be collected during the dry season. Sediment chemistry will be analyzed at 40 random sites and seven fixed sites. The 2007 analyte list for sediment will remain unchanged from 2006.

Bivalve Bioaccumulation

The bivalve monitoring component maintains the long-term database started by the State Mussel Watch Program. 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). Similar to sediment and water, tissue concentrations in bivalves will be analyzed once per year during the dry season when Estuary conditions are more consistent on an interannual basis, to meet the trend evaluation and guideline comparison objectives. Bivalves are analyzed annually for organics and this list remains unchanged from 2005. Trace element analysis has been reduced to a five-year interval. This analysis was most recently completed in 2001. Trace elements may be included in 2007, pending TRC discussion and approval.

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. The next sampling is set to occur at a subset of random sites in 2007. Pending approval from the TRC, details of this sampling effort will be developed in the Spring of 2007.

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 *Eohaustorius* (a solid phase test with survival as the endpoint) and *Mytilus* (an elutriate test with normal larval development as the endpoint). Toxicity Identification Evaluations (TIEs) will be conducted in samples that show significant toxicity.

3.2 Episodic Toxicity Monitoring

A preliminary plan for episodic toxicity program was presented to the TRC this fall and a final plan will be presented in December. In 2007, the primary goal for the episodic toxicity program to identify causes of sediment toxicity. Since the program began, we have consistently seen toxicity to bivalves and amphipods in the Bay. Toxicity to amphipods exhibits a seasonality aspect with samples collected in the winter exhibiting a much higher mortality; toxicity to bivalves remains unaffected by seasons.

The episodic toxicity monitoring element for 2007 is currently being formulated. At this time, it is anticipated that the monitoring will be conducted in two phases. In Phase I (January through March), four tributaries will be sampled to identify toxicity and to identify a tributary that will be suitable for a focused study. The two most toxic tributaries will be sampled a second time to conduct sediment chemistry analyses and to conduct TIEs. In Phase II, three sites will be sampled along a gradient of the tributary and a triad approach will be conducted in which sediment toxicity, sediment chemistry and benthos will be evaluated. In addition, TIEs will be conducted. This proposal will be further refined in the next several months and presented to the TRC in December 2006 for approval.

3.3 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a triennial basis. The results of the 2006 sampling season will be summarized in a report in 2007. The next sampling event is scheduled for 2009. Resources for the 2009 fish tissue monitoring component will be set aside in 2007 and 2008 to lessen the budgetary impact in the 2009 monitoring year.

3.4 U. S. Geological Survey Participation

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 study will be 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 will provide 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 addition to the suspended sediment work, the USGS will continue to assist SFEI in the further refinement of the multi-box model.

3.4.2 Hydrography and Phytoplankton

This study will be 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 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 assist with sediment collection and bivalve retrieval operations.

4. Pilot Studies

4.1 Exposure and Effects Pilot Study

In 2007, the RMP will continue a Pilot Study of contaminant exposure and effects in the Bay. The 2003 RMP Program Review Panel recommended an increase in the EEPS budget and stated that biological effects research should be a priority. In response to this concern, the SC allocated \$200,000 each year for EEPS through 2008. This includes funds for SFEI labor and subcontractors (e.g., analytical laboratories).

In 2007, EEPS will continue to follow the monitoring priorities outlined in the Four-year Plan (2005): avian exposure and effects, fish exposure and effects, and benthos. The EEPS committee will meet late in 2006 to decide which studies to fund for 2007. At the present time, the following studies are considered likely candidates for 2007.

- **Avian Exposure and Effects.** In 2007, EEPS has the option of either funding an effects study on tern or exposure study on Clapper rails. At present, the tern study is envisioned as providing additional funding to USGS for analysis of organics in livers of terns. This part of a larger study examining biomarkers and reproductive effects. A second alternative is funding a field study of mercury exposure in clapper rails (i.e., blood and feathers) and a food web dynamics study (stable isotopes). This project would collaborate with the invasive spartina project. Approximately \$75,000 has been set aside in 2007 for avian studies.
- **Fish Effects.** EEPS has funded a two-year study of fish effects examining the impact of chemical contamination of growth and reproduction of shiner surfperch. This project will be completed in 2006. Funding has been set aside for 2007 and 2008 for additional fish effects work (approximately \$50,000 for each year). In 2006, a second fish study undertaken by Dr. Kevin Kelly of California State Long Beach was initiated looking at endocrine disrupters in shiner surfperch and pacific staghorn sculpin. The study was proposed as a two-year study; however, funding for the first year was only approved. The EEPS committee will decide late in 2006 whether to continue funding the Cal. State Long Beach work or to solicit new studies for 2007.
- **Initiation of a benthic survey of the Bay to validate effects thresholds.** In 2008, the State is scheduled to promulgate Sediment Quality Objectives (SQOs) that are based in part on benthic community assessments. The goal of this work is two-fold. First, the SQO effect thresholds will be investigated and validated. Second, the project will begin a process of identifying what is causing effects and

toxicity in the Bay. It is anticipated that this work will be conducted in the laboratory and field. This is a three-year project that is funded at \$40,000 per year.

In addition to subcontracts, there are labor and direct costs associated with this project. Estimated funding for the next two years is \$200,000 per year (e.g., 2007, and 2008).

5. Special Studies

5.1 Second Small Tributary Loading Study

Small tributaries form a major pathway for loads of contaminants that enter the Bay each year. Models developed for the Bay are highly sensitive to the magnitude of loads from small tributaries but present load estimates for this pathway lack accuracy and precision.

The RMP has made tremendous progress in characterizing loads from the Delta and from the Guadalupe River; however, neither of these tributaries is likely to be representative of the loads from many of the small tributaries into the Bay. In 2005, based on a recommendation from the Sources Pathways and Loading Workgroup (SPLWG), a reconnaissance study of small tributaries was conducted to identify a tributary for a third loading study. From this initial work, a small industrial watershed in Hayward was chosen for additional studies in 2007. Information from 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.

The funding level for 2007 is \$154,000.

5.2 Emerging Contaminants

Pharmaceuticals in Effluent and the South Bay

Pharmaceuticals such as antibiotics (e.g., erythromycin and trimethoprim), analgesics (e.g., ibuprofen and acetaminophen), antiinflammatories (e.g., diclofenac and naproxen), antidepressants (e.g., Prozac), antihypertensives (e.g., atenolol and propranolol), anticancers (e.g., paclitaxel and tamoxifen), and sexual performance enhancers (e.g., Viagra and Levitra), among other drugs, are used to treat illness, disease, and medical conditions in humans and animals. The primary pathway is ingestion followed by subsequent excretion into the municipal sewage system, while the secondary pathway is disposal of unused and outdated medications directly into the sewage system. These biologically active compounds and their metabolites are not completely removed by current wastewater treatment technologies and are often found in treated effluents and receiving waters.

The objective of this study is to evaluate the extent of the concentration levels and occurrence of pharmaceuticals in the San Francisco Bay water and in influent and effluent from two Bay area wastewater treatment plants. A total of 30 samples will be collected: ten from the South Bay and five influent and effluent samples from two wastewater treatment plants.

The deliverable will be a RMP Technical Report and a paper to be submitted for potential publication in a peer reviewed scientific journal.

Perfluorinated Compounds in Pacific Harbor Seals

This study will determine concentrations of perfluorinated compounds in Pacific harbor seals (*Phoca vitulina richardsi*). Harbor seals are an ideal indicator species for persistent bioaccumulative contaminants in the Estuary because they are apex predators that eat a diet consisting primarily of fish. Perfluorinated compounds are of particular concern because they are very stable compounds that are not known to undergo abiotic or biotic degradation (Martin *et al.* 2004). In addition to perfluorinated compounds, this study will also determine concentrations of polybrominated diphenyl ethers and other flame retardants in seal blood.

The Marine Mammal Center and Moss Landing Marine Laboratories plan to capture harbor seals in the summer of 2006 and 2007. Seals will be weighed, measured, and tagged; blood samples will be collected for a battery of tests to assess health and fitness (e.g., blood cell count, exposure to infectious diseases, presence of pathogenic bacteria, etc.). Additional blood samples can be collected for chemical analyses. Animals targeted by this study will be young of the year pups that wean in May and feed on fish throughout the summer. Approximately ten young of the year seals will be tagged for a future study assessing health and survival. Although the focus of the Marine Mammal study will be young of the year, it is likely that seals of all ages will be captured and handled. Blood for perfluorinated compounds will be obtained from all age classes to ascertain whether age has an impact on contaminant loads. In 2006, three samples will be collected; in 2007, the remaining seven samples will be collected.

Because the RMP has relatively few opportunities to analyze seal blood, it is proposed that PBDEs and hexabromocyclododecane be analyzed in addition to perfluorinated compounds. Hexabromocyclododecane is an alternative flame retardant for PBDEs. Levels of hexabromocyclododecane are increasing in Europe where the penta and octa mixes of PBDEs were banned in 2004. California recently implemented a ban on the use of penta and octa PBDEs. As indicated above, concentrations of PBDEs in harbor seals were the highest levels reported and show an increasing trend. Hexabromocyclododecane has not been measured in seals in the San Francisco Bay.

The results of this study will be summarized in a technical report and a journal manuscript.

The estimated funding level for the two emerging contaminant studies 2007 is \$60,200.

5.3 Remote Sensing of Sediment Transport

Monitoring suspended sediment concentrations, SSC, in coastal waters and estuaries is crucial for proper ecosystem management. Such monitoring is traditionally conducted in-situ, with measurements representing SSC at a few discrete points in space and time. However, recent advancement of satellite remote sensing allows for synoptic views of coastal and estuarine dynamics that would otherwise be unavailable. Results are drastically altering our perceptions of coastal ocean transport processes.

This project will use moderate-resolution (250m, 500m, and 1000m) MODIS satellite imagery to investigate episodic sediment transport patterns in San Francisco Bay. Development of an event-scale sediment budget has the potential to significantly improve current estimates of contaminant loading from the Delta to the Bay. It is conceptualized that such episodic contaminant loads account for a significant portion of annual contaminant loads. However, at present we know very little regarding the percent of episodic sediment and contaminant loads that remain within the Bay.

The project includes three tasks: 1) identify MODIS images with a high percentage of coverage in the Bay corresponding to periods of high Delta flow and process these images to produce true- and false-color images showing two-dimensional sediment transport patterns and quantifying relative concentrations of suspended matter, 2) where appropriate, utilize existing edge-detection algorithms (Oram et al. 2005) to delineate the boundaries of plumes exiting the Golden Gate and estimate mass of suspended sediment within the plume, and 3) compare remote observations with in-situ USGS SSC measurements collected at Mallard Island to determine the fraction of material entering the Bay via the Delta that is lost to the Pacific Ocean during a given event.

The TRC approved Task 1, identification of MODIS images with adequate coverage of the Bay during high flow events. The moderate resolution imaging spectroradiometer (MODIS) is a key instrument aboard the EOS Terra and Aqua satellites. These two satellites are capable of viewing the entire earth every 1 to 2 days. Task 1 would identify 'clear' MODIS images of San Francisco Bay from 1995 to the present. The definition of 'clear' will need to be established in this task. Essentially, an image will be designated 'clear' if the number of observed pixels within the Bay (or segments thereof) exceeds a certain threshold. Images identified as 'clear' will then be compared to precipitation and Delta outflow records. Images corresponding to periods of high precipitation and/or Delta outflow will be selected for further analysis.

It is anticipated that upon completion of Task 1 that a presentation will be made to the TRC and potential funding for additional tasks discussed for future years.

The estimated funding level for 2007 is \$8,000.

5.4 Small Fish

The EEPS began sampling small fish for mercury in the Bay in 2005 and continued this work in 2006. The preliminary results of this study show tremendous variation spatially (e.g., higher concentrations observed in the South Bay) and tremendous variation among species (e.g., higher concentrations observed in benthic

species). These results are extremely useful for several reasons including evaluation of the success of the TMDLs and the potential risk to piscivorous wildlife. Funding for this project in 2007 will be dormant under the EEPS program; however, because of the great interest in the preliminary results, the TRC elected to fund the small fish program as a special study for 2007. In addition to mercury, the small fish will be analyzed for organics. EEPS will fund the program again in 2008 for mercury.

Small fish will be sampled from three habitat types, nearshore demersal (benthic), nearshore pelagic, and mid-channel benthic. These fish will provide information about the mercury and organic exposure of piscivores that specialize on either type of small fish prey. The nearshore benthic species are less mobile and have smaller home ranges than the pelagic species. Therefore, this sampling design will provide both fine-scale and sub-embayment-level information on spatial variation. Fish that are likely to be sampled include: arrow goby and cheekspot goby; topsmelt (saline) and Mississippi silversides (brackish); and bay goby.

Young-of-the-year fish will be collected in early fall, allowing capture of as much of the summer increase in growth, consumption, and consequent mercury uptake as possible. Number of sites sampled will be based on budgetary allotment. Given the current budget, fish can be collected from seven sites in each sampling year. Sites will be fixed, rather than randomly located, to allow analysis of trends in bioaccumulation of mercury over time.

The estimated funding level for 2007 is \$58,000.