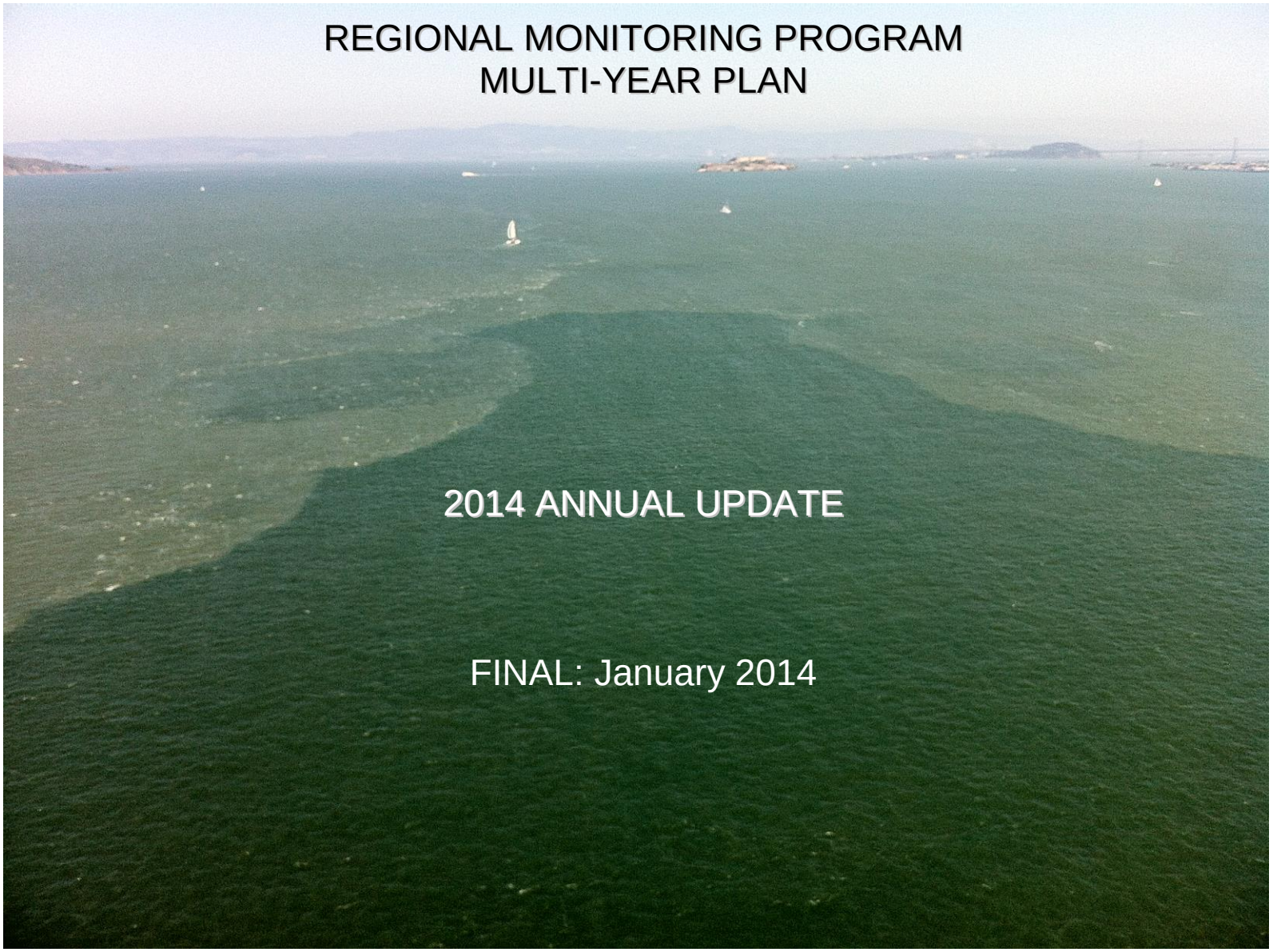


REGIONAL MONITORING PROGRAM
MULTI-YEAR PLAN

2014 ANNUAL UPDATE

FINAL: January 2014

RMP ORIGIN AND PURPOSE

In 1992 the San Francisco Bay Regional Water Board passed Resolution No. 92-043 directing the Executive Officer to send a letter to regulated dischargers requiring them to implement a regional multi-media pollutant monitoring program for water quality (RMP) in San Francisco Bay. The Water Board's regulatory authority to require such a program comes from California Water Code Sections 13267, 13383, 13268 and 13385. The Water Board offered to suspend some effluent and local receiving water monitoring requirements for individual discharges to provide cost savings to implement baseline portions of the RMP, although they recognized that additional resources would be necessary. The Resolution also included a provision that the requirement for a RMP be included in discharger permits. The RMP began in 1993, and over the past ~~20~~ 21 years has been a successful and effective partnership of regulatory agencies and the regulated community.

The goal of the RMP is to provide the high quality body of knowledge on estuarine contamination needed for managing water quality in this treasured aquatic ecosystem.

This goal is achieved through a cooperative effort of a wide range of regulators, dischargers, scientists, and environmental advocates. This collaboration has fostered the development of a multifaceted, sophisticated, and efficient program that has demonstrated the capacity for considerable adaptation in response to changing management priorities and advances in scientific understanding.

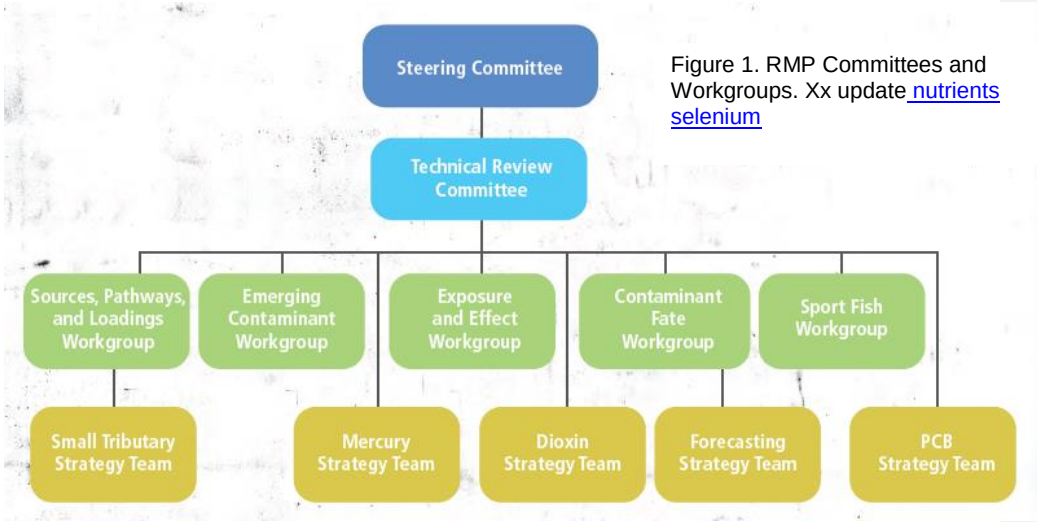
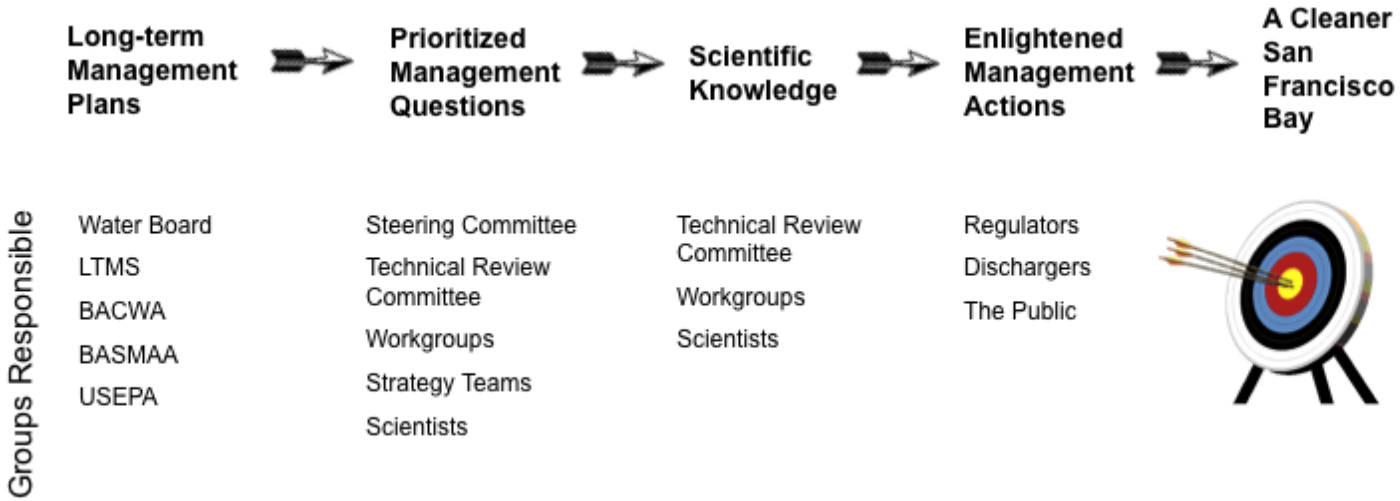


Figure 1. RMP Committees and Workgroups. Xx update nutrients selenium

RMP PLANNING

This collaboration and adaptation is achieved through the participation of stakeholders and scientists in frequent committee and workgroup meetings. The Steering Committee (Figure 1) consists of representatives from discharger groups (wastewater, stormwater, dredging, industrial) and regulatory agencies (Regional Water Board, USEPA, and U.S. Army Corps of Engineers). The Steering Committee determines the overall budget and allocation of program funds, tracks progress, and provides direction to the Program from a manager's perspective. Oversight of the technical content and quality of the RMP is provided by the Technical Review Committee (TRC), which provides recommendations to the Steering Committee. Six workgroups report to the TRC and address the main technical subject areas covered by the RMP: sources, pathways, and loadings; contaminant fate; exposure and effects; emerging contaminants; sport fish contamination; and nutrients. The workgroups consist of regional scientists and regulators and invited scientists recognized as authorities in their field. The workgroups directly guide planning and implementation of pilot and special studies. RMP "strategy teams" comprise one more layer of planning activity. These stakeholder groups meet as needed to develop long-term RMP study plans for addressing high priority topics. Topics addressed to date include mercury, PCBs, dioxins, small tributary loads, and forecasting (modeling). A selenium strategy team will be convened in 2014.

Figure 2. Science in support of water quality management. Xx better design in progress



The RMP supports management efforts to protect and restore water quality in the Bay. It does this by developing the scientific understanding needed to answer the key questions on priority topics that underpin current and future management policies and actions. RMP stakeholders and scientists work closely together to ensure the linkage of science and management.

The annual planning cycle begins with a workshop in October in which the Steering Committee articulates general priorities among the information needs on water quality topics of concern. In the second quarter of the following year the workgroups and strategy teams forward recommendations for study plans to the TRC. At their June meeting, the TRC combines all of this input into a study plan for the following year that is submitted to the Steering Committee. The Steering Committee then considers this recommendation and makes the final decision on the annual workplan.

In order to fulfill the overarching goal of the RMP, the Program has to be forward-thinking and anticipate what decisions are on the horizon, so that when their time comes, the scientific knowledge needed to inform the decisions is at hand. Consequently, each of the workgroups and teams develops five-year plans for studies to address the highest priority management questions for their subject area. Collectively, the efforts of all these groups represent a substantial body of deliberation and planning.

PURPOSE AND ORGANIZATION OF THIS DOCUMENT

The purpose of this document is to guide efforts and summarize plans developed within the RMP. The intended audience includes representatives of the many organizations who directly participate in the Program. This document will also be useful for individuals who are not directly involved with the RMP but are interested in an overview of the Program and where it is heading.

The organization of this Multi-Year Plan parallels the RMP planning process (Figure 2). Section 1 presents the long-term management plans of the agencies responsible for managing water quality in the Bay and the overarching management questions that guide the Program. The agencies' long-term management plans provide the foundation for RMP planning (page 6). The first step the RMP takes to support these plans, is to distill prioritized lists of management questions that need to be answered in order to turn the plans into effective actions (page 7). The prioritized management questions then serve as a roadmap for scientists on the Technical Review Committee, the workgroups, and the strategy teams to plan and implement scientific studies to address the most urgent information needs. This information sharpens the focus on management actions that will most effectively and efficiently improve water quality in the Bay.

Section 2 provides an overview of the budget of the RMP, including where the funding comes from and how it is allocated among different elements of the Program. This section provides a summary of the priority topics to be addressed by the Program over the next five years.

Section 3 presents the five-year plans developed by the workgroups and strategy teams for specific priority topics: mercury, PCBs, dioxins, emerging contaminants, small tributary loads, exposure and effects, forecasting, nutrients, and status and trends. Led by the stakeholder representatives that participate in these groups, each workgroup and strategy team has developed a specific list of management questions for each topic that the RMP will strive to answer over the next five years. With guidance from the science advisors on the workgroups, plans have been developed to address these questions. These plans include proposed projects and tasks and projected annual budgets. Information synthesis efforts are ~~underway for several of the strategies that will~~often conducted to yield recommendations for a next phase of studies. For now, study plans and budget allocations for these strategies are largely labelled as "to be determined". Other pieces of information are also included to provide context for the multi-year plans. First, for each high priority topic, specific management policies or decisions that are anticipated to occur in the next few years are listed. Second, the latest advances in understanding achieved through the RMP and other programs on Bay water quality topics of greatest concern are summarized. Lastly, additional context is provided by listing studies performed within the last two years and studies that are currently underway.

Section 4 describes five-year plans for other elements that are essential to the mission of the RMP: communications, data management, and quality assurance.

A Living Document

The RMP Multi-Year Plan is updated annually to provide an up-to-date description of the priorities and directions of the Program. An annual Planning Workshop is held in conjunction with the October Steering Committee meeting. A draft Multi-Year Plan is prepared after the workshop, and approved by the Steering Committee at the January meeting.

More detailed descriptions of the elements of the RMP are provided in the annual Program Plan and in the annual Detailed Workplan (both available at **www.sfei.org/rmp/what**).

For additional information on the RMP please visit our website at **www.sfei.org/rmp**.

Please contact Jay Davis, RMP Lead Scientist, at jay@sfei.org with questions or suggestions for improving this document.

Figure 3. Annual planning calendar for the Steering Committee.

Annual Steering Committee Calendar

- January
  - Approval of Multi-Year Plan
  - Review of incomplete projects from the previous year
- April
  - Multi-year Plan: Focus on selected element(s)
  - Plan for Annual Meeting
  - Additional guidance to workgroups
- August
  - Multi-year Plan: mid-year check-in, workshop planning
  - Decision on special studies recommended by the TRC for next year
  - Plan for Annual Meeting
  - Report on SFEI financial audit
  - Brief discussion of fees for year after next
- October
  - Confirm chair(s)
  - Planning Workshop
  - Decision on fees for the year after next
  - Approve Program Plan and detailed budget for next year
  - Approval of Pulse outline for next year
  - Decision on workshops to be held next year

Agendas and meeting summaries available at http://www.sfei.org/rmp/sc

CURRENT AND ANTICIPATED MANAGEMENT DECISIONS, POLICIES, AND ACTIONS BY THE REGULATORY AGENCIES THAT MANAGE BAY WATER QUALITY

Decisions, Policies, and Actions	Timing
ONGOING AND EXISTING	
Determination of Reasonable Potential and Permit Limits	Ongoing
Long-Term Management Strategy for Placement of Dredged Material/Dredged Material Management Office Regional Sediment Management Strategy	Ongoing
Dredging Permits Bioaccumulation testing triggers and in-Bay disposal levels	Annual
Biennial 303(d) List and 305(b) Report	~~2012-13~~ ~~2014-15~~2016
Copper Compare levels to site specific objectives triggers Evaluation of the site-specific objectives	Annual Triennial (2015)
Cyanide Compare levels to site specific objectives triggers Evaluation of the site-specific objectives	Annual Triennial (2015)
Selenium North Bay Selenium TMDL South Bay Selenium TMDL	~~2013-14~~2014 > 2015
Dioxins ~~Review/reissue permit requirements~~ Review 303(d) listings and establish TMDL development plan or alternative	~~2013-14~~ ~~2013-14~~2018
Mercury Review existing TMDL and establish plan to revise ~~Revised mercury TMDL and/or implementation Plan~~	~~2013-14~~2018 ~~2016-18~~
PCBs Review existing TMDL and establish plan to revise ~~Revised PCBs TMDL and/or implementation plan~~	~~2014-15~~2020 ~~2019-20~~

Decisions, Policies, and Actions	Timing
NEW AND FUTURE	
Nutrients Nutrient Management Strategy Nutrient Water Quality Objective~~New estuarine numerical endpoints~~ ~~Assessment of ammonia/ammonium~~	~~2012-15~~Ongoing ~~2012-14~~2024
Legacy Pesticides (DDT, Dieldrin, Chlordane) Delist	~~2012-13~~2016
Pathogens Review Bay beaches 303(d) listings and establish TMDL development plan	~~2012-13~~2015
Sediment Hot Spots Review 303(d) listings and establish TMDL development plan or alternative	~~2012-13~~2016
Chemicals of Emerging Concern ~~State Water Board policy?~~ ~~Regional Water Board plan or policy~~Review of RMP strategy	~~2013-14~~ ~~2013-14~~Annual
Toxicity ~~Adoption of n~~New state ~~policy~~ plan on effluent and receiving water toxicity	~~2013~~2014
Sediment Quality Objectives 303(d) listings	2016
BAY WATERSHED PERMITS	
Municipal Regional Stormwater Permit	2014, 2019
Mercury and PCBs Watershed Permit for Municipal and Industrial Wastewater	2017
Nutrient Watershed Permit for Municipal	2014, 2019

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Decisions, Policies, and Actions	Timing
Wastewater	
~~*Sediment Quality Objectives*~~ ~~303(d) listings~~ ~~Determination of reasonable potential and permit requirements~~	~~2014-15~~ ~~Annual~~

RMP Goal and Management Questions

RMP stakeholders have articulated an overarching goal and a tiered framework of management questions that organize and guide RMP studies. The management questions are closely linked to existing and planned regulations.

Level 1 (Core) Management Questions

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

	Question 1	Question 2	Question 3	Question 4	Question 5
Level 1 (Core) Questions	Levels of concern and associated impacts	Concentrations and masses (spatial distribution)	Sources, pathways, loadings, and processes	Increased or decreased (trends)	Projected concentrations, masses, and impacts
Level 2 Questions	Q1 Which chemicals have potential for impacts?	Q1 Are there particular regions of concern?	Q1 Which sources, pathways, etc. contribute most to impacts?	Q1 Effects of management actions on concentrations and mass?	Q1 Impacts forecast under various management scenarios?
	Q2 What is the potential for impacts due to contamination?		Q2 Opportunities for management intervention for important pathways?	Q2 Effects of management actions on potential for adverse impacts?	Q2 Which contaminants predicted to increase?
	Q3 What are appropriate guidelines?		Q3 Effects of management actions on loads and processes?		
	Q4 What contaminants are responsible for impacts?				

General Goal of the RMP

Collect data and communicate information about water quality in the San Francisco Estuary in support of management decisions.

Consistent with, these general goals, the RMP addresses NPDES permit provisions for special studies and routine monitoring of the Bay

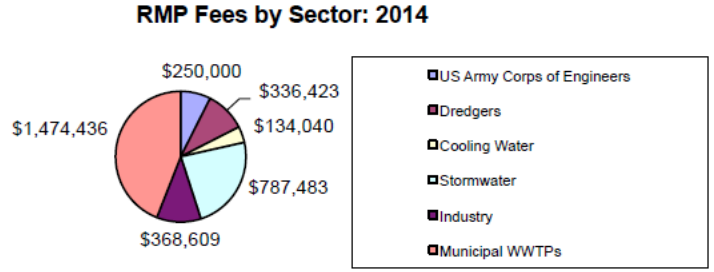
The following key criteria are used to evaluate potential RMP elements (in order of priority):

1) addresses relevant NPDES permit requirements
2) supports policies and adaptive implementation
3) addresses scientific information needs

BUDGET: Revenue – 2014

RMP fees were $2.99 million in 2005 and 2006, increased by 2% per year in 2007-2010, and were $3.24 million for 2010, 2011 and 2012. Fees increased by 1.5% in 2013, and will increase by 2% in 2014 and 2015.

RMP fees for 2014 are divided among the discharger groups as indicated. The proportion contributed by the Army Corps has decreased over the years as their contribution has stayed constant at $250,000 per year since 1993.

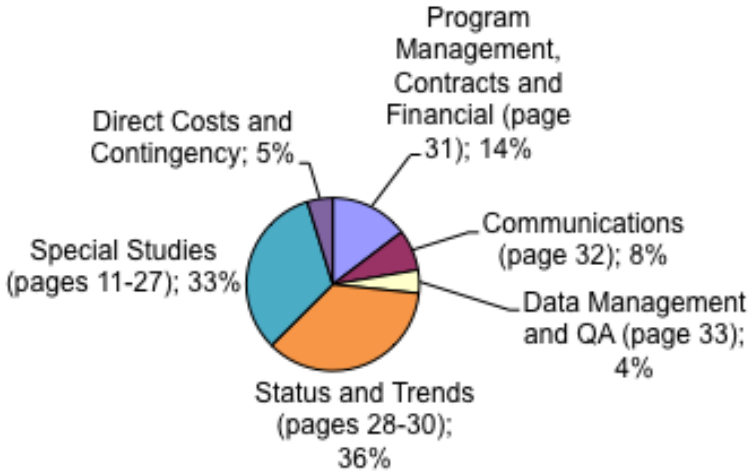


~~RMP fee increases have not kept pace with Bay Area inflation rates. This has contributed to a decrease in the amount of work done per year by the Program.~~

Year	Jun Bay Area CPI	% CPI Increase	Actual RMP Fee Increase	Basis	Target Fees
2005	201.2				$ 2,990,242
2006	209.1	3.9%	0.0%	Fixed %	$ 2,990,242
2007	216.1	3.3%	2.0%	Fixed %	$ 3,050,047
2008	225.2	4.2%	2.0%	Fixed %	$ 3,111,048
2009	225.7	0.2%	2.0%	Fixed %	$ 3,173,269
2010	228.1	1.1%	2.0%	Fixed %	$ 3,236,734
2011	233.6	2.4%	0.0%	Fixed %	$ 3,236,734
2012	239.8	2.7%	0.0%	Fixed %	$ 3,236,734
2013	245.9	2.5%	1.5%	Fixed %	$ 3,285,285
2014			2.0%	Fixed %	$ 3,350,991
2015			2.0%	Fixed %	$ 3,418,010
	AVERAGE	2.5%			
	22.2%	% INCREASE 2005-2013			9.9%
Data from ABAG: http://www.abag.ca.gov/planning/research/cpi.html					

BUDGET: Expenses – 2014

Program Management, Contracts and Financial (page 31)	$ 567,722
Communications (page 32)	$ 297,378
Data Management and QA (page 33)	$ 167,613
Status and Trends (pages 28-30)	$ 1,390,235
Special Studies (pages 11-27)	$ 1,266,393
Direct Costs and Contingency	$ 185,000



Unencumbered Reserve
An unencumbered reserve of $200,000 is maintained to respond to unanticipated urgent priorities.

Unencumbered Funds
Higher than anticipated revenues and elimination or reduction of lower priority elements sometimes leads to accumulation of unencumbered funds ($532,000 as of ~~April 2013~~January 2014, in addition to the $200,000 unencumbered reserve) that can be used for high priority topics at the discretion of the Steering Committee.

COORDINATION WITH OTHER ORGANIZATIONS AND PROGRAMS

Small Tributary Loads
- MRP cities, counties, and districts
- San Francisco Bay Water Board
- San Francisco Estuary Institute

Nutrients
- U.S. Geological Survey
- State Water Board
- San Francisco Bay Water Board
- Bay Area Clean Water Agencies
- Central Contra Costa Sanitation District
- Interagency Ecological Program
- State and Federal Contractors Water Agency
- San Francisco Estuary Institute

Forecasting
- U.S. Geological Survey
- Bay Area Clean Water Agencies
- San Francisco Estuary Institute

Emerging Contaminants
- State Water Board
- San Francisco Bay Water Board
- National Oceanic and Atmospheric Administration
- Southern California Coastal Water Research Project
- San Francisco Estuary Institute

Legacy Contaminants
- State Water Board (SWAMP)
- San Francisco Bay Water Board
- San Francisco Estuary Institute

Exposure and Effects
- State Water Board
- San Francisco Bay Water Board
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- Bay Planning Coalition
- National Oceanic and Atmospheric Administration
- Southern California Coastal Water Research Project
- U.S. Geological Survey
- San Francisco Estuary Institute

Status and Trends
- U.S. Geological Survey
- State Water Board (SWAMP)
- San Francisco Bay Water Board
- Interagency Ecological Program
- San Francisco Estuary Institute

Communication
- San Francisco Estuary Partnership
- California Water Quality Monitoring Council
- San Francisco Estuary Institute

Data Management
- State Water Board (CEDEN)
- San Francisco Estuary Institute

RMP SPECIAL STUDIES: ~~2011~~2012-2018

RMP expenditures on special study topics. Figures for ~~2011-2013~~2012-2014 are actual amounts. Figures for ~~2014~~ 2015 and beyond are estimates for planning.

	2012	2013	2014	2015	2016	2017	2018
TOPIC							
Mercury	$0	$0	$0	$0	$0	$0	$0
PCBs	$0	$0	$0	$80,000	$160,000	$100,000	$100,000
Dioxins	$95,500	$0	$24,000	$40,000	$0	$0	$0
Emerging Contaminants	$117,000	$141,000	$183,000	$100,000	$100,000	$100,000	$100,000
Small Tributaries	$428,000	$468,000	$487,000	$475,000	TBD	TBD	TBD
Other SPL	$0	$0	$0	$0	$0	$0	$0
Exposure and Effects	$130,000	$114,000	$80,000	$50,000	TBD	TBD	TBD
Forecasting	$100,000	$100,000	$0	$0	$0	$0	$0
Selenium	$0	$0	$10,000	TBD	TBD	TBD	TBD
Nutrients	$150,000	$405,000	$520,000	$500,000	$470,000	$620,000	$720,000
ANNUAL TOTALS FOR SPECIAL STUDIES	**$1,020,500**	**$1,228,000**	**$1,304,000**	**$1,245,000**	**$730,000**	**$820,000**	**$920,000**
ANNUAL TOTAL AVAILABLE FOR SPECIAL STUDIES	$895,434	$1,287,280	$1,197,993	$1,028,589	$1,087,544	$1,100,836	$1,175,864
REMAINING	**-$125,066**	**$59,280**	**-$106,007**	**-$216,411**	**$357,544**	**$280,836**	**$255,864**

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TBD – To be determined through synthesis efforts and workgroup discussion.

Nutrient synthesis and monitoring, and **forecasting** of future scenarios for nutrients are high priorities. Characterization of **small tributary loads** of pollutant remains a high priority. Screening for and improving tools for monitoring **emerging contaminants** is also a continuing priority. ~~Projected increases in the costs of USGS water quality monitoring would result in **dramatically reduced funds available for special studies in 2015 and beyond**.~~

Small Tributary Loading

Note: "Small tributary" refers to the rivers, creeks, and storm drains that enter the Bay downstream from the Region 2 Water Board boundary (Mallard Island).

Relevant Management Policies and Decisions

- Refine pollutant loading estimates for future TMDLs and management decisions, including TMDL updates.
- Provisions of the Municipal Regional Permit (MRP).
- Prioritizing small tributaries for cleanup actions.
- Identifying the best management actions for small tributaries.

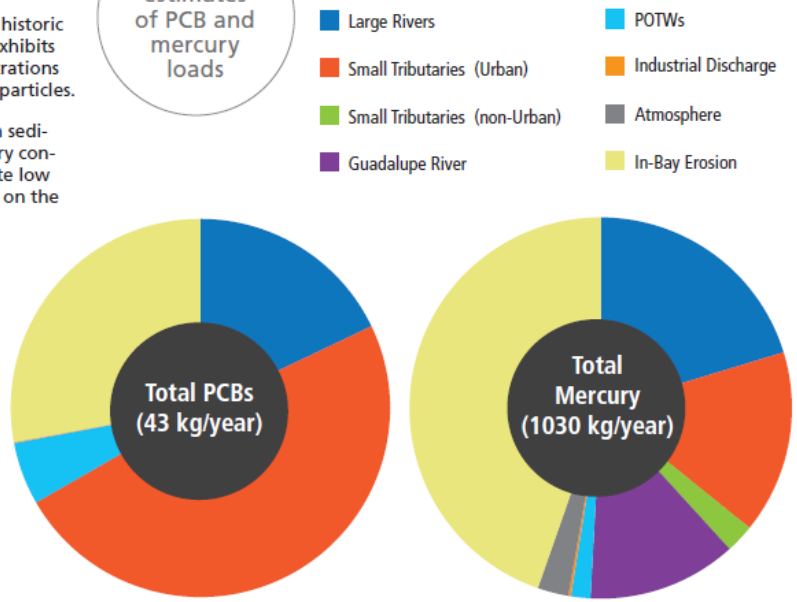
Recent Noteworthy Findings

- Small tributaries are the dominant loading pathway for suspended sediments, PCBs, and mercury.
- Mercury loads in stormwater are primarily associated with suspended sediment particles and most pollutant mass enters the Bay during the largest storms.
- Older urban systems exhibit moderate PCB concentrations in water and moderately high PCB concentrations on sediment particles.
- PCB concentrations vary more widely in stormwater and soil samples relative to mercury.
- PCBs in stormwater are commonly associated with suspended sediment particles, and in very contaminated watersheds may also occur as an emulsion.
- PCBs are associated with small areas with highly polluted soils within our watersheds – finding such areas is a challenge.
- Dioxin loads measured in two tributaries suggest a regional load estimate of 8.9 g of dioxin toxic equivalents. Concentrations appear to be highest in industrialized urban areas.
- Just six stormwater samples were used to identify Pulgas Creek and Santa Fe Channel as high leverage watersheds in relation to pollutant sources and sensitive Bay margin areas.
- The Guadalupe River with historic mercury mines upstream exhibits very high mercury concentrations in water and on sediment particles.
- Walnut Creek with its high sediment load has high mercury concentrations in water despite low concentrations of mercury on the sediment particles.

Priority Questions for the Next Five Years

1. Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
2. What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
3. How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?
4. 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?

The latest estimates of PCB and mercury loads



SMALL TRIBUTARIES LOADING STRATEGY

Monitoring loads from representative watersheds will be the major emphasis for the next several years. Monitoring of representative source characterization sites will provide data needed for model development in subsequent years. This work will be closely coordinated with and substantially augmented by MRP monitoring.

Small tributaries loading studies in the RMP from 2011 to 2016. Numbers indicate budget allocations in $1000s.

Task ID	Funder	Task Description	2011	2012	2013	2014	2015	2016
0	RMP	**Coordination and management**			20	25	40	TBD
1		**Watershed and Associated Bay Modeling**						
1A		Regional Watershed Spreadsheet Model						
1A.1	RMP	Phase I – Water, Sediment, PCBs and Mercury	20	20	25	~~25~~30	35	TBD
1A.1	BASMAA	Phase I – Sediment		33		~~TBD~~(32)		
1A. 2	RMP	Phase II – Other Pollutants of Concern						
1A.2	BASMAA	Phase II– PBDE, DDT, chlordane, dieldrin		35		~~TBD~~(20)		
1A.3	RMP	Phase III – Periodic Updates					TBD	TBD
1B	RMP	Coordination with Bay Margins Modeling						
1C	TBD	HSPF dynamic modeling					TBD	TBD
2	RMP	**Source Area Monitoring / EMC Development**	20	80	80	80	TBD	TBD
3		**Small Tributaries Monitoring**						
3.1	BASMAA	Multi-Year Plan Development	15					
3.2	BASMAA	Standard Operating and Quality Assurance Procedures	55					
3A	RMP	Monitor Two Representative Small Tributaries	300	328	343	~~300~~352	~~300~~400	TBD
3AB.1	BASMAA	Monitor Two to Four Representative Small Tributaries or Sites Downstream of Management Actions	255	510	(480)	(480)	TBD	TBD
3AB.2	BASMAA	Lab Analyses, Quality Assurance, Data Management	183	316	(320)	(320)	TBD	TBD
4	RMP	**Reporting, Stakeholder Admin, Adaptive Updates**	41					
	BASMAA	**Data Analysis, Communications, Administration**	45	84	(85)	TBD	TBD	TBD
RMP Total			**381**	**428**	**~~518~~468**	**~~430~~487**	**TBD**	TBD
BASMAA Total		**Task 1**		**28**		**TBD**	TBD	TBD
		Tasks 2-4	**558**	**910**	**885**	**TBD**	TBD	TBD
Total			**934**	**1,366**	**1,403**	**TBD**	**TBD**	TBD

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Nutrients

Relevant Management Policies and Decisions

Primary

- Nutrient numeric endpoints
- Evaluate need for revised objectives for dissolved oxygen (DO) and ammonia
- Water quality assessment – impairment status
- NPDES permits (e.g., POTW, MRP) - on-going

Secondary

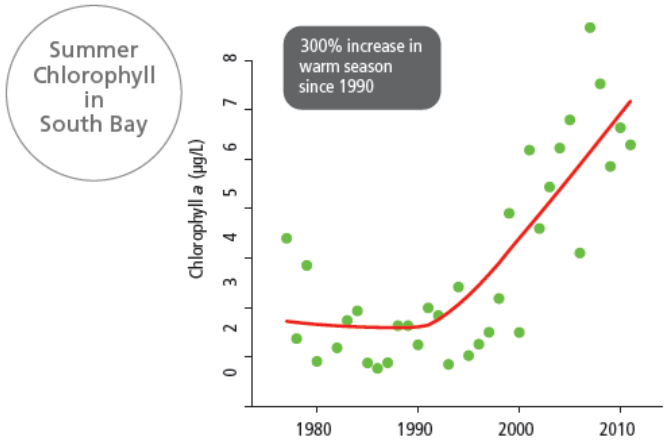
- Delta Flows
- Regional Sediment Strategy
- Watershed TMDLs
- Recycled Water Policy and POTW projects

Recent Advances in Understanding and Priority Information Needs

- There is a growing body of evidence that suggests the historic resilience of San Francisco Bay to the harmful effects of nutrient enrichment is changing.
- Since the late 1990s, regions of the Bay have experienced significant increases in phytoplankton biomass (30-105% from Suisun to South Bay) and significant declines in DO concentrations (2.0 and 4.0% in Suisun Bay and South Bay, respectively).
- USGS has found declining suspended sediment in the Bay – however, no data are available for shallow subtidal regions.
- There is a need for long-term status and trends monitoring of nutrients and eutrophication.
- At present, Bay water quality objectives related to nutrients are limited to un-ionized ammonia and dissolved oxygen.
- There are outstanding questions about the role and importance of ammonium with respect to beneficial use impairment.

Priority Questions for the Next Five Years

1. Is there a problem or are there signs of a problem?
   a. Are anthropogenic nutrients currently, or trending towards, adversely affecting beneficial uses of the Bay?
   b. Are beneficial uses in segments of the Bay impaired by any form of nutrients?
   c. Are trends spatially the same or different in the segments of the Bay?
2. What are appropriate guidelines for assessing the Bay's health with respect to nutrients and eutrophication?
3. Which nutrient sources, pathways, and transformation processes contribute most to concern?
   a. What is the relative contribution of each loading pathway (POTW, Delta, urban stormwater runoff, non-point sources, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?
   b. What is the contribution of nutrient regeneration (benthic fluxes) from sediments and denitrification/nitrogen fixation to Bay nutrient budgets?
4. What nutrient loads can the Bay assimilate (without impairment of beneficial uses)?
5. What future impairment is predicted for nutrients in the Bay?



NUTRIENT STRATEGY

Five-Year Goals for Nutrient Strategy

1) Document our current understanding of nutrient dynamics in the Bay, highlighting what is known and the crucial questions that need to be answered
2) Implement a monitoring program that supports regular assessments of the Bay, and characterizes/quantifies key internal processes that exert important influence over the Bay's response to nutrient loading
3) Establish guidelines (water quality objectives; i.e., assessment framework) for eutrophication and other adverse effects of nutrient overenrichment, if needed
4) Quantify nutrient loads to and important processes in the Bay
5) Establish a modeling strategy to support decisions regarding nutrient management for the Bay

The Nutrient Science Strategy for the Bay is a collaborative effort with major contributions from RMP, USGS, the State and Regional Boards, BACWA, and hopefully others. Funding and oversight are provided by these multiple organizations. Multiagency collaboration is essential to address the information needs for nutrients in the Bay.

Nutrient studies in the Bay from 2011 to ~~2017~~2018. Numbers indicate budget allocations in $1000s.

Element	Funding Agency	Questions Addressed	2011	2012	2013	2014	2015	2016	2017	2018
Coordination and Management	RMP	1-5	20	10	20	20	20	20	20	20
	SWRCB	1-5	15	5			TBD	TBD	TBD	TBD
	BACWA	1-5	10	135	135	75+TBD	?150?	?150?	?150?	?150?
Conceptual Model	RMP	1-5		80	50		30			
Nutrient Loads and Data Gaps	RMP	3		20	30					
Synthesis: Suisun Bay, Lower South Bay, other	BACWA			100	100	100+TBD	TBD	TBD	TBD	
Science Plan Develop: V1,V2…	BACWA				15	15	TBD	TBD	TBD	TBD
	SFBRWQCB					100				
	RMP						TBD	TBD	TBD	
Assessment (NNE)	SFBRWQCB	2		60***	155***	100***	TBD	TBD	TBD	TBD
	BACWA						TBD	TBD	TBD	TBD
Monitoring: ship-based *S&T (USGS, Cloern)*	*RMP*	*1,3*	*110*	*110*	*110*	*172*	*223*	*223*	*223*	*223*
	USGS[2]	1	400	400	470	TBD	TBD	TBD	TBD	TBD
	IEP			?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)
	BACWA						TBD	TBD	TBD	TBD
Monitoring: Moored Sensor	RMP				200	215	300	350	400	500
	BACWA				75	75+TBD	TBD	TBD	TBD	TBD
	USGS+DWR			?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)	?(>500k)
Monitoring Special Studies: Algal Biotoxins	RMP				65					
	other					TBD	TBD	TBD	TBD	TBD
Monitoring Special Studies: Phytoplankton composition	BACWA				60	60+TBD	?150?	TBD	TBD	
Monitoring: Suisun Bay	SFBRWQCB	1	100	110	?	TBD	TBD	TBD	TBD	TBD
Monitoring: Progr. Development, management	SWRCB	1,3		10	20	20				
includes science planning (e.g., data analysis) and institutional/financial planning, program spin-up, and management + interpretation/reporting	RMP					50	50	50	150	150
	BACWA				35	40+TBD	?200?	?200?	?150?	?150?
Management and load reduction options, cost/benefit	BACWA									
POTW and refinery effluent characterization	Dischargers, BACWA	3		200	300	200	TBD	TBD	TBD	TBD
Data analysis	BACWA				15	TBD	TBD	TBD	TBD	TBD

Element	Funding Agency	Questions Addressed	2011	2012	2013	2014	2015	2016	2017	2018
Stormwater nutrient load monitoring	RMP	3		30	40	35	TBD	TBD	TBD	TBD
Modeling*	RMP	4,5		100	100	200	100	50	50	50
	BACWA	4,5				?150?	?400?	?450?	?450?	?450?
Delta loads to Suisun	IEP	3			90	90	TBD	TBD		
Phytoplankton growth (Suisun)	IEP, SFCWA	1,3,4			100	100				
	other						TBD	TBD		
General Allocation	RMP						TBD	TBD	TBD	TBD
		RMP Nutrients	**20**	**140**	**405**	**320**	**400**	**420**	**570**	**670**
		RMP Forecasting		**100**	**100**	**200**	**100**	**50**	**50**	**50**
		RMP S&T Monitoring	**110**	**110**	**110**	**172**	**223**	**681**	**677**	**900**
		RMP Total	**130**	**350**	**505**	**520**	**TBD**	**TBD**	**TBD**	**TBD**
		SWRCB Total	**15**	**15**	**40**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
		SFBRWQCB Total	**100**	**170**	**155**	**200**	**TBD**	**TBD**	**TBD**	**TBD**
		BACWA Total	**10**	**235**	**450**	**340 + TBD**	**TBD**	**TBD**	**TBD**	**TBD**
		IEP Total			**140+?**	**140+?**	**?>500k?**	**?>500k?**	**?>500k?**	**?>500k?**
		SFCWA Total			**50+?**	**50+?**	**TBD**	**TBD**	**TBD**	**TBD**
		Dischargers		**200**	**300**	**200**	**TBD**	**TBD**	**TBD**	**TBD**
		USGS Total	**400**	**400**	**470+?**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
		Overall Total	**555**	**880**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**

***** joint with RMP Forecasting Strategy ** $110K to USGS, $30K for stormwater loads *** Anticipated
TBD – To be determined.
[1] Forecasted for BACWA

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Forecasting (Modeling)

Relevant Management Policies and Decisions

- NPDES permits for nutrients
- The next iteration of the mercury and PCBs TMDLs
- Potential TMDLs for other contaminants
- Priorities for cleaning up local watersheds and contaminated margin sites
- Identifying best options for management actions to reduce impairment

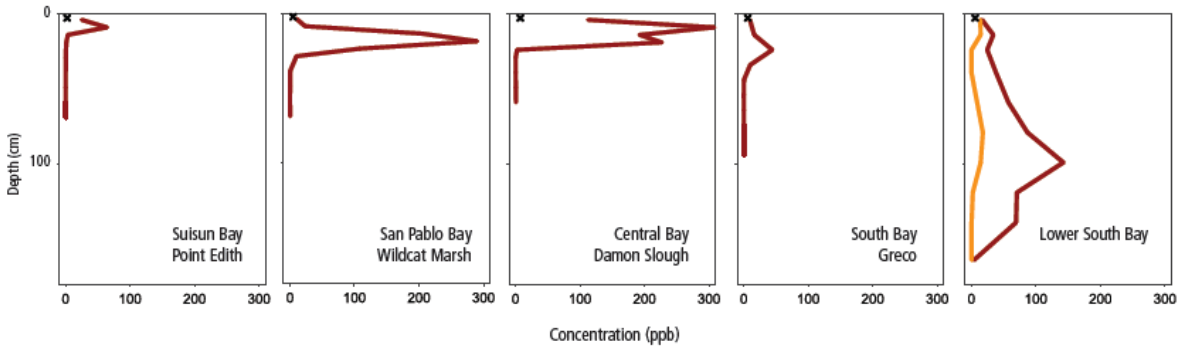
Recent Noteworthy Findings

- Sediment cores from open-water sites exhibited total mercury and PCB concentrations in deeper sediments that were generally similar to surface sediments, suggesting diminished concern for prolonged recovery due to erosion of contaminated subsurface material.
- Sediment cores from wetland sites showed wide fluctuations with peak concentrations of mercury and PCBs corresponding to approximately 1960. The wetland cores are subject to minimal mixing, and thus preserve a signal of past variation in loading and concentrations in the Bay.

Priority Questions for the Next Five Years

1. What patterns of exposure are forecast for major segments of the Bay under various management scenarios?
2. What is the contribution of contaminated Bay margins to Bay impairment?
3. What are the projected impacts of Bay margin management actions to Bay recovery?

PCBs in Wetland Cores



Sediment cores from Bay tidal marshes provide a clear picture of trends over time because of the consistent deposition and lack of vertical mixing in the marsh environment. Six wetland cores examined by RMP document drastic decreases in PCB concentrations since the 1960s. In Wildcat Marsh, for example, concentrations dropped from a maximum of 290 ppb at a depth of 19 cm to 10 ppb at a depth of 4 cm, a 97% decrease. These wetland cores document a major reduction in loads from local watersheds and in concentrations in the Bay.

FORECASTING (MODELING)

The ultimate goal of the Forecasting Strategy is to predict recovery of contaminated Bay regions and sites under different management scenarios. Efforts in the next few years will focus on modeling nutrients.

Forecasting studies in the RMP from 2010 to 2018. Numbers indicate budget allocations in $1000s.

Element	Funding Agency	Forecasting Questions Addressed	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Margins Conceptual Model	RMP	1,2,3	40									
Bioaccumulation Conceptual Model	RMP	1,2,3		40								
Bay Modeling*	RMP	1,2,3				100	100	200	~~TBD~~100	~~TBD~~50	~~TBD~~50	~~TBD~~50
	BACWA	1,2,3				TBD	TBD	TBD	TBD	TBD	TBD	TBD
RMP Total			**40**	**40**	**0**	**100**	**100**	**200**	**~~TBD~~100**	**~~TBD~~50**	**~~TBD~~50**	**~~TBD~~50**
Non-RMP Total					**0**	**0~~TBD~~**	**0~~TBD~~**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
Overall Total			**40**	**40**	**0**	**100~~TBD~~**	**100~~TBD~~**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**

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***** joint with Nutrient Strategy TBD – To be determined through synthesis efforts and workgroup discussion.

Emerging Contaminants

Relevant Management Policies and Decisions

- Development of State Water Board Policy on CECs in freshwater, coastal, and marine ecosystems
- Regional Water Board policy
- State Water Board Toxicity Policy
- Narrative water quality objectives prohibiting toxicity and water quality degradation

Recent Noteworthy Findings

- Perfluorinated chemicals in bird eggs are high relative to other locations that have been studied and in South Bay exceed a published health risk threshold.
- Triclosan was detected in sediment at seven out of ten sites with concentrations ranging from 5-10 ppb in the Central and South Bay, and a maximum of 40 ppb. Sediment toxicity thresholds are not available, but these concentrations may be of some concern.
- A screening study of alternative flame retardants generally found low concentrations. Some phosphate-based chemicals are present in sediment at levels comparable to PCBs and PBDEs; work is underway to determine if they accumulate in biota.
- A screening study of pharmaceuticals and personal care products generally found concentrations well below available acute and chronic toxicity thresholds.
- Chlorinated paraffin concentrations in the Bay also are low relative to other ecosystems.
- A small screening study (6 samples from 4 locations) in 2009 found nonylphenol concentrations in small fish ranging from 50 to 420 ppb, similar to other estuaries in California.

Priority Questions for the Next Five Years

1. What emerging contaminants have the greatest potential to adversely impact beneficial uses in the Bay?

Xx Delete "greatest"

Tier IV *High Concern*	*No CECs currently in this tier*
Tier III *Moderate Concern*	• PFOS • Fipronil • Nonylphenol • PBDEs
Tier II *Low Concern*	• HBCD • Pyrethroids* • Pharmaceuticals • Personal care products • PBDDs and PBDFs
Tier I *Possible Concern*	• Alternative flame retardants • Pesticides • Plasticizers • Many, many others

Conceptual tiered risk and management action framework for San Francisco Bay. The rankings continually evolve as new information becomes available.

EMERGING CONTAMINANTS

Emerging contaminant studies in the RMP have been augmented substantially by coordination and pro bono work. Completion of a two-year study developing a bioanalytical screening tool is a highlight for 2013-2014.

Emerging contaminant studies and monitoring in the RMP from 2008 to 2018. Numbers indicate budget allocations in $1000s. Matching funds and source indicated in parentheses. CDFO-Canada Department of Fisheries and Oceans; MMC-Marine Mammal Center; NIST-National Institute of Standards and Technology.

Element	Questions Address-ed	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Perfluorinated Compounds	1	35	52			87		TBD	TBD	TBD	TBD	TBD
Alternative Flame Retardants ~~(Duke Univ)~~	1	48						~~TBD~~107	TBD	TBD	TBD	TBD
Chlorinated Paraffins in Biota (CDFO)	1	0 (5)										
Triclosan in Sediment (USEPA)	1	0 (5)										
White Paper on ECs in Wastewater	1		30									
Nonylphenol in Small Fish (Cal Poly)	1		0 (2)									
AXYS Brominated Dioxins in Sediments and Biota (AXYS)	1			0(18)								
Broadscan Screening of Biota for EC (NIST, SCCWRP, MMC, SDSU)	1			55 (75)	70 (75)			~~TBD~~	TBD	TBD	TBD	TBD
AXYS Mussel Study (AXYS)	1			27 (33)								
NOAA Mussel Pilot Study (NOAA, SCCWRP, SWRCB)	1			33 (50)								
EC Synthesis, Strategy Development	1				30	30	20	20	20	20	20	20
Bioanalytical Tools	1						70	56	TBD	TBD	TBD	TBD
PBDE Synthesis	1						36					
Current Use Pesticides	1						15	~~TBD~~	TBD	TBD	TBD	TBD
EC Strategy Implementation	1								TBD	TBD	TBD	TBD
Nanoparticles (Duke Univ.)	1			0 (5)					TBD	TBD	TBD	TBD
General Allocation	1								80	80	80	80
RMP Total		**83**	**82**	**115**	**100**	**117**	**141**	**~~TBD~~246**	**TBD**	**TBD**	**TBD**	**TBD**
Non-RMP Total		**10**	**2**	**176**	**75**	**0**	**~~TBD~~0**	**~~TBD~~0**	**TBD**	**TBD**	**TBD**	**TBD**
Overall Total		**93**	**84**	**291**	**175**	**117**	**~~TBD~~141**	**~~TBD~~246**	**TBD**	**TBD**	**TBD**	**TBD**

Gray cells – further work on this topic not anticipated
Possibilities: additional work on flame retardants, broadscan followup

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Exposure and Effects

Relevant Management Policies and Decisions

- Implementation of sediment quality objectives
- The next iteration of the mercury TMDL
- Permitting decisions regarding dredging projects
- Continued implementation of narrative water quality objective prohibiting toxicity

Recent Noteworthy Findings

- In every year since RMP sampling began in 1993, 26% or more of sediment samples have been determined to be toxic to one or more test species. The causes of this toxicity remain unidentified.
- Studies have indicated that mercury is impairing hatchability of Forster's tern eggs in San Francisco Bay, but that the reduction of nest success at the TMDL bird egg monitoring target of 0.5 ppm is less than 10%.
- A study examining possible endocrine responses in shiner surfperch and staghorn sculpin found hormonal imbalances that appeared to be related to PCB exposure.
- Tern embryos are less sensitive to PBDE exposure than the most sensitive species studied (American Kestrel). Effects on tern embryos at the concentrations found in the Bay do not appear likely.

Priority Questions for the Next Five Years

Effects on Benthos

1. What are the spatial and temporal patterns of impacts of sediment contamination?
2. Which pollutants are responsible for observed impacts?
3. Are the toxicity tests, benthic community assessment approaches, and the overall SQO assessment framework reliable indicators of impacts?

Effects on Fish

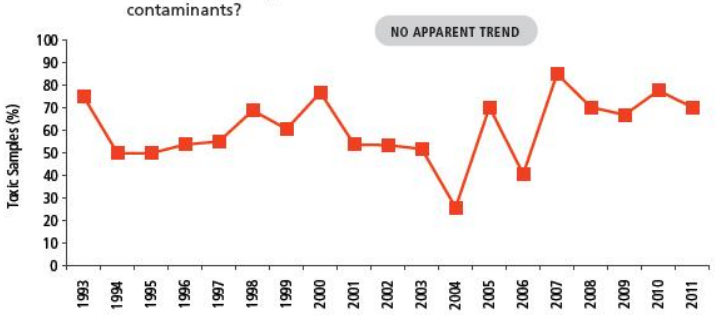
4. Are pollutants, individually or in combination, reducing the reproductive ability, growth, and health of sensitive fish populations?
5. What are appropriate thresholds of concern for contaminant concentrations for Bay species?
6. What are cost-effective indicators for monitoring effects of contaminants?

Effects on Birds

7. Is there clear evidence of pollutant effects on survival, reproduction, or growth of individual birds?
8. Are pollutants in the Bay adversely affecting bird populations?
9. What are appropriate guidelines for protecting bird populations that are at risk?
10. Do spatial patterns in accumulation indicate particular regions of concern?

Sorting benthos.
Photograph by Ellen Willis-Norton

Percent Toxic Sediment Samples



EXPOSURE AND EFFECTS

Studies to address information needs relating to dredged material testing are a priority for 2014.

Exposure and effects studies and monitoring in the RMP from 2008 to 2014. Numbers indicate budget allocations in $1000s.

	Element	Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Benthos	Benthic Assessment Tools	3	20	25	30		50	76	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~
	Causes of Sediment Toxicity: TIEs and LC50 Work	2	10	80								
	Causes of Sediment Toxicity: Molecular TIEs	2			60							
	Causes of Sediment Toxicity: Moderate Toxicity Strategy	2,3					50		~~TBD~~30	TBD	TBD	TBD
	USEPA Water Quality Synthesis (National Coastal Condition Assessment) (USEPA)	1,3				(100)	(50)					
	Hotspot Followup Study	1,2,3				60	30		~~TBD~~	~~TBD~~50	TBD	TBD
	Reference Site, Benthos Recovery After Dredging	1							50			
Fish	Endocrine Disruption in Fish	4,6	35									
	Effects of PAHs on Flatfish (NOAA)	4,5,6	40	50								
	Effects of Copper on Salmon (NOAA)	4,5				37		(38)				
Birds	Mercury and Selenium Effects on Terns (USGS)	7,8,9,10	75	54								
	PBDEs: Sensitivity in Terns	8			48							
RMP Total			**179**	**209**	**138**	**97**	**130**	**76**	**~~TBD~~80**	**TBD**	**TBD**	**TBD**
Non-RMP Total			**0**	**0**	**0**	**100**	**50**	**38**	**TBD**	**TBD**	**TBD**	**TBD**
Overall Total			**179**	**209**	**138**	**197**	**180**	**114**	**TBD**	**TBD**	**TBD**	**TBD**

Gray cells – further work on this topic not anticipated

Mercury

Relevant Management Policies and Decisions

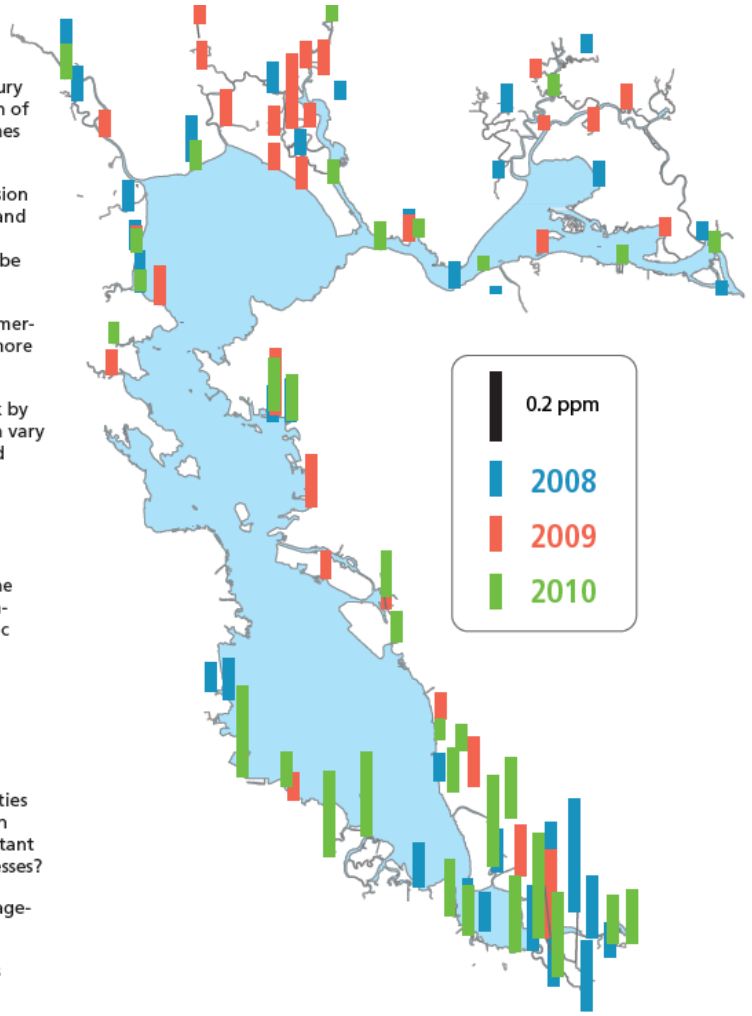
- Review new information and prepare plan to update the current mercury TMDL and implementation plan
- The next iteration of the mercury TMDL
- Identifying best options for management actions to reduce mercury impairment

Recent Noteworthy Findings

- The median mercury concentration in striped bass in 2009 was 0.44 ppm, higher than the TMDL target of 0.20 ppm. Concentrations have shown no decline since 1970.
- Monitoring of mercury in small fish indicates that a high proportion (85% in 2008-2010) of samples was above the 0.03 ppm TMDL target for wildlife prey.
- The small fish monitoring also indicates that concentrations are relatively high in the Lower South Bay region.
- Based on mercury concentrations in blood, nearly 60% of all breeding Forster's Terns sampled in the Bay are at high risk of toxic effects.
- Sediment cores suggest extensive transport and mixing of past loads and diminished concern for erosion of contaminated subsurface material.
- A mass budget for methylmercury indicates that in-Bay production of methylmercury is about 100 times greater than external loading.
- Source control (principally erosion of mining waste, stormwater, and wastewater) is being pursued but will take many decades to be effective.
- Control of internal net methylmercury production may achieve more rapid reductions.
- Opportunities for reducing risk by controlling internal production vary by habitat (open Bay, managed pond, tidal marsh).

Priority Questions for the Next Five Years

1. Where is mercury entering the food web? – we may have answered this sufficiently – topic for Strategy Team discussion.
2. Which processes, sources, and pathways contribute disproportionately to food web accumulation?
3. What are the best opportunities for management intervention for the most important pollutant sources, pathways, and processes?
4. What are the effects of management actions?
5. Will total mercury reductions result in reduced food web accumulation?



Mercury concentrations (ppm) in silverside from 2008-2010.

MERCURY

The Mercury Strategy began with a multi-year suite of studies in 2008. The synthesis completed in 2012 led to a focus on reducing methylmercury production in tidal marsh restoration projects and salt ponds.

Mercury and methylmercury studies and monitoring in the RMP from 2008 to 2017. Numbers indicate budget allocations in $1000s.

General Area	Element	Mercury Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mercury Strategy	Methylmercury Synthesis	1,2,3,4,5				75						
	Food Web Uptake (Small Fish) (Status and Trends)	1,4	150	150	150	20			~~TBD~~	TBD	TBD	TBD
	High Leverage Pathways (DGTs)	2	58	58								
	High Leverage Pathways (Isotopes)	2,5	40	40								
	Methylmercury Fate Model	3,4		25								
	Methylmercury in Marshes and Salt Ponds	1,3,4					25					
RMP Total			248	273	150	95	25	0	~~TBD~~0	TBD	TBD	TBD
Non-RMP Total			0	0	0	0	0	0	0~~TBD~~	TBD	TBD	TBD
Overall Total			248	273	150	95	25	0	0~~TBD~~	TBD	TBD	TBD

~~Possibilities: RFP to determine contribution of air dep, coordinated monitoring of wetland restoration impact on MeHg, dredged material re-use, fate on the margins in sensitive areas, effectiveness of management actions, demethylation patterns, marsh design, pond design and management, continued long-term monitoring to evaluate impact of climate change, awareness of safe eating guidelines~~

PCBs

Relevant Management Policies and Decisions

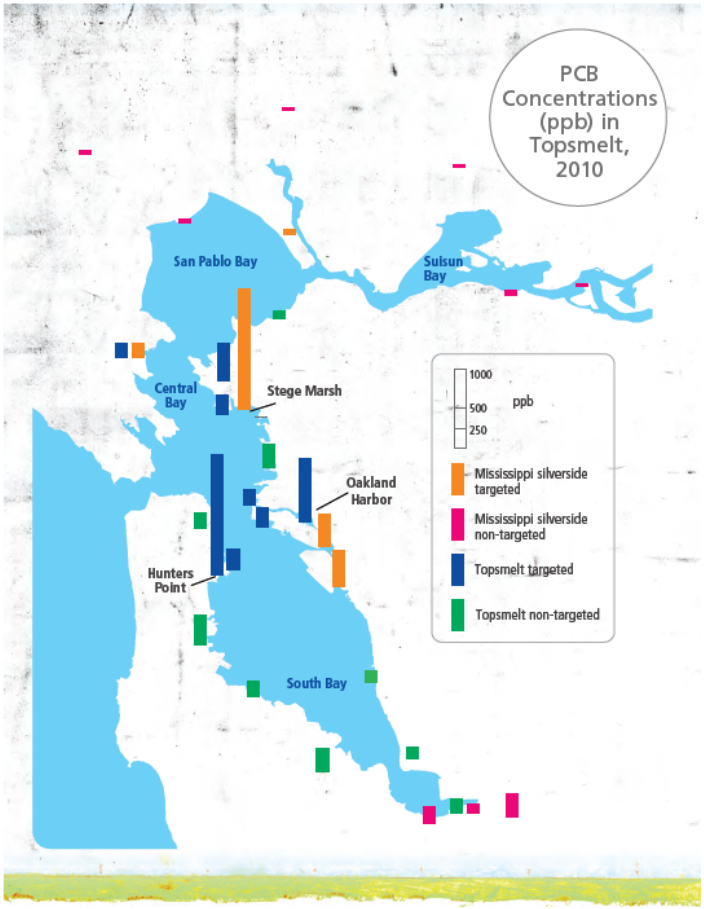
- Review new information and prepare plan to update the current TMDL
- The next iteration of the PCBs TMDL
- What management actions are the best options for reducing PCB impairment?

Recent Noteworthy Findings

- Sport fish were lower on a wet weight basis in the most recent sampling (2009), though on a lipid weight basis concentrations were comparable to past sampling rounds.
- Risks to fish-eating birds persist. In 2000-2003, 17% of 149 tern eggs were above an effects threshold.
- Small fish accumulate high concentrations of PCBs that correlate with concentrations in sediment.
- Bivalve monitoring continues to indicate declines, with half-lives ranging among stations from 7 to 14 years, and longer half-lives in the South Bay.
- Bay sediment appears to be cleaner than in the 1990s. The Bay-wide average was 7.0 ppb in 2004-2009 compared to 31 ppb in the 1990s. A different sampling design and different methods probably contribute to this apparent decrease.
- Average concentrations in Suisun Bay sediments are lower than in the other Bay segments.
- Bay cores show some areas with higher concentrations at depth, but this is less of a concern than previously thought.
- A new PCB has been identified in effluents and the environment across the U.S. PCB 11 and several other PCBs are inadvertent by-products in the manufacturing of commonly used pigments. These pigment PCBs are distinct from the Aroclor-derived PCBs that are the subject of the PCBs TMDL.

Priority Questions for the Next Five Years

1. What potential for impacts on humans and aquatic life exists due to PCBs?
2. What are appropriate guidelines for protection of beneficial uses?
3. What is the total maximum daily load of PCBs that can be discharged without impairment of beneficial uses?
4. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
5. What are the present loads and long-term trends in loading from each of the major pathways?
6. What role do in-Bay contaminated sites play in segment-scale recovery rates?
7. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?
8. What management actions have the greatest potential for accelerating recovery or reducing exposure?
9. What is the most appropriate index for sums of PCBs?



PCBs

Studies under the PCB Strategy began in 2010. A synthesis completed in 2013 will set the stage for a multi-year study plan for 2014 and beyond.

PCB studies and monitoring in the RMP from 2010 to 2017. Numbers indicate budget allocations in $1000s.

General Area	Element	PCB Questions Addressed	2010	2011	2012	2013	2014	2015	2016	2017
PCB Strategy	Food Web Uptake (Small Fish)	1,7	50				~~TBD~~	TBD	TBD	TBD
	PCB Conceptual Model Update	1,2,3,4,5,6,7,8,9		53			~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~
	Priority Margin Site Conceptual Models							40	60	
	Priority Margin Site Monitoring							40	100	100

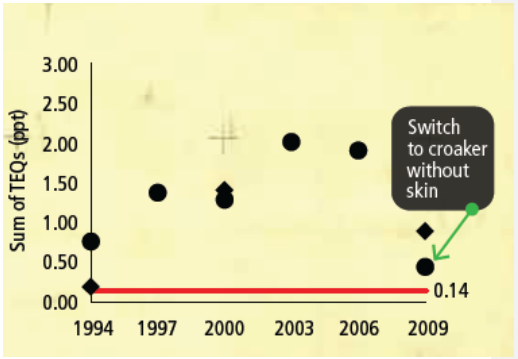
DIOXINS

Relevant Management Policies and Decisions

- Reissue permit requirements in 2013-2014
- Review 303(d) listings
- Establish TMDL development plan in 2013-2014

Recent Noteworthy Findings

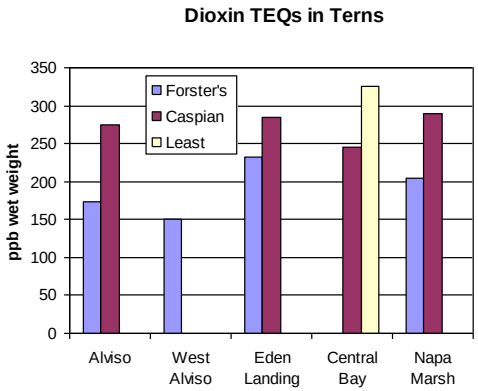
- The key sport fish indicator species (shiner surfperch and white croaker) have been higher than the Water Board screening value of 0.14 ppt and show no sign of decline, but there is a great deal of uncertainty regarding the human health risk associated with dioxins in sport fish.
- Dioxin-toxic equivalents in Least Tern, Caspian Tern, and Forster's Tern eggs are at or above estimated thresholds for adverse effects; risks especially significant in combination with dioxin-like PCBs.
- Few data on dioxins are available on other priority questions – the Dioxin Strategy was developed to address this need.
- Recent wetland cores suggest rapidly declining inputs from local watersheds during recent decades, though additional coring data are needed to support this hypothesis



Dioxin and furan TEQ concentrations (ppt) in white croaker (circles) and shiner surfperch (diamonds). Baywide averages.

Priority Questions for the Next Five Years

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



Mean concentrations of dioxin and furan TEQs in three tern species, 2000-2003. Mean concentrations for the California Least Tern fall within the effects threshold range. Concentrations within the effects threshold range were observed in some eggs of all species. From Adelsbach and Maurer (2007).

DIOXINS

Dioxin studies and monitoring in the RMP from 2008 to 2017. Numbers indicate budget allocations in $1000s. Unlike the other contaminants, dioxin costs have generally been itemized explicitly as add-ons to RMP studies.

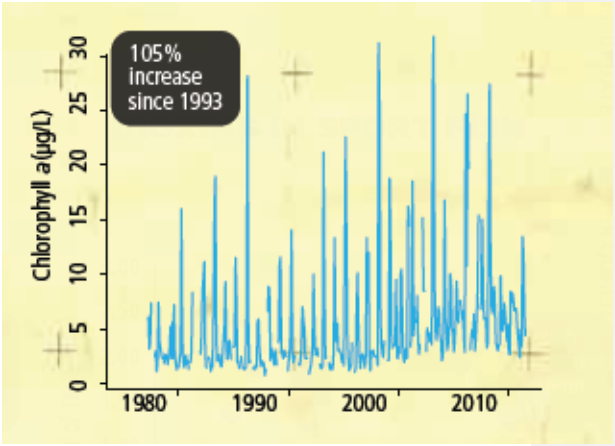
Dioxin Strategy studies began in 2008, with a multi-year plan extending through 2013. Synthesis activities are planned for 2015 after the data from the earlier studies are available.

General Area	Element	Dioxin Questions Addressed	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Dioxin Strategy	Quality Assurance	1,2,3,4,5,6		14						TBD	TBD	TBD
Status and Trends	Sport Fish	1,2,4		22					24	TBD	TBD	TBD
	Avian Eggs	1,2,4					13			TBD	TBD	TBD
	Surface Sediments	2,3		58	58					TBD	TBD	TBD
	Water	2,3		26		26				TBD	TBD	TBD
Loads	Small Tributary Loading	4,5,6			65		52			TBD	TBD	TBD
	River Loading (THg)	4,5,6			34					TBD	TBD	TBD
Forecast	Sediment Cores	3,4,6			57					TBD	TBD	TBD
	Synthesis: One-Box Model	3,4,5,6								20	TBD	TBD
	Synthesis: Food Web Model	5,6								20	TBD	TBD
Loads	Atmospheric Deposition	5,6			20					TBD	TBD	TBD
RMP Total			0	120	234	26	65	0	TBD	TBD	TBD	TBD
Non-RMP Total			0	0	0	0	0	0	TBD	TBD	TBD	TBD
Overall Total			0	120	234	26	65	0	TBD	TBD	TBD	TBD

STATUS AND TRENDS

Relevant Management Decisions

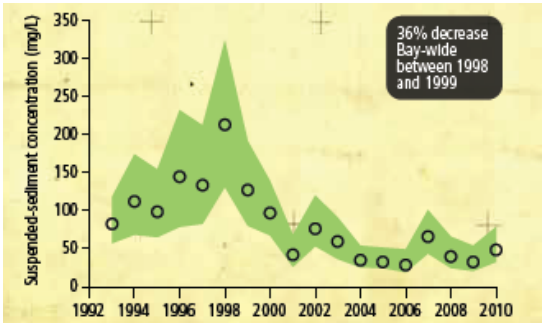
- Revision of Mercury and PCB TMDLs in 2016-2020
- Development of Se TMDL in 2013-2014 (North Bay) and 2015 beyond (South Bay)
- De-listing of legacy pesticides (2012-2013)
- Evaluation of sediment and water quality objectives
    - Copper site-specific objective and cyanide anti-degradation policy
    - 303 (d) listings
    - Reasonable potential analysis
- Dredged material management
    - Defining ambient conditions in Bay (PCBs, Hg, PAHs, etc.)
- Identification of causes of sediment toxicity in the Bay
- Development of and assessment with nutrient numeric endpoints; management of ammonium
- Providing fundamental science to evaluate the health of the Bay and to model the fate and transport of contaminants.



Chorophyll trend in the South Bay.

Recent Advances in Understanding

- Annual sampling of water and sediment chemistry has documented a general lack of trend in persistent pollutants and spatial patterns that vary by pollutant but are consistent from year to year.
- A sudden decrease in suspended sediment concentrations occurred in 1999.
- Increasing chlorophyll concentrations have been observed in the Bay and are attributed to a variety of possible drivers (e.g., decrease in SSC concentrations and an increase in bivalve predators).



Suspended sediment trend at a representative station.

- PBDEs appear to be leveling off (BDE 47) or declining (BDE 209)
- Concentrations of mercury in sediment correlate poorly with methylmercury in sediment (MeHg represents 1% of total Hg).

Priority Questions for the Next Five Years

1. Are chemicals at levels of concern?
2. What are the concentrations and masses of priority contaminants?
3. Have concentrations and masses increased or decreased?

STATUS AND TRENDS

Status and trends monitoring budget allocations in the RMP from 2012 to 2018. Allocations are spread evenly over the years, even though the expenditures (see next page) occur intermittently.

	2013	2014	2015	2016	2017	2018
% increase subcontractors	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
STATUS AND TRENDS TOTAL	**$1,057,400**	**$1,033,663**	**$1,191,072**	**$1,203,524**	**$1,217,444**	**$1,231,711**
Water Chemistry (biennial 22 sites)	$81,667	$83,708	$85,801	$61,250	$62,781	$64,351
Aquatic Toxicity (every five years)	$2,333	$2,392	$2,451	$1,000	$1,025	$1,051
Bivalves (biennial 11 sites)	$22,500	$23,063	$23,639	$24,230	$24,836	$25,457
Sediment Chemistry (biennial 47 sites dry/47 wet)	$92,500	$92,500	$94,813	$97,183	$99,612	$102,103
Sediment Toxicity (biennial, margins only, dry and wet, 27 sites)	$25,750	$0	$0	$27,054	$27,730	$28,423
Sediment Benthos (quadrennial, margins only, dry 27 sites)	$30,900	$0	$15,836	$16,232	$16,638	$17,054
Fieldwork and Logistics and Vessel	$218,000	$184,000	$215,250	$220,631	$226,147	$231,801
Suspended Sediment in SF Bay	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000
Hydrography and Phytoplankton	$110,000	$173,000	$223,000	$223,000	$223,000	$223,000
Fish Contamination Study (quintennial)	$0	$0	$54,000	$55,350	$56,734	$58,152
Cormorant Eggs (triennial)	$25,000	$25,625	$26,266	$26,922	$27,595	$28,285
Forster's Tern Eggs (triennial)	$25,000	$25,625	$26,266	$26,922	$27,595	$28,285
Archiving	$8,750	$8,750	$8,750	$8,750	$8,750	$8,750
Data Management	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000

	~~2013~~	~~2014~~	~~2015~~	~~2016~~	~~2017~~	~~2018~~
~~% increase subcontractors~~	~~2.5%~~	~~2.5%~~	~~2.5%~~	~~2.5%~~	~~2.5%~~	~~2.5%~~
~~**STATUS AND TRENDS TOTAL**~~	~~**$1,057,400**~~	~~**$1,033,663**~~	~~**$1,217,465**~~	~~**$1,203,524**~~	~~**$1,217,444**~~	~~**$1,231,711**~~
~~Water Chemistry (biennial 22 sites)~~	~~$81,667~~	~~$83,708~~	~~$85,801~~	~~$61,250~~	~~$62,781~~	~~$64,351~~
~~Aquatic Toxicity (every five years)~~	~~$2,333~~	~~$2,392~~	~~$2,451~~	~~$1,000~~	~~$1,025~~	~~$1,051~~
~~Bivalves (biennial 11 sites)~~	~~$22,500~~	~~$23,063~~	~~$23,639~~	~~$24,230~~	~~$24,836~~	~~$25,457~~
~~Sediment Chemistry (biennial 47 sites dry/47 wet)~~	~~$92,500~~	~~$92,500~~	~~$94,813~~	~~$97,183~~	~~$99,612~~	~~$102,103~~
~~Sediment Toxicity (biennial, margins only, dry and wet, 27 sites)~~	~~$25,750~~	~~$0~~	~~$26,394~~	~~$27,054~~	~~$27,730~~	~~$28,423~~
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~~Suspended Sediment in SF Bay~~	~~$250,000~~	~~$250,000~~	~~$250,000~~	~~$250,000~~	~~$250,000~~	~~$250,000~~
~~Hydrography and Phytoplankton~~	~~$110,000~~	~~$173,000~~	~~$223,000~~	~~$223,000~~	~~$223,000~~	~~$223,000~~
~~Fish Contamination Study (quintennial)~~	~~$0~~	~~$0~~	~~$54,000~~	~~$55,350~~	~~$56,734~~	~~$58,152~~
~~Cormorant Eggs (triennial)~~	~~$25,000~~	~~$25,625~~	~~$26,266~~	~~$26,922~~	~~$27,595~~	~~$28,285~~
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~~Archiving~~	~~$8,750~~	~~$8,750~~	~~$8,750~~	~~$8,750~~	~~$8,750~~	~~$8,750~~
~~Data Management~~	~~$165,000~~	~~$165,000~~	~~$165,000~~	~~$165,000~~	~~$165,000~~	~~$165,000~~

Status and Trends sampling was scaled back significantly in 2012, with a change from annual to biennial sampling of water and sediment. The amount of information gained from annual sampling was diminishing, while needs for special studies to generate information on other topics were increasing. The reduction of Status and Trends effort freed up approximately $400,000 per year for studies on other topics.

STATUS AND TRENDS

Actual (2012-2013) and anticipated (2014-2019) status and trends monitoring expenditures in the RMP from ~~2013~~ 2012 to 2019, indicating the years in which sampling is planned to actually occur. Projections are in 2012 dollars.

	2012	2013	2014	2015	2016	2017	2018	2019
Water Chemistry (biennial 22 sites)	$0	$55,000	$0	$190,000	$0	$55,000	$0	$190,000
Aquatic Toxicity (every five years)	$0	$0	$0	$7,000	$0	$0	$0	$0
Bivalves (biennial 11 sites)	$~~60~~45,000	$0	$~~60~~45,000	$0	$~~60~~45,000	$0	$~~60~~45,000	$0
Sediment Chemistry (biennial 47 sites dry/27 wet)	$110,000	$0	$185,000	$0	$110,000	$0	$185,000	$0
Sediment Toxicity (biennial 27 sites dry/27 wet)	$51,500	$0	$~~51,500~~0	$0	$51,500	$0	$51,500	$0
Sediment Benthos (biennial 27 sites dry/27 wet)	$61,800	$0	$~~61,800~~0	$0	$61,800	$0	$~~61,800~~0	$0
Fieldwork and Logistics	$214,000	$~~221~~192,000	$~~214~~230,000	$~~221~~192,000	$~~214~~230,000	$~~221~~192,000	$~~214~~230,000	$~~221~~192,000
Fish Contamination Study (~~triennial~~quintennial)	$0	$0	$270,000	$0	$0	$0	$0	$270,000
Cormorant Eggs (triennial)	$75,000	$0	$0	$75,000	$0	$0	$75,000	$0
Forster's Tern Eggs (triennial)	$75,000	$0	$0	$75,000	$0	$0	$75,000	$0

PROGRAM MANAGEMENT

- Includes four general categories of activities
  - Program Management ($~~255,000~~266,000)
    - Internal coordination (staff management), coordination with Program participants, external coordination with related groups, Program planning
  - Contract and Financial Management ($~~160,000~~179,000)
  - Workgroup and Peer Review Coordination ($~~110,000~~221,000 - includes honoraria and travel)

Program Review

Periodically, the RMP conducts an overall peer review of the Program as a whole. Two Program Reviews have been conducted to date, in 1997 and in 2003. The timing and scope of Program Reviews are determined by the Steering Committee.

- The RMP has evolved considerably since the 2003 Review, with greatly enhanced planning processes that have made the Program much more forward-looking and thoroughly peer-reviewed.
  - Workgroups have been permanently established to address the major topical areas of the Program.
  - Strategy Teams consisting of stakeholders and local scientists have been formed to identify the highest priority management questions on important topics and to formulate long-term workplans to answer them.
  - The Steering Committee has also taken a more forward-thinking approach, capturing all of the workgroup and strategy team plans in a RMP Master Plan, and in holding an annual planning workshop (beginning in 2010) to provide direction to all of the subcommittees.
  - With carefully considered guidance from stakeholders and peer reviewers, the RMP has prioritized and addressed the topics recommended in the 2003 review, and is continually sharpening its focus on using the resources that are available in an efficient manner to provide the information that is most needed to support TMDLs and other management initiatives.
- The Steering Committee does not consider a Program Review appropriate in 2013 because ongoing review of critical elements is well established. A Review will be conducted after the Master Planning process has become established and when a clear need for an overarching review becomes apparent.

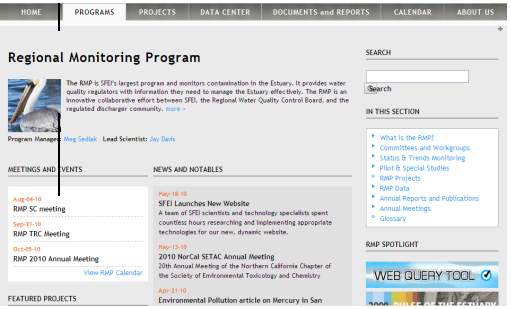
Peer Review

Extensive peer review is a key to the cost-effective production of reliable information in the RMP. This peer review is accomplished through the following mechanisms.

- Workgroups. The RMP Workgroups include leading scientists that work with stakeholders to develop workplans. Peer review occurs at all stages of a project: planning, implementation, and reporting.
- Technical Review Committee. Provides general technical oversight of the Program.
- Peer-reviewed Publications. Another layer of peer review occurs when journal publications are prepared. This occurs for most significant RMP studies.

COMMUNICATIONS

- Averages $275,000 per year (8% of the total budget).
- Includes the Pulse of the Estuary, Annual Meeting, Multi-Year Plan, State of the Estuary report card, RMP web site, Annual Monitoring Results, technical reports, journal publications, newsletter, oral presentations and posters, media outreach.
- These platforms are used to make information from the RMP available to the following target audiences.
    - Primary Audience
        - RMP Participants. Need information to encourage support for the RMP and water quality programs in the Bay. The Pulse, Annual Meeting, Multi-Year Plan, State of the Estuary report card, RMP web site, newsletter, fact sheets, oral presentations, media outreach.
    - Secondary Audiences
        - Other regional managers. Need information to inform their decisions and evaluate effectiveness of their actions. A target audience for all communication products.
        - Regional law and policy makers. Need information to encourage support for water quality programs in the Bay. The Pulse, State of the Estuary report card, media outreach.
        - Regional Scientists. Need to share information to increase understanding of water quality and maintain technical quality of the science. A target audience for all communication products.
        - Media, public outreach specialists, educators. Need information to encourage support for the RMP and water quality programs in the Bay, and to protect their health. The Pulse, Master Plan, State of the Estuary report card, RMP web site, newsletter, fact sheets, media outreach. and scientists from other regions.
        - Managers



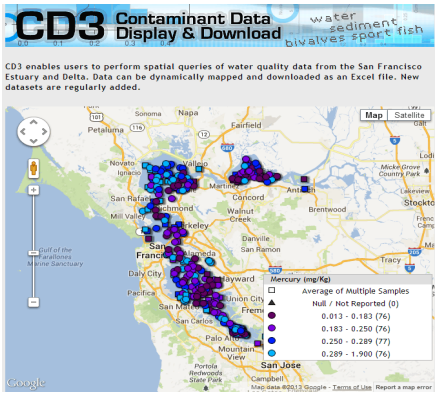
Highlights for the Next Five Years

- Next Pulse: ~~CECs in 2013~~2015
- Closer partnership with SFEP to reach broader audience
- Annual Meeting joint with State of the Estuary in ~~2013~~2015
- Workshops: xx~~Methylmercury in restored marshes and salt ponds~~
- Continued web site improvement

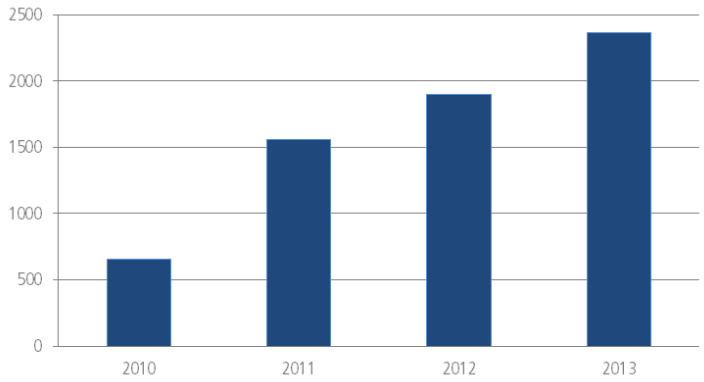
Home page for the RMP web site.

DATA MANAGEMENT AND QUALITY ASSURANCE

- **Data Management** ($~~125,000~~289,000 per year)
  - The RMP database contains approximately ~~900,000~~xx records generated since the Program began in 1993.
  - Includes formatting, uploading, and reporting each year's data; managing, maintaining, and improving the RMP database to enable easy access to RMP data through the RMP website; coordination with statewide data management initiatives (i.e., SWAMP and CEDEN); support for quality assurance evaluation, data analysis, and RMP report production.
  - Web-based data access tools include user-defined queries, data download and printing functionality, maps of sampling locations, and visualization tools. Through the user-defined query tool, results can be downloaded into Excel in both a cross-tabulated and flat-file format. Dynamic mapping of concentrations allows users to view spatial distributions across the Estuary, and statistical functions, such as cumulative distribution function plots, provide aggregated summaries.
  - These platforms are used to make information from the RMP available to water quality managers, stakeholders, scientists, and the public.



A data display by the RMP CD3 Tool.



2400 users used the Contaminant Data Display and Download Tool in 2013.

- **Quality Assurance** ($~~30,000~~30,000 per year)
  - Includes QA review of the data that are submitted by the laboratories. Development and application of the QAPP. Review in comparison to data quality objectives and prior results. Review of congener ratios.
  - Troubleshooting problems with chemical analyses.
  - Occasional special studies to assess sampling methods, analytical methods, or lab performance.

New Initiatives for the Next Five Years

- Efficiencies in Data Uploading and Formatting
- Enhancement of Visualization Tools
- Coordination with the Estuary Portal
- Coordination with SFEI ~~Data Access Initiative: "Project~~

RMP AND NON-RMP STUDIES RELATED TO WATER QUALITY IMPACTS OF DREDGING AND DREDGED MATERIAL DISPOSAL

Notable Activities

- In 2011 the RMP created a web page to provide the latest information on thresholds for bioaccumulation testing and in-Bay disposal (http://www.sfei.org/content/dmmo-ambient-sediment-conditions). These thresholds are based on RMP Status & Trends data.

Dredging related studies. Dollar amounts in thousands.

	Study	2009	2010	2011	2012	2013	2014	2015	2016	2017
RMP Status & Trends	S&T Sediment Triad	260	250	250	250		250		250	
RMP Status & Trends	USGS Suspended Sediment Studies	250	250	250	250	250	250	250	250	250
RMP Exposure and Effects	Benthic Assessment Tools		30		50	76				
RMP Exposure and Effects	Causes of Sediment Toxicity: TIES	76								
RMP Exposure and Effects	Causes of Sediment Toxicity: Molecular TIES		60							
RMP Exposure and Effects	Causes of Sediment Toxicity: Moderate Toxicity Strategy				50		30			
RMP Exposure and Effects	~~New Reference Site(1), Recovery of Benthos After Dredging~~Impact of Dredging on Benthos						50			
RMP Exposure and Effects	Effects of PAHs on Flatfish	50								
RMP Exposure and Effects	Hotspot Followup			60	30			50		
LTMS	Eelgrass Buffer Zone Study(2) - proposed									

1 identifying a reference site for toxicity testing rather than referring to disposal sites
2 evaluating the appropriateness of the 250 foot buffer zone in effect to protect eelgrass from dredging

RMP STUDIES SATISFYING SPECIFIC PERMIT CONDITIONS

Industrial Wastewater Treatment Plants

Policy	Provision	Study
Mercury Watershed Permit	Better understand mercury fate, transport, the conditions under which methylation occurs, and biological uptake	Mercury Strategy Studies: Food Web Uptake (small fish), DGTs, Isotopes
Copper Action Plan	Investigate possible copper sediment toxicity	S&T Sediment Toxicity
Copper Action Plan	Investigate sublethal effects on salmonids	Effects of Copper on Salmon (NOAA)

RMP STUDIES SATISFYING SPECIFIC PERMIT CONDITIONS

Municipal Wastewater Treatment Plants

Policy	Provision	Study
Mercury Watershed Permit	Better understand mercury fate, transport, the conditions under which methylation occurs, and biological uptake	Mercury Strategy Studies: Food Web Uptake (small fish), DGTs, Isotopes
Copper Action Plan	Investigate possible copper sediment toxicity	S&T Sediment Toxicity
Copper Action Plan	Investigate sublethal effects on salmonids	Effects of Copper on Salmon (NOAA)

RMP STUDIES SATISFYING SPECIFIC PERMIT CONDITIONS

Urban Stormwater

Policy	Provision	Study
Municipal Regional Stormwater Permit (MRP)	C.8.e Pollutants of Concern and Long-Term Trends Monitoring	Small Tributary Loading Strategy (STLS) Studies
MRP	C.11.b. Monitor Methylmercury	STLS
MRP	C.11.g. Monitor Stormwater Mercury Pollutant Loads and Loads Reduced	STLS
MRP	C.11.h. Fate and Transport Study of Mercury in Urban Runoff	Mercury Strategy Studies (Small Fish, DGTs, Isotopes); Modeling Strategy Studies
MRP	C.12.g. Monitor Stormwater PCB Pollutant Loads and Loads Reduced	STLS
MRP	C.12.h. Fate and Transport Study of PCBs in Urban Runoff	PCBs in small fish, Modeling Strategy Studies, Priority Margin Site Studies
MRP	C.13.e. Studies to Reduce Copper Pollutant Impact Uncertainties	S&T Sediment Toxicity, Effects of Copper on Salmon (NOAA)
MRP	C.14.a. Control Program for PBDEs, Legacy Pesticides, and Selenium.	STLS