



RMP
**REGIONAL MONITORING
PROGRAM FOR WATER QUALITY
IN SAN FRANCISCO BAY**

sfei.org/rmp

MULTI-YEAR PLAN
2017 ANNUAL UPDATE

FINAL: January 2017

Approved by Steering Committee, 1/17/17

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 ensuing years has been a successful and effective partnership of regulatory agencies and the regulated community.

The goal of the RMP is to collect data and communicate information about water quality in San Francisco Bay in support of management decisions.

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.

RMP PLANNING

This collaboration and adaptation is achieved through the participation of stakeholders and scientists in frequent committee and workgroup meetings (Figure 1).

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

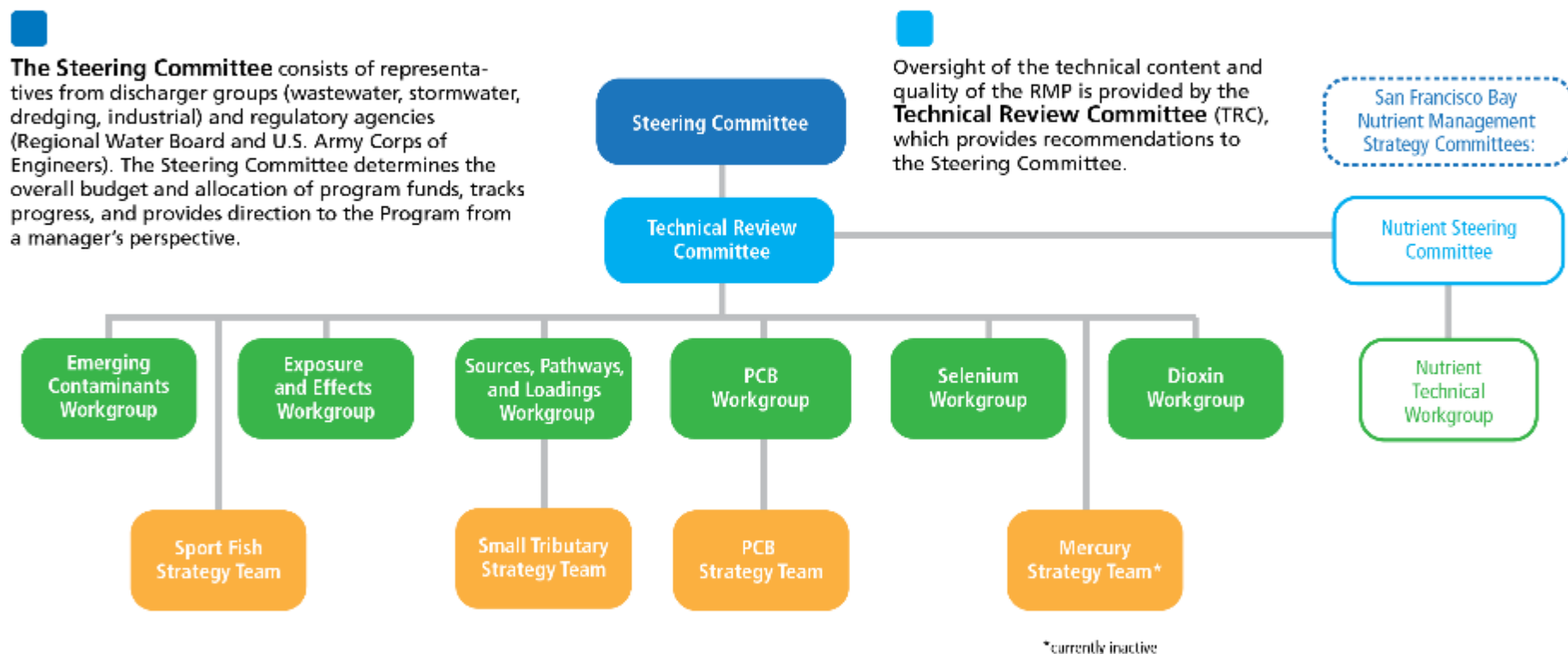
The purpose of this document is to guide efforts and summarize plans developed within the RMP. The intended audience includes representatives of the many organizations who directly participate in the Program. This document will also be useful for individuals who are not directly involved with the RMP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

Figure 1. Collaboration and adaptation in the RMP are achieved through the engagement of stakeholders and scientists in frequent committee and workgroup meetings.

PROGRAM OVERSIGHT

Collaboration and adaptation in the RMP are achieved through the engagement of stakeholders and scientists in frequent committee and workgroup meetings.

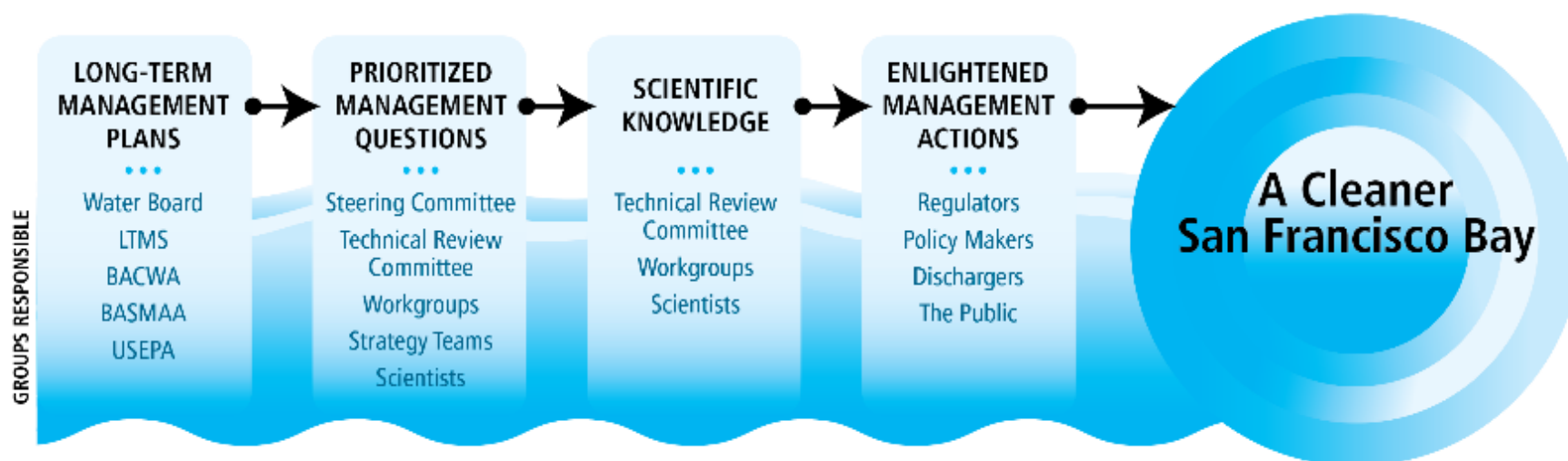


Workgroups report to the TRC and address the main technical subject areas covered by the RMP. The Nutrient Technical Workgroup was established as part of the committee structure of a separate effort - the Nutrient Management Strategy - but makes recommendations to the RMP committees on the use of the RMP funds that support nutrient studies. 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 special studies.

RMP strategy teams constitute one more layer of planning activity. These stakeholder groups meet as needed to develop long-term RMP study plans for addressing high priority topics.

*currently inactive

Figure 2. Science in support of water quality management.



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 the current focus areas: PCBs, dioxins, selenium, emerging contaminants, small tributary loads, exposure and effects, and nutrients. 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 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: Status and Trends Monitoring, Program Management, Communications, Data Management, and Quality Assurance.

Section 5 contains lists of RMP studies that are relevant to specific permit conditions for dredging, wastewater discharges, and stormwater discharges.

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 before 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 Detailed Workplan (available at www.sfei.org/rmp).

Figure 3. Annual planning calendar for the Regional Monitoring Program.

Annual Steering Committee Calendar

- January
 - Approve Multi-Year Plan
 - Review of incomplete projects from the previous year
 - Approve annual report outline
- April
 - Plan for Annual Meeting
 - Provide additional planning guidance to workgroups
- July
 - Multi-year Plan: mid-year check-in, workshop planning
 - Approve special studies recommended by the TRC for the next year and update projects list for SEP funding
 - Plan for Annual Meeting
 - Report on SFEI financial audit
 - Briefly discuss fees for year after next
 - Select annual report theme for next year
- October
 - Confirm chair(s) and Charter
 - Planning Workshop
 - Decision on fees for the year after next
 - Approve workplan and budget for next year
 - Approve general Pulse outline for next year
 - Decision on workshops to be held next year

Each meeting (except October) includes a Science Program Update from a workgroup or strategy team focus area.

Annual Technical Review Committee Calendar

- March
 - Confirm chair(s)
 - Provide additional planning guidance to workgroups
- June
 - Recommend special studies for funding
 - Review S&T target analyte list, CEC tiers
 - Review plans for Annual Meeting and annual report
- September
 - Prepare for Annual Meeting
- December
 - Review Pulse outline for next year
 - Informatics update
 - Present workplan for next year and outcome of Multi-Year Planning Workshop

Each meeting includes a Science Program Update from a workgroup or strategy team focus area, and feedback on current and proposed studies.

Annual Workgroup Calendar

Workgroups meet annually in April-June to discuss results from prior studies and select proposals to recommend to the TRC and SC for funding for the next year.

Agendas and meeting summaries available at <https://sites.google.com/a/sfei.org/rmp-operations/home/workgroup-notes>

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

Decisions, Policies, and Actions	Timing
<i>ONGOING AND EXISTING</i>	
<i>Determination of Permit Limits</i>	Ongoing
<i>Long-Term Management Strategy for Placement of Dredged Material/Dredged Material Management Office</i>	Ongoing
<i>Regional Sediment Management Strategy</i>	
<i>Dredging Permits</i>	
Bioaccumulation testing triggers and in-Bay disposal levels ⁺	2015, 2019,...
<i>303(d) List and 305(b) Report</i>	2017, 2022
<i>Copper</i>	
Compare levels to site specific objectives triggers ⁺	2016, 2018,...
<i>Cyanide</i>	
Compare levels to site specific objectives triggers ⁺	2016, 2018,...
<i>Selenium</i>	
North Bay Selenium TMDL	2016
EPA Water Quality Criteria	2018
South Bay Selenium TMDL	>2017
<i>Dioxins</i>	
Review 303(d) listings and establish TMDL development plan or alternative	2018
<i>Mercury</i>	
Review existing TMDL and establish plan to revise [*]	2018
<i>PCBs</i>	
Review existing TMDL and establish plan to revise ^{**}	2020
<i>BAY WATERSHED PERMITS</i>	
<i>Municipal Regional Stormwater Permit</i>	2015, 2020 [*]
<i>Mercury and PCBs Watershed Permit for Municipal and Industrial Wastewater</i>	2017
<i>Nutrient Watershed Permit for Municipal Wastewater</i>	2019

* The schedules for revising the Mercury and PCB TMDLs coincide with the schedule for reissuing the Municipal Regional Stormwater Permit.

See meeting summary from 11/10/15 Planning Workshop for additional details.

+ Triggers will be updated on the RMP sampling frequency (every 4 years for sediment, every 2 years for water)

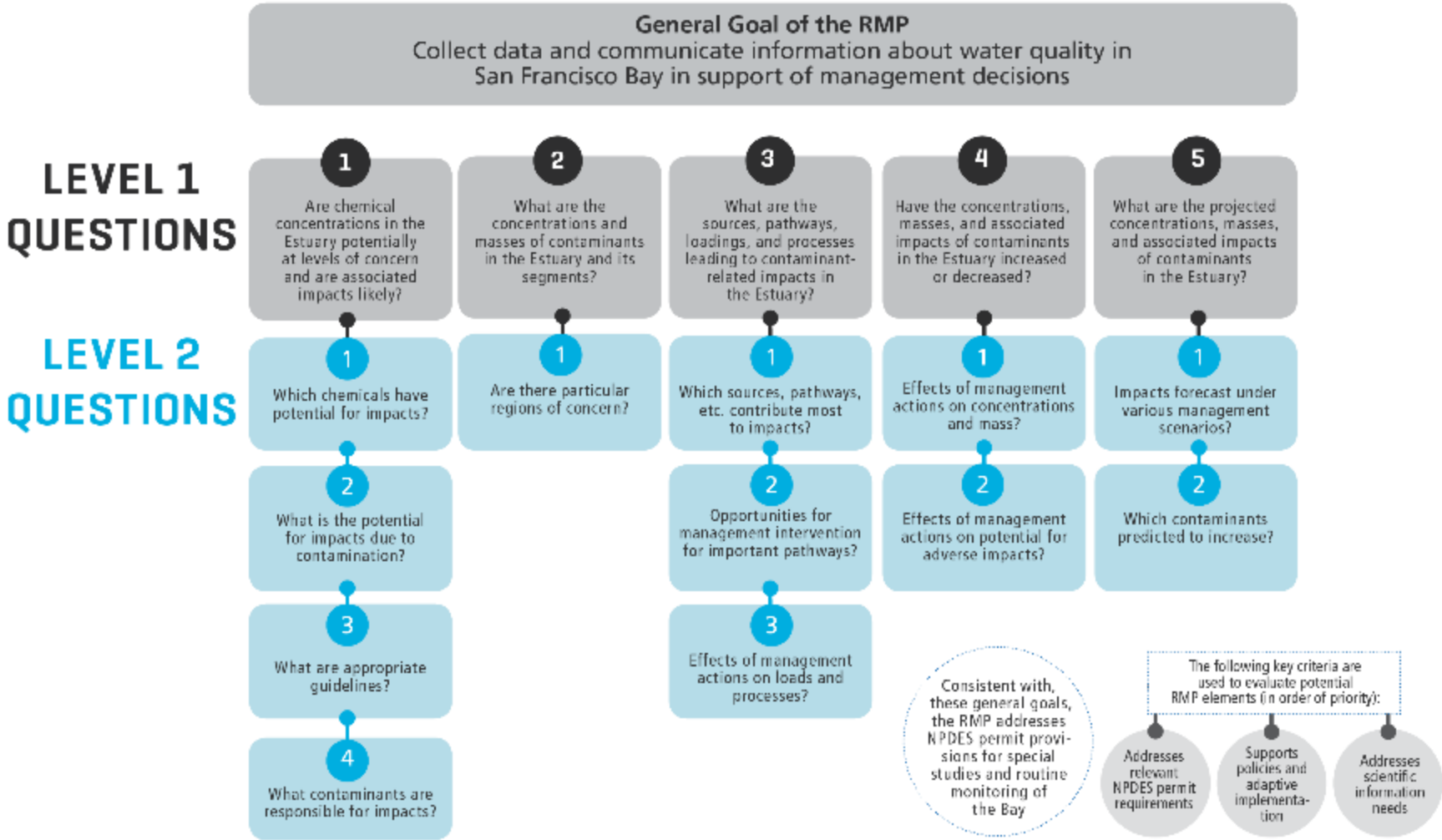
Decisions, Policies, and Actions	Timing
<i>NEW AND FUTURE</i>	
<i>Nutrients</i>	
Nutrient Management Strategy	Ongoing
Nutrient Water Quality Objective	2024
<i>Legacy Pesticides (DDT, Dieldrin, Chlordane)</i>	
Monitoring recovery	Ongoing
<i>Pathogens</i>	
Bay Beaches Bacteria TMDL	2016
<i>Chemicals of Emerging Concern</i>	
Review of RMP strategy	Annual
Development of action plans	
Pharmaceutical take-back programs	
Flammability Standards	
Safer Consumer Products regulations	
Federal significant new use rules	
<i>Toxicity</i>	
New state plan on effluent and receiving water toxicity	2017
<i>Suisun Marsh</i>	
Establish TMDL for DO, mercury, nutrients, salinity	2018
<i>Pesticides</i>	
USEPA Registration Review of fipronil and imidacloprid	2017
<i>Sediment Hot Spots</i>	
Review 303(d) listings and establish TMDL development plan or alternative	2017, 2022
<i>New beneficial uses related to tribal and subsistence fishing</i>	2017

Potential future management drivers for the RMP include accelerated wetland restoration with Measure AA funding and water quality impacts from increased water recycling. The RMP role in addressing these future management drivers has not yet been established, but may include studies of impacts and benefits of reusing biosolids, effluent, and reverse osmosis concentrate in the Baylands. The Program may also need to expand or develop partnerships to cover wetlands (e.g., a "Wetlands RMP").

PROGRAM HIGHLIGHTS

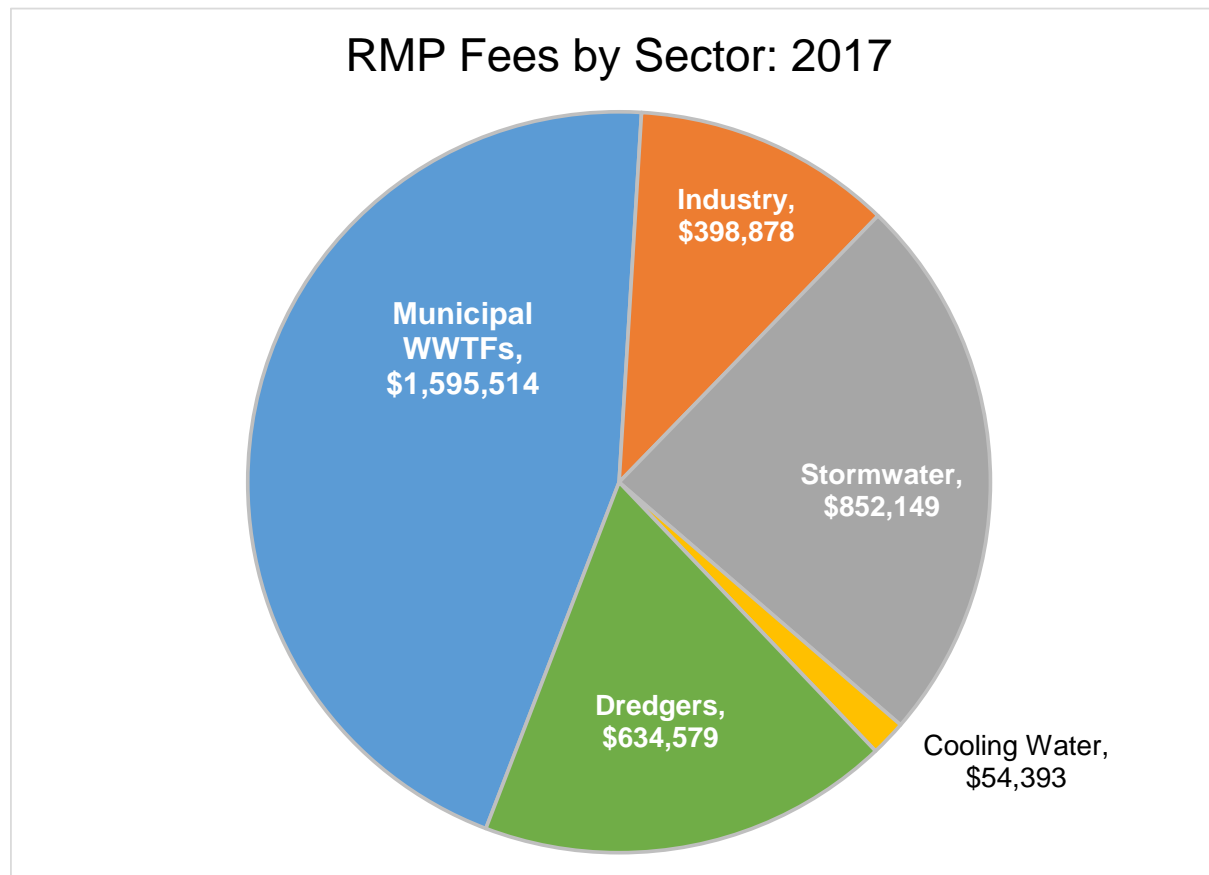
RMP GOAL AND MANAGEMENT QUESTIONS

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.



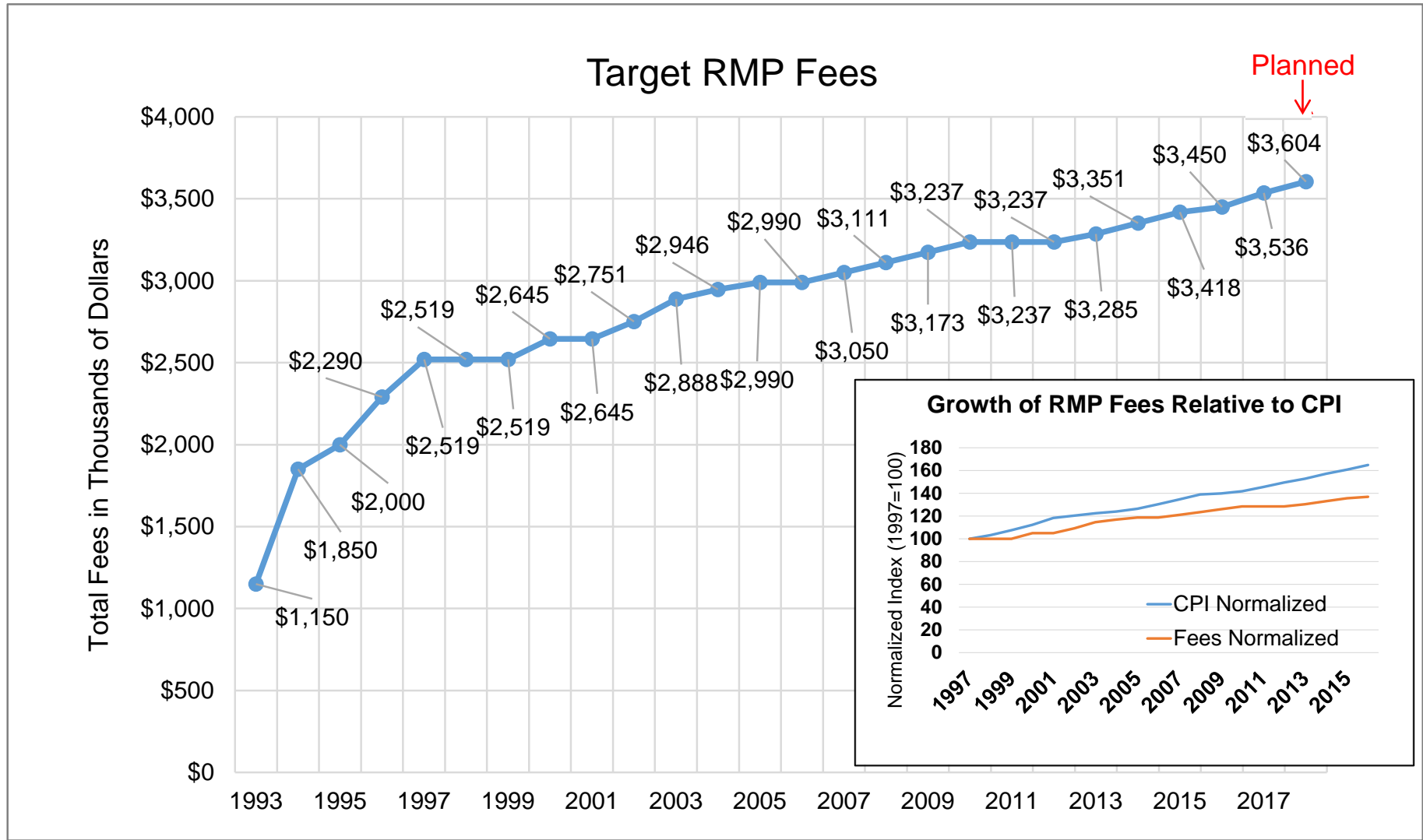
BUDGET: Revenue by Sector

The RMP fees are divided among five major discharger groups. Total fees in 2017 will be \$3.536 million. Municipal wastewater treatment agencies are the largest contributor, and stormwater agencies are the second largest contributor. The contribution from dredgers includes \$250,000 from the U.S. Army Corps of Engineers. Refineries constitute the majority of the industrial sector, and also contribute to the Program due to dredging activities at their facilities. The last cooling water discharge is phasing out of operation - discharges to the Bay and payments to the RMP will cease in 2018. The fees formerly paid for cooling water discharges will not be passed on to the other participants. In addition to fees, the RMP also receives penalty funds for Supplemental Environmental Projects and Alternative Monitoring Requirement funds from municipal wastewater agencies (see page 12 for more information).



BUDGET: Revenue by Year

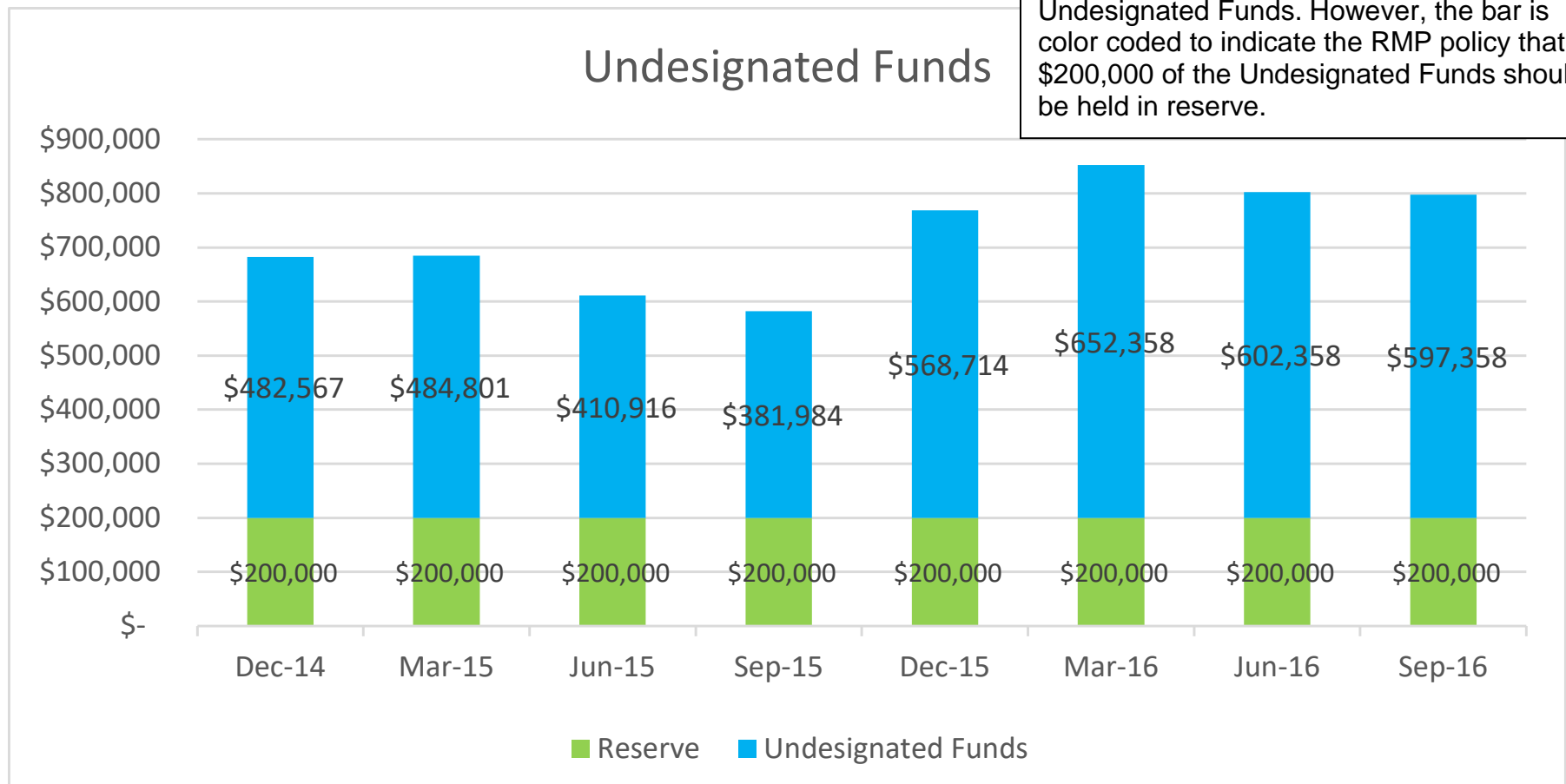
Target RMP fees in 2017 are \$3.536 million. The RMP fees are set by the Steering Committee every three years and are approved to be \$3.604 million in 2018. For 2019-2021, the Steering Committee is planning for 3%/year increases in fees. Over the past 20 years, RMP fee growth has not kept up with inflation.



BUDGET: Reserve Funds

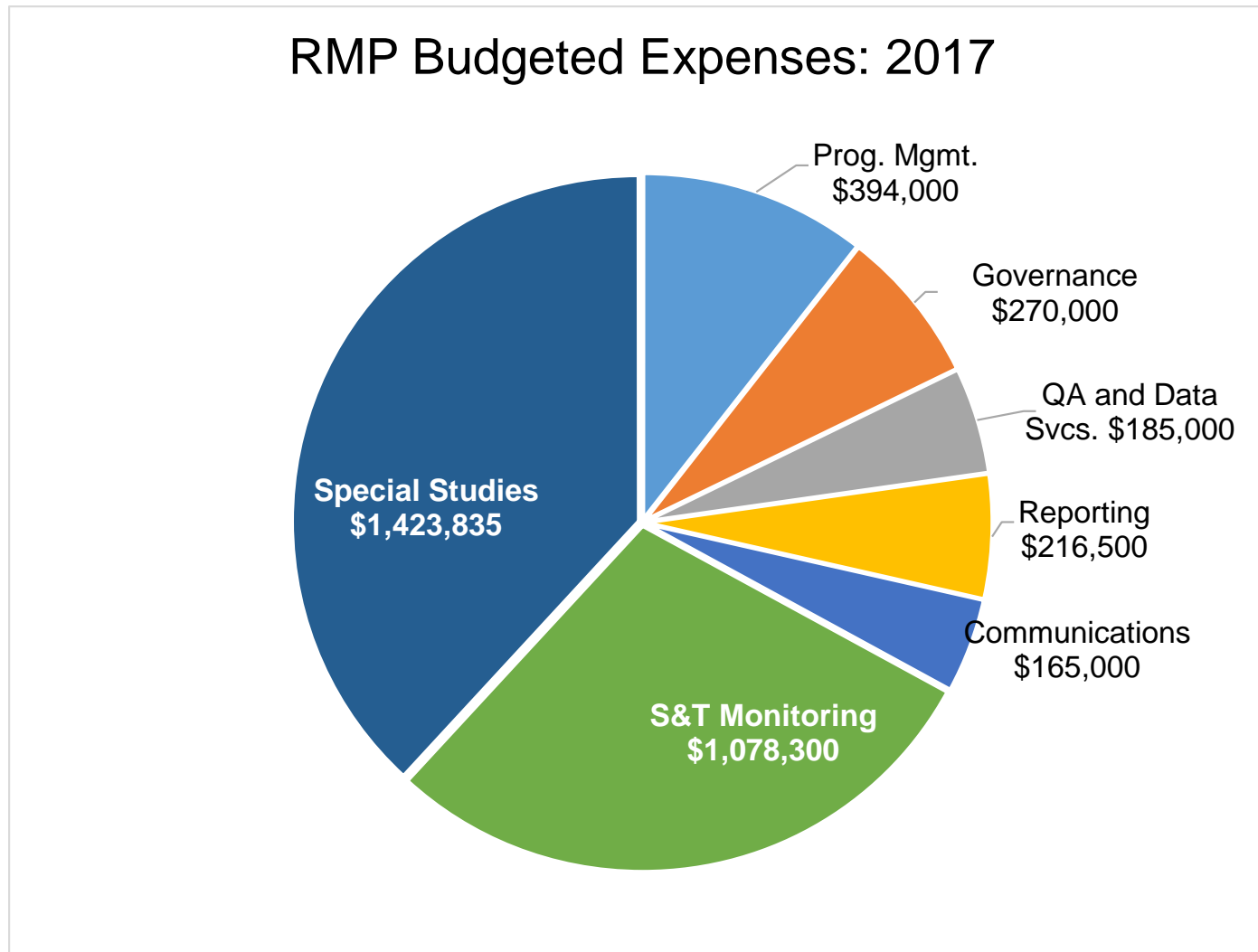
The RMP maintains a balance of Undesignated Funds for contingencies. Higher than anticipated revenues and elimination or reduction of lower priority elements sometimes leads to accumulation of funds that can be used for high priority topics at the discretion of the Steering Committee. It is the policy of the RMP to maintain a minimum balance of \$200,000 of the Undesignated Funds as a reserve for unanticipated urgent priorities.

Bay RMP Undesignated Funds balance over the past three budget years. The height of the bar shows the total balance of the Undesignated Funds. However, the bar is color coded to indicate the RMP policy that \$200,000 of the Undesignated Funds should be held in reserve.



BUDGET: Budgeted Expenses

The budget for the RMP reflects the priorities of the program. On average, sixty percent of the expenses are for monitoring and special studies. Reporting results and properly archiving data each typically comprise 10% of the budget. Governance meetings (~8%) are critical to ensure that RMP is addressing stakeholder needs. Finally, ~12% of the budget is needed for program management, including fiduciary oversight of contracts and expenditures. The 2017 budget for the Program is shown below.



BUDGET: Special Studies 2014-2020

RMP actual and planned expenditures on special study topics. Costs for 2013-2016 are actual amounts. 2017 are budget values. Costs for 2018 and beyond are estimates for planning based on the most recent feedback from the Workgroups and Strategy Teams. The special studies budgets for 2018-2020 were estimated by assuming RMP revenue will increase by 3% year-over-year, subtracting ~40% for programmatic expenses (see page 11), and subtracting estimated Status and Trends monitoring costs for each year (see page 38).

FOCUS AREA	2014	2015	2016	2017	2018	2019	2020
	<i>Actuals</i>	<i>Actuals</i>	<i>Actuals</i>	<i>Budget</i>	<i>Forecast</i>	<i>Forecast</i>	<i>Forecast</i>
Mercury	\$0	\$0	\$0	\$0	\$0	\$0	\$0
PCBs	\$0	\$85,000	\$40,000	\$70,000	\$120,000	\$160,000	\$160,000
Dioxins	\$24,000	\$0	\$0	\$52,000	\$0	\$0	\$0
Emerging Contaminants	\$150,000	\$75,000	\$130,000	\$284,835	\$505,000	\$545,000	\$470,000
Small Tributaries*	\$487,000	\$470,000	\$311,000	\$370,000	\$470,000	\$470,000	\$470,000
Exposure and Effects	\$136,000	\$0	\$35,000	\$55,000	\$60,000	\$200,000	\$150,000
Forecasting	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Selenium	\$33,000	\$84,000	\$47,000	\$106,000	\$106,000	\$106,000	\$56,000
Nutrients*	\$520,000	\$470,000	\$300,000	\$373,000	\$500,000	\$500,000	\$500,000
Microplastic	\$0	\$9,000	\$25,000	\$75,000	\$200,000	\$350,000	\$270,000
Sediment	\$0	\$0	\$0	\$50,000	\$20,000	\$100,000	\$100,000
SPECIAL STUDIES TOTAL	\$1,350,000	\$1,193,000	\$888,000	\$1,435,835	\$1,981,000	\$2,431,000	\$2,176,000
PREDICTED TOTAL SPECIAL STUDIES BUDGET				\$1,678,408	\$1,610,538	\$1,677,873	\$1,736,349
<i>Predicted RMP Core Budget for Special Studies</i>				\$1,071,308	\$1,075,538	\$1,142,873	\$1,201,349
<i>Predicted AMR Funds</i>				\$235,000	\$235,000	\$235,000	\$235,000
<i>Predicted SEP Funds</i>				\$372,100	\$300,000	\$300,000	\$300,000

*The estimated RMP budgets on this table do not cover all of the funding needs for the Nutrients Management Strategy and Small Tributary Loading Strategy. Funding for these strategies is partially provided from other sources.

In 2016, the RMP became eligible to receive penalty funds for Supplemental Environmental Projects. Wastewater agencies also began to provide the RMP with Alternative Monitoring Requirement (AMR) funds for additional emerging contaminants studies. These new funding streams will augment the core RMP budget for special studies.



Fishing on the Bay. Photograph by Shira Bezalel

SMALL TRIBUTARY LOADING

Relevant Management Policies and Decisions

- Refining pollutant loading estimates for future TMDL updates
- Informing provisions of the current and future versions of the Municipal Regional Stormwater Permit (MRP).
- Identifying small tributaries to prioritize for management actions.
- Informing decisions on the best management practices for reducing concentrations and loads.



Recent Noteworthy Findings

- Based on particle ratio information collected by the RMP in stormwater to-date, the most polluted watersheds with regard to PCBs appear to be those draining to Pulgas Creek Pump Station North and South, Santa Fe Channel, an outfall at Gilman Street, an outfall to Lower Silver Creek, and the Ettie Street Pump Station. The outfall at Gilman Street, Santa Fe, and Ettie Street sites also appear to be relatively polluted for mercury.
- PCB legacy source areas include electrical distribution use and production areas, waste handling areas, railway yards and lines, older industrial areas, and buildings and pavements where caulking was used in concrete joint sealants.
- Mercury sources include older urban areas, waste handling areas, cement plants, crematoria, refineries, and legacy
- Pulgas Creek Pump Station-South has the highest PCB load per unit area, or “yield” (85 g/km^2), measured to date, and Guadalupe River has the highest mercury yield (387 g/km^2).
- The most recent estimates based on simple scaling of climatically adjusted empirical data for PCB loads are similar to those in the TMDL (20 kg), whereas new evidence suggests a regional load of 113 kg mercury, which is lower than that of the TMDL (160 kg).

Note: “Small tributary” refers to the rivers, creeks, and storm drains that enter the Bay from the nine counties that surround the Bay

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?
5. Which sources or watershed source areas provide the greatest opportunities for reductions of Pollutants of Concern (POCs) in urban stormwater runoff?

Stormwater sampling. Photograph by Jennifer Sun

SMALL TRIBUTARIES LOADING STRATEGY

Screening and characterization to identify high-leverage watersheds will be the major emphasis for the next several years. This work will be closely coordinated with and substantially augmented by MRP monitoring.

Small tributaries loading studies in the RMP from 2015 to 2021. Numbers indicate budget allocations in \$1000s.

Funder	Task Description	2013	2014	2015	2016	2017	2018	2019	2020	2021
RMP	Coordination and management	20	25	26	26	30	32	35	38	40
	Regional Watershed Spreadsheet Model									
RMP	Phase I – Water, Sediment, PCBs and Mercury	25	30	35	35	40	?			
BASMAA	Phase I – Sediment		(32)							
RMP	Phase II – Other Pollutants of Concern								?	?
BASMAA	Phase II– PBDE, DDT, chlordane, dieldrin		(20)							
RMP	Phase III – Periodic Updates									
RMP	Source Area Monitoring / EMC Development	80	80							
BASMAA	Source Area Monitoring / EMC Development			(450)	(350)	(450)	TBD			
	Small Tributaries Monitoring									
RMP	Monitor Two Representative Small Tributaries	343	352							
BASMAA	Monitor Two to Four Representative Small Tributaries or Sites Downstream of Management Actions	(480)	(480)							
BASMAA	Lab Analyses, Quality Assurance, Data Management	(320)	(320)							
BASMAA	Data Analysis, Communications, Administration	(85)								
RMP	Watershed Screening and Characterization			374	150	200	120			
BASMAA	Watershed Screening and Characterization			(~200)	(~200)	(~200)	TBD			
RMP	Trends Strategy			35	100	100	318	435	432	430
RMP Total		468	487	470	311	370	470	470	470	470
BASMAA Total		885	852	650	550	650	TBD	TBD		
TOTAL		1,403	1339	1,120	861	1,020	TBD	TBD		

NUTRIENTS

Relevant Management Policies and Decisions

- Development of nutrient numeric endpoints and assessment framework
- Evaluating need for revised objectives for dissolved oxygen and other parameters
- Assessment of water quality impairment status
- Implementation of NPDES permits for wastewater and stormwater

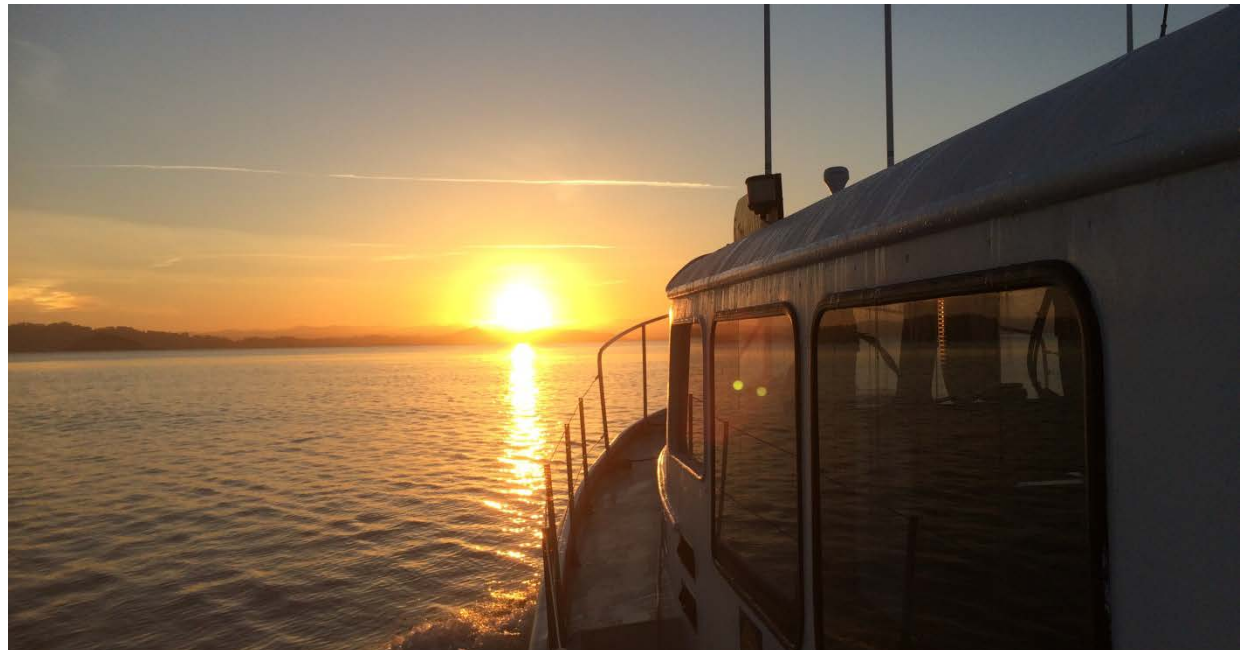
Recent Noteworthy Findings

- Dissolved oxygen concentrations in the sloughs of Lower South Bay are often below the water quality objective of 5 mg/L, and frequently 2-3 mg/L, usually on ebb tides.



- Toxin-producing algal species are frequently detected in the Bay, and algal toxins are often present in the water column and biota.
- Restored salt ponds in Lower South Bay could be transforming nutrients and loading organic matter into adjacent sloughs.
- Preliminary computer models of major wastewater treatment plant discharges are clarifying their relative zone of influence.
- High-frequency and shipboard monitoring data illustrate that the Bay is quite variable in its response to high nutrient loads, on time-scales ranging from tidal to interannual.

ategy for
effort
om
State
a Science
District,
Innyvale,
ding and
hese
ugh the
address
utrients



NUTRIENT STRATEGY

Priority Questions for the Next Five Years

1. What conditions in different Bay habitats would indicate that beneficial uses are being protected versus experiencing nutrient-related impairment?
2. In which subembayments or habitats are beneficial uses being supported? Which subembayments or habitats are experiencing nutrient-related impairment?
3. A. To what extent is nutrient over-enrichment, versus other factors, responsible for current impairments?
B. What management actions would be required to mitigate those impairments and protect beneficial uses?
4. A. Under what future scenarios could nutrient-related impairments occur, and which of these scenarios warrant pre-emptive management actions?
B. What management actions would be required to protect beneficial uses under those scenarios?
5. What nutrient sources contribute to elevated nutrient concentrations in subembayments or habitats that are currently impaired, or would be impaired in the future, by nutrients?

6. When nutrients exit the Bay through the Golden Gate, where are they transported and how do they influence water quality in the Gulf of Farallones or other coastal areas?
7. What specific management actions, including load reductions, are needed to mitigate or prevent current or future impairment?

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

Left, page 16 – Water quality sensor

Right, page 16 – The *R/V Questuary*

Right, page 17 – SFEI and collaborators at USGS servicing moored sensor monitoring equipment installed at Dumbarton Bridge

Photographs by Phil Breshnahan



NUTRIENTS

Nutrient studies in the Bay from 2013 to 2020. Numbers indicate budget allocations in \$1000s. The exact distribution of projects between RMP and Nutrient Permit funds past 2017 is not yet defined; only general allocations are indicated

Tasks	Funding Agency	Questions Addressed	2013	2014	2015	2016	2017	2018	2019	2020
<i>RMP funding</i>										
Program coordination	RMP	1-5	20	20						
Monitoring/special studies: moored sensors	RMP	1	200	215	190	30	220			
Monitoring/special studies: ship-based channel monitoring							153			
Monitoring/special studies: algal biotoxins	RMP	1	65							
Monitoring/special studies: stormwater loads	RMP	3	40	35						
Monitoring/special studies: monitoring program development	RMP	1,3		50		20				
Monitoring/special studies: dissolved oxygen						200				
Monitoring/special studies: HF mapping					115					
Modeling ¹	RMP	4,5	100	200	165					
Synthesis: conceptual model report	RMP	1-5	50							
Synthesis: nutrient loads and data gaps	RMP	3	30							
General allocation (exact projects TBD)	RMP					50		500	500	500
SUBTOTALS	RMP Nutrients Studies		505	520	470	300	373	500	500	500
RMP S&T ship-based monitoring (USGS, Cloern)	RMP S&T	1,3	110	172	172	223	229	235	242	248
SUBTOTALS	RMP S&T Monitoring		110	172	172	192	229	235	242	248
<i>Nutrient Management Strategy funding</i>										
Program coordination and management	Permit	1-5	(135)	(75)	(150)	(270)	(324)			
Science plan development	Permit	1-5	(15)	(15)						
Monitoring/special studies: ship-based sampling	Permit	1			(75)	(95)				
Monitoring/special studies: moored sensor	Permit	1	(75)	(75)	(150)		(122)			
Monitoring/special studies: POTW and refinery effluent characterization ³	Dischargers, Permit	3	(315)	(200)						
Monitoring/special studies: algal toxins	Permit	1			(175)	(125)	(76)			
Monitoring/special studies: phytoplankton composition	Permit	1	(60)	(60)						
Monitoring/special studies: monitoring program	Permit/SWR	1,3	(55)	(60)	(80)		(58)			

SECTION 3: FOCUS AREAS

Tasks	Funding Agency	Questions Addressed	2013	2014	2015	2016	2017	2018	2019	2020
development	B									
Monitoring/special studies: research vessel	Permit	1,3				(200)				
Delta Loads to Suisun	DWR-EMP	3	(90)	(90)						
Synthesis: Suisun Bay, Lower South Bay, other	Permit	1,3	(100)	(150)						
Biological endpoints (DO, toxins)	Permit						(185)			
Science plan development	SFBRWQCB	1-5			(100)					
Biogeochemical modeling and application ¹	Permit/CCCS D/DSP/Palo Alto/Sunnyvale/State Board						(518)	(545)		
Data management, plan development and implementation	Permit						(71)			
Data Analysis/Synthesis	Permit						(60)			
Permit funds, reserves, and additional support (exact projects TBD)	Permit				(280)	(190)	(175)	(880)	(880)	(880)
SUBTOTALS	NMS Total		(845)	(725)	(1,010)²	(880)²	(1,589)²	(1,250)²	(880)²	(880)²
GRAND TOTAL - RMP, BACWA and other funding sources³			1,460	1,417	1,652	1,372	2,191	1,985 + ?	1,622 + ?	1,622 + ?

¹ Suisun modeling funded by CCCSD and DSP; Lower South Bay modeling funded by City of Palo Alto & City of Sunnyvale; Modeling scenarios funded by the State Water Board

² Indicates fiscal year

³ This table only lists contributions from other funding sources for projects that SFEI is directly involved in. There are additional efforts by numerous agencies (USGS, DWR-EMP, SFCWA, SFBRWQCB, SWRCB) that directly or indirectly support the Nutrient Management Strategy, but are not included here for simplicity

TBD = To be determined.

EMERGING CONTAMINANTS

Relevant Management Policies and Decisions

- Regional Action Plans for emerging contaminants
- Early management intervention, including green chemistry and pollution prevention
- State and federal pesticide regulatory programs

Recent Noteworthy Findings

- PFOS and related compounds were detected in treated wastewater discharged to the Bay. Higher levels were observed at two facilities, SFO Airport and Fairfield-Suisun, impacted by industrial firefighting agents that contain these chemicals. At other facilities, PFOS-related compounds had shorter carbon chains, consistent with known use trends. A large number of compounds could not be identified with available methods.

- Levels of PFOS may finally be declining in Bay wildlife following a nationwide phase-out of this former Scotchgard ingredient in 2002. However, other members of the same chemical family are still in use, present in the Bay and its wildlife, and may have similar toxic properties.
- Fipronil and imidacloprid, broad-spectrum insecticides with growing urban uses, were detected in Bay Area sewage, treated wastewater, and biosolids. Pesticides appear to persist despite wastewater treatment. Topical flea control treatments are one likely source of this contamination.
- The Water Board has established an optional reduced monitoring schedule for municipal wastewater discharges to the Bay in exchange for increased payments to the RMP. The intended use of these funds is monitoring and special studies for contaminants of emerging concern.

Priority Question for the Next Five Years

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



Harbor seal sampling. Conducted under NOAA-NMFS permit number 16991. Photograph by Linda Wanczyk.

EMERGING CONTAMINANTS

Emerging contaminant studies and monitoring in the RMP from 2013 to 2020. Numbers indicate budget allocations in \$1000s. Budgets in parentheses represent funding or in-kind services from external partners. Budgets that are starred represent funding that has been allocated for the given study within other workgroups.

Element	Study	Funder	Questions addressed	2013	2014	2015	2016	2017	2018	2019	2020
CEC Strategy				20	20	20	48	50	60	60	75
MODERATE CONCERN CECs											
PFOS/PFAS	Perfluorinated Compounds in Harbor Seals	RMP	1		26						
	Sediment, Effluent Precursor Monitoring	AXYS	1		(30)						
	CECs in Municipal Wastewater ¹	RMP	1			27.5					
	Effluent TOF analysis	DTSC				(50)					
	Perfluorinated and Polyfluorinated Compounds in San Francisco Bay: Synthesis and Strategy	RMP	1					56			
	Sediment & Egg TOF analysis	RMP	1							100	
	Trunkline Influent	RMP	1								50
	Identify Unknown PFAS	RMP	1								
	RMP Status and Trends ²	RMP S&T	1		F		E		E	F	
NP/NPE	Archived Margin Sediment	RMP	1						50		
	Archived Tissue	RMP	1							75	
PBDE	PBDE Summary Report	RMP	1	36							
	RMP Status and Trends ²	RMP S&T	1		S, B,F		B, E		S, B, E	F	B
Fipronil	Fipronil, Fipronil Degradates, and Imidacloprid in Municipal Wastewater	RMP	1				30				
	Fipronil, Fipronil Degradates, and Imidacloprid in Biosolids	ASU	1				(8)				
	CECs in Municipal Wastewater ¹	RMP	1			27.5					
	Fish	RMP	1							50	
	RMP Status and Trends ^{2,3}	RMP	1		S				S		

Element	Study	Funder	Questions addressed	2013	2014	2015	2016	2017	2018	2019	2020
LOW or POSSIBLE CONCERN CECs											
Alt. Flame Retardants	Monitoring Alternative Flame Retardants in SF Bay Water, Effluent, Stormwater, Sediment and Biota	RMP	1		104						
	Phosphate Flame Retardants in Ambient Bay Water	RMP / ECCC	1		(2)			47			
	Stormwater	RMP	1							80	
Pharmaceuticals	Pharmaceutical Contamination in Wastewater	RMP / POTWs	1				(68)		15		
	Pharmaceutical Compounds in Ambient Bay Water & Sediment	RMP	1								150
	Antibiotics in Sediment Cores	U Minn	1					(8)			
Bisphenols	Bisphenol Compounds in Ambient Bay Water	RMP / SIU	1			(25)		50			
	Bisphenol Compounds in Archived Sediment	RMP	1							50	
Personal Care/Cleaning	Triclosan in Small Fish	RMP	1					41			
	Musks in water & sediment	RMP	1						80		
	Quats in (archived) sediment	RMP	1							50	
	Siloxanes in bivalves	ECCC	1		(5)						
Pesticides	Current Use Pesticides in Ambient Bay Water	RMP	1	15							
	Imidacloprid, Imidacloprid Degradates and other Neonicotinoids in Ambient Bay Water	RMP	1					40			
	DPR priorities in water & sediment	RMP	1						80		
	Emerging concerns	RMP	1								75
SDPA/BZT	Water, Sediment	ECCC	1		(3)						
OH-BDEs / Triclosan	Water, Sediment cores	U Minn	1		(125)						
Halogenated Carbazoles	Sediment, Tissue	SIU	1			(15)	(20)	(40)			
Brominated Azo Dyes	Sediment, Tissue	RMP							60		
NON-TARGETED & OTHER STUDIES											
Non-targeted	Non-targeted Analysis of Water-soluble CEC compounds	RMP / Duke / AXYS	1				52 (10) (6)				
	Water & Sediment	RMP	1						120		
	Follow-up Targeted Study	RMP	1							80	

Element	Study	Funder	Questions addressed	2013	2014	2015	2016	2017	2018	2019	2020
	Tissue (Polar and Nonpolar Compounds)	RMP	1								120
	RO Concentrate								40		
RELEVANT STUDIES IN OTHER WORKGROUPS											
Bioassay (EEWG)	Linkage of In Vitro Estrogenic Assays with In Vivo End Points	RMP / SCCWRP / UF	1	70	56 (125)			45			
	Development of Glucocorticoid Bioanalytical Screens	RMP / SCCWRP / UF	1							100 (100)	100 (100)
RMP-funded Special Studies Subtotal - ECWG				71	150	75	130	284	505	545	470
RMP-funded Special Studies Subtotal – Other Workgroups				70	56	0	0	45	0	100	100
Pro-Bono & Externally Funded Studies Subtotal				0	165	90	112	48	TBD	100+	100+
OVERALL TOTAL				141	371	165	242	377	505	745+	670+

CEC Multi-Year Plan Table Notes

1 – The 2015 CECs in Municipal Wastewater study was a \$55k study that included analyses of PFOS/PFAS and fipronil; in this table the budget for this study has been split between these two contaminant groups.

2 – When a CEC is proposed for inclusion in the the RMP Status and Trends monitoring, there is a letter in the cell denoting the matrix for which monitoring is proposed: W = water; S = sediment; B = bivalve; E = eggs; F = fish.

3 – Analysis of fipronil and fipronil degradates is a proposed recommendation for inclusion in the RMP Status and Trends monitoring effort. The current Status and Trends monitoring budget does not include these analyses.

4- The CEC Strategy for the Bay is currently being updated. The proposed studies for 2018-2020 shown on this table may change after the strategy update is complete.



Left – Passive sampler deployed in San Leandro Bay. Photograph by Jennifer Sun.

Center – Collecting grab samples for non-targeted analysis of polar organic compounds on Napa River. Photograph by Rebecca Sutton.

MICROPLASTIC

Relevant Management Policies and Decisions

- Regional bans on plastic bags and foam packaging materials.
- State and Federal bans on microbeads.
- Trash TMDL.
- Potential for public outreach and education regarding pollution prevention for microplastic and macroplastic that can disintegrate to microplastic.
- In 2016, the RMP convened a Microplastic workgroup to develop a strategy for the monitoring microplastic in San Francisco Bay. The workgroup consisted of national experts on the topic and a wide range of stakeholders. Following the meeting, RMP staff produced a strategy document. The proposed studies listed on the next page are from the strategy document. SFEI was awarded a \$880K external grant from the Gordon and Betty Moore Foundation to complete many of these tasks.

Recent Noteworthy Findings

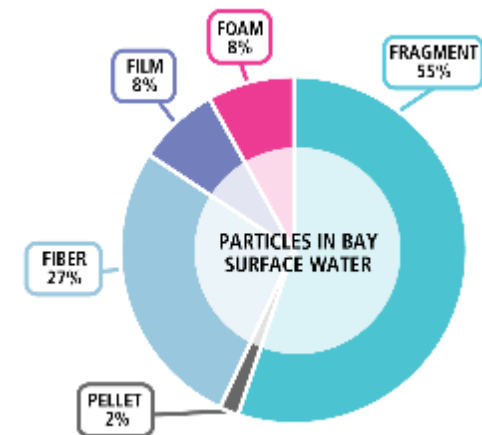
- In 2015, the RMP conducted a small study to monitor microplastic in treated effluent and Bay surface water. Bay surface water appeared to have higher microplastic levels than other urban water bodies sampled in North America, such as the Great Lakes and Chesapeake Bay. Microbeads derived from personal care products and tiny fibers, a portion of which were likely derived from synthetic textiles and carpets, were recovered from all nine Bay sites. Tiny particles, primarily fibers, were also detected in treated effluent from Bay Area facilities; not all of these particles are known to be plastic.
- While conducting the surface water trawls of San Francisco Bay, nine small prey fish were inadvertently caught at one site. These fish were found to contain 52 particles. This average of nearly six particles per fish is higher than one to three particles typically found in Great Lakes fish. 50% of the particles were classified as fragments, while 33% were classified as fibers.



Ian Wren of San Francisco Baykeeper deploying the Manta Trawl. Photograph courtesy of Meg Sedlak.

Priority Questions for the Next Five Years

1. How much microplastic pollution is there in the Bay?
2. What are the health risks?
3. What are the sources, pathways, loadings, and processes leading to microplastic pollution in the Bay?
4. Have the concentrations of microplastic in the Bay increased or decreased?
5. What management actions may be effective in reducing microplastic pollution?



Percent contribution by particle type for Bay surface water (Sutton et al. 2016).

Microplastics, commonly defined as plastic particles smaller than 5 mm, come in a broad range of shapes and sizes. Commonly observed particles include: fragments, fibers or lines, pellets, films, or foam bits. Differences in size and shape can affect the way particles move through the environment, and may modify their potential for toxicity.

MICROPLASTIC

Microplastic studies and monitoring in the RMP from 2011 to 2020. Numbers indicate budget allocations in \$1000s. Text in purple font indicates funding from the Gordon and Betty Moore Foundation (\$880k) and related RMP funds. Text in blue font indicates externally projects that will be used to inform work conducted as part of this strategy.

Element	Study	Funder	Questions Addressed	2015	2016	2017	2018	2019	2020	Beyond
Pilot Study	Microplastic in Ambient Bay Water	RMP	1	9						
Strategy	Microplastic Strategy	RMP	1,2,3,4,5		25					
	Private Foundation Grant Match	RMP*	1,2,3,4,5			75 ¹				
Method Development	New methods for collection, extraction, analysis, and intercomparison – USEPA, NOAA	External	1,3		(x)	(x)				
	Follow-up method development	RMP					150 ²			
	Laboratory intercomparison	RMP						100		
Monitoring biota	Bivalves	RMP	1,2,4				50		50	
	Sport fish	RMP						200		
	Benthic organisms	RMP								50
	Prey fish	External*				(130)				
Monitoring water and sediment	Archived ambient & margins sediment	External*	1,3,4			(100)				
	Sediment cores	RMP								50
	Surface water: Bay / Sanctuaries	External*				(220)				
Characterizing sources, pathways, loadings, processes	Refine conceptual model	RMP	1,3					50		
	Stormwater and wastewater effluent	External*					(90)			
	Model transport in Bay and ocean	External*					(80)			
Evaluating control options	Options for source control / Efficacy of microbead ban, foam bans	RMP / External*	5				(40)		80	60
	Characterize microplastic composition to identify management actions	RMP							140	
Synthesis	Synthesize findings (e.g. report, factsheet, video), hold symposium	External*	1,3					(220)		
RMP Subtotal				9	25	75	200	350	270	160
External Subtotal				0	0	450	210	220	0	0
Overall Total				0	25	545	410	550	270	160

1 -- The RMP Steering Committee has approved \$75k of RMP funds in 2017 to match the private foundation funding.

2 – The \$150k allocated for follow-up method development is a placeholder for projects that may be identified following the completion of USEPA and NOAA method development. Use of these funds will be determined after October 2017.

EXPOSURE AND EFFECTS

Relevant Management Policies and Decisions

- Implementation of narrative water quality objectives for toxicity, bioaccumulation, and aquatic organisms population and community ecology
- Implementation of sediment quality objectives
- Permitting decisions regarding dredging projects
- Contaminated sediment 303(d) listing and delisting decisions

Recent Noteworthy Findings

- **Assessing the Impacts of Periodic Dredging on Benthic Habitat Quality:** The objective of this effort is to assess the quality of benthic assemblages from a fish forage standpoint, in areas that are periodically dredged in the Central Bay compared to non-dredged areas.

A literature review will be conducted regarding fish feeding and benthic invertebrate assemblages and a field study design will be developed. The project is co-funded by the RMP and the Long Term Management Strategy for Dredging.

- **The site specific objectives for copper in the Bay appear to be protective of migrating salmon.** RMP studies conducted by NOAA indicate that even at very high concentrations of copper in seawater (> 100 ug/L), Chinook salmon's sense of smell is not impaired. For juvenile salmon, copper concentrations up to 50 ug/L did not have impacts on the olfactory system at salinities >10 ppt. No further work on this topic is planned.

- **Bioanalytical Tools:** A project funded by the RMP in 2013 and 2014 evaluated linkages between in vitro assays and in vivo endpoints that point to population level effects in estuarine fish. The study succeeded in establishing a linkage between in vitro estrogen assays and in vivo feminization of juvenile fish, but further work is needed to better quantify the relationship.

- **Amphipod sediment toxicity tests can be affected by grain size.** Laboratory studies showed that clay has size-specific mortality effects on the amphipod species used in RMP sediment toxicity testing. Larger amphipods appear to be more sensitive to clay particles. In 2016, additional studies using sediment samples from the Bay confirmed these findings. Future RMP sediment toxicity testing will focus on smaller amphipods to minimize this effect.

Priority Questions Over the Next Five Years*

1. What are the spatial and temporal patterns of impacts of sediment contamination?
2. Which pollutants are responsible for observed impacts of sediment contamination?
3. Are the toxicity tests, benthic community assessment approaches, and overall Sediment Quality Objectives (SQO) assessment framework reliable indicators of impacts?
4. Do spatial patterns in bioaccumulation in birds indicate particular regions of concern?
5. What are appropriate thresholds of concern for contaminant concentrations in Bay fish species?

* These Priority Questions will be updated in 2017 at the Exposure & Effects Workgroup meeting.



Sampling scheme for one study area (Richardson Bay Marina) in the "Assessing the Impacts of Periodic Dredging on Benthic Habitat Quality" project.

EXPOSURE AND EFFECTS

Exposure and effects studies and monitoring in the RMP from 2011 to 2020. Numbers indicate budget allocations in \$1000s.

	Element	Funder	Questions Addressed	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Benthos	Benthic Assessment Tools	RMP	3		50	76							
	Causes of Sediment Toxicity: TIEs and LC50 Work	RMP	2										
	Causes of Sediment Toxicity: Molecular TIEs	RMP	2										
	Causes of Sediment Toxicity: Moderate Toxicity Strategy	RMP	2,3		50		30		30				
	USEPA Water Quality Synthesis (USEPA/NCCA)	RMP / USEPA	1,3	(100)	(50)								
	Hotspot Follow-up Study	RMP	1,2,3	60	30								
	Reference Site, Benthos Recovery After Dredging	RMP / LTMS	NONE				50 (~300)						
	Benthos/Toxicity Monitoring Strategy		1,2,3							10			
	Evaluate Impacts of Dredging on Eelgrass Habitat		NONE										
Fish	Effects of Copper on Salmon	RMP/NOAA	5	37		38							
	Sediment Bioaccumulation Guidance	RMP	5								50	50	
	Contribute to LTMS Studies of Essential Fish Habitat		NONE									50 (TBD)	50 (TBD)
Bioanalytical Tools¹	Linkage of In Vitro Estrogenic Assays with In Vivo End Points	RMP/ SCCWRP/UF	NONE			70	56 (125)			45			
	Development of Glucocorticoid Bioanalytical Screens	RMP/ SCCWRP/UF	NONE									100 (100)	100 (100)
Other	Strategy for Monitoring Temp, Salinity and Acidification due to Climate Change	RMP/SFEP/ EPA/OST/ Cal SeaGrant	NONE						5 (20)		10		
RMP Total				97	130	184	136	0	35	55	60	200	150
Non-RMP Total				100	50	0	425	0	20	0	100	100+	100+
Overall Total				197	180	184	561	0	55	55	160	300+	250+

1 – Bioanalytical tools projects were funded through the Emerging Contaminants program prior to 2017

2 – Gray cells – further work on this topic not anticipated



Relevant Management Policies and Decisions

- PCBs TMDL and potential update
- Implementation of NPDES permits
- Selecting management actions for reducing PCB impairment

Recent Noteworthy Findings

- Shiner surfperch have concentrations 12 times higher than the TMDL target, and these have resulted in an advisor from the Office of Environmental Health Hazards Assessment (OEHA) recommending no consumption for all surfperch in the Bay. Concentrations in shiner surfperch and white croaker show no clear sign of decline.
- For birds, seals and fish there is evidence of PCB exposures in certain locations that may be reducing health and survival.
- Wetland sediment cores provide evidence of dramatic declines from the 1960s to the present.
- The RMP list of 40 congeners has been confirmed as the most appropriate PCB index for monitoring in support of the PCB TMDL.

- Recent estimates of total loads for POTWs and industrial facilities were well below the wasteload allocations in the TMDL.
- Santa Fe Channel, Pulgas Creek Pump Station North and South, Ettie Street Pump Station, and North Richmond Pump Station appear to have relatively polluted sediment particles and have the potential to be high leverage watershed where control actions are a cost-effective way of reducing downstream impacts.



Bay margins sampling. Photograph by Don Yee.

- Average concentrations in Suisun Bay sediments are lower than in the other Bay segments.

Priority Questions for the Next Five Years

1. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
2. What are the present loads and long-term trends in loading from each of the major pathways?
3. What role do in-Bay contaminated sites play in segment-scale recovery rates?
4. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?
5. What management actions have the greatest potential for accelerating recovery or reducing exposure?
6. What are the near-term effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

PCBs**PCB studies and monitoring in the RMP from 2010 to 2020.**

Numbers indicate budget allocations in \$1000s. Budgets in parentheses represent funding from external sources.

Studies under the PCB Strategy began in 2010. A synthesis completed in 2014 set the stage for a multi-year study plan for 2015 and beyond, focusing on monitoring the receiving water response to management actions in high-leverage watersheds.

Element	PCB Questions Addressed	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Food Web Uptake (Small Fish)	1, 4	50										
PCB Conceptual Model Update	1,2,3,4,5,6		53									
Development and updating of multi-year workplan and continued support of PCB Workgroup meetings							10	10	10	10	10	10
Prioritize Margin Units	1, 4, 5, 6						30					
Develop Conceptual Site Models and Mass Balances for PMUs (4 PMUs)	1, 4, 5, 6						45	30 (30)	60	60		
PMU Field Studies to Support Development of Conceptual Site Models and Monitoring Plans	1, 4, 5, 6							(202)	TBD	TBD	TBD	TBD
Synthesis of DMMO data for PCB hot spots and mass removed	5, 6									50		
PMU Monitoring (5 PMUs)	1, 4, 5, 6									TBD	150	150
RMP Total		50	53	0	0	0	85	40	70	120	160	160
SEP Funding		0	0	0	0	0	0	232	TBD	TBD	TBD	TBD
Overall Total		50	53	0	0	0	85	272	TBD	TBD	TBD	TBD

SELENIUM

Relevant Management Policies and Decisions

- North Bay Selenium TMDL
- USEPA Selenium Criteria for the Bay-Delta
- South Bay Selenium TMDL (under consideration)

Recent Noteworthy Findings

- Sturgeon, a benthic species, is recognized as a key indicator of selenium impairment in the North Bay due to its susceptibility to selenium bioaccumulation.
- Muscle tissue selenium concentrations have exceeded the North Bay TMDL target in some individual sturgeon, but means have remained below the target.
- The highest tissue selenium concentrations were measured in white sturgeon caught in Suisun Bay; the lowest were in Central Bay.
- No long-term trend has been apparent in sturgeon selenium concentrations since 1987.
- Selenium concentrations measured in sturgeon muscle plugs and muscle fillets are well-correlated.

- The Lower South Bay has much higher average selenium concentrations in water than the other Bay segments, but white sturgeon collected in South Bay have had lower concentrations than North Bay sturgeon
- Selenium concentrations in cormorant and tern bird eggs are usually well below a target developed to protect birds in Newport Bay. The Newport Bay target was established for mallards, which are considered more sensitive to selenium toxicity than piscivorous species such as cormorants and terns.

Priority Questions for the Next Five Years

1. What are appropriate thresholds?
2. Are the beneficial uses of San Francisco Bay impaired by selenium?
3. What is the spatial pattern of selenium impairment?
4. How do selenium concentrations and loadings change over time?
5. What is the relative importance of each pathway of selenium loading in the Bay?



White sturgeon collected in RMP fish sampling.
Photograph by Zachary Epperson.

In July 2016, a Selenium Monitoring Workshop was held to begin developing a long-term selenium monitoring plan for North Bay, including sturgeon, clam, and water monitoring. The primary objective of this monitoring is early detection of changes in selenium exposure. The multi-year plan, to be completed in 2017, will likely include selenium monitoring in all of these matrices.

Selenium

Selenium studies and monitoring in the RMP from 2014 to 2020. Numbers indicate budget allocations in \$1000s.

A long-term monitoring plan for selenium sturgeon, clams and water is in development. The budget allocations for 2018-2020 and beyond may include selenium monitoring in one or more of these matrices once this monitoring plan is complete.

Element	Selenium Questions Addressed	2014	2015	2016	2017	2018	2019	2020
Selenium Strategy Coordination	1,2,3,4,5	10	10	10	25	10	10	10
Selenium Information Synthesis	1,2,3,4,5		10					
Selenium Sturgeon Plugs	1,2,3,4	23	35			46	46	46
Selenium Sturgeon Derby	1,2,3,4		29	37	42			
Selenium in North Bay Clams	1, 2, 3, 4, 5				39 + TBD	TBD	TBD	TBD
Selenium in North Bay Water	1, 2, 3, 4, 5					TBD	TBD	TBD
Selenium South Bay Synthesis	1,2,3,4,5					50		
Selenium South Bay Food Web Sampling	1,2,3,4						50	
Selenium South Bay Model	5							TBD
TOTAL		33	84	47	TBD	TBD	TBD	TBD

DIOXINS

Relevant Management Policies and Decisions

- Review 303(d) listings and establish TMDL development plan or alternative

Recent Noteworthy Findings

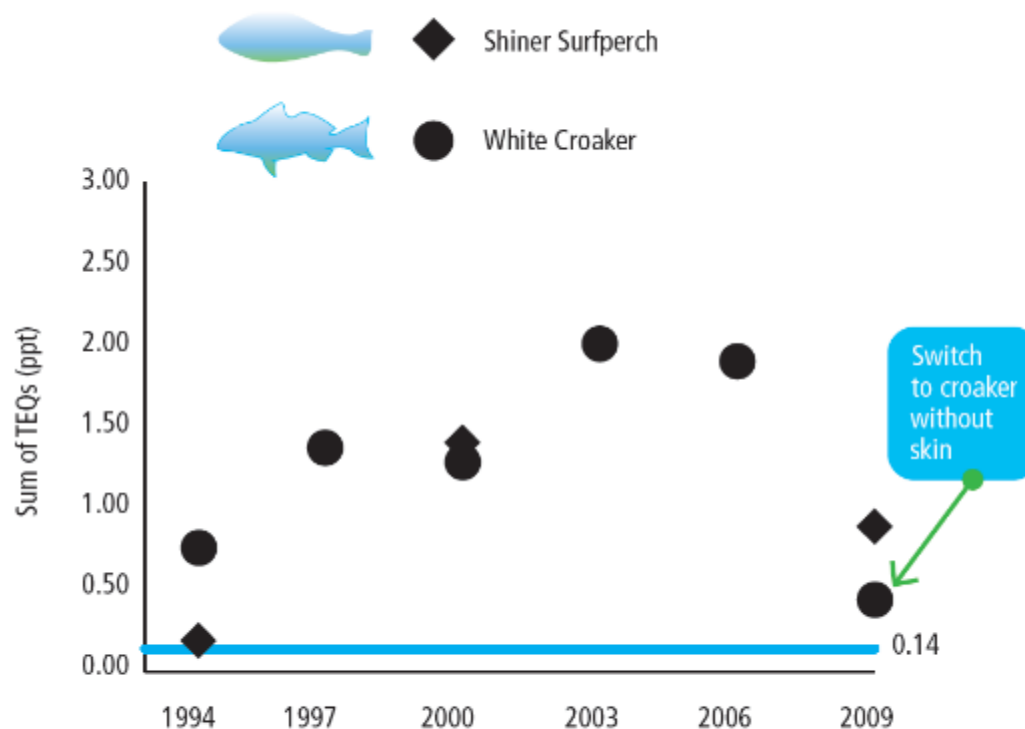
- The key sport fish indicator species (shiner surfperch and white croaker) have been higher than the Water Board screening value of 0.14 ppt and show no sign of decline, but there is a great deal of uncertainty regarding the human health risk associated with dioxins in sport fish.
- Dioxin toxic equivalents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

Priority Questions for the Next Five Years

- What is the dioxin reservoir in Bay sediments and water?
- Have dioxin loadings/concentrations changed over time?
- What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?

Priority Questions for the Next Five Years

- What is the dioxin reservoir in Bay sediments and water?
- Have dioxin loadings/concentrations changed over time?
- What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?



Baywide average dioxin and furan TEQ concentrations (ppt) in white croaker (circles) and shiner surfperch (diamonds). Blue line indicates screening value.

DIOXINS

Dioxin studies and monitoring in the RMP from 2008 to 2019. 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 2017 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	2018	2019	2020
Dioxin Strategy	Quality Assurance	1,2,3,4,5,6		14											
Status and Trends	Sport Fish	1,2,4		22					24						
	Avian Eggs	1,2,4					13								
	Surface Sediments	2,3		58	58										
	Water	2,3		26		26									
Loads	Small Tributary Loading	4,5,6			65		52								
	River Loading (THg)	4,5,6			34										
Forecast	Sediment Cores	3,4,6			57										
	Synthesis	1,2,3,4,5,6										52 ¹			
Loads	Atmospheric Deposition	5,6			20										
RMP Total			0	120	234	26	65	0	24	0	0	52	0	TBD	TBD
Non-RMP Total			0	0	0	0	0	0	0	0	0	0	0	TBD	TBD
Overall Total			0	120	234	26	65	0	24	0	0	52	0	TBD	TBD

1 – This synthesis task for RMP dioxin data (\$40k) was combined with the synthesis of DMMO dioxin data (\$12k; goal is to reduce testing requirements for dredged material for reuse sites). Combining these two synthesis tasks resulted in a cost savings of approximately \$8k.

SEDIMENT STRATEGY AND STUDIES RELATED TO WATER QUALITY IMPACTS OF DREDGING, DREDGED MATERIAL DISPOSAL, AND SEDIMENT MANAGEMENT

Sediment and dredged material management is a multi-faceted challenge. Decisions require information on sediment contamination, toxicology, and sediment transport. Therefore, the studies relevant to this focus area are reviewed by several different workgroups in order to provide the correct technical oversight.

The regulatory drivers and priority questions for the next five years are shown below. On the facing page, all of the proposed studies are listed. Studies that would be overseen by the Technical Review Committee and a new Sediment Strategy Workgroup are listed at the top. Studies that are already listed in the budgets of other workgroups are shown at the bottom of the table.

The RMP does not have a Sediment Strategy Workgroup. However, to start, the advisory committee for the Healthy Watersheds, Resilient Baylands Project, which will be funded by a WQIF grant and RMP funding, can serve as the workgroup on this topic. Eventually, the questions related to beneficial reuse and sediment supply may need two different workgroups.

Relevant Management Policies and Decisions

1. 2011 Programmatic Essential Fish Habitat Agreement
2. PCB TMDL
3. Mercury TMDL
4. Long-Term Management Strategy

Priority Questions for the Next 5 Years

1. What is the chemical quality of dredged material that can be disposed in-Bay or beneficially reused?
2. Are there impacts to fish, benthic species, and submerged habitats from dredging?
3. Where, how, and how much should dredged material be reused within the Bay or baylands?
4. What are the sources, pathways and loadings of sediment to the Bay and subembayments?
5. What is the sediment supply available for marsh restoration?



Crude oil tanker on San Francisco Bay. Photograph by Carolyn Doebling.

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/dmno-ambient-sediment-conditions>). These thresholds are based on RMP Status & Trends data.

SEDIMENT STRATEGY AND OTHER STUDIES

Sediment Strategy and other studies related to dredging from 2014 to 2020. Numbers indicate budget allocations in \$1000s.

Element	Questions Addressed	Funding Source	Work group	2014	2015	2016	2017	2018	2019	2020
Sediment Monitoring Strategy	4,5	RMP / (WQIF)	Sediment				50 (238)			
Collect and synthesize data to update sediment budgets for the Bay and subembayments	4,5	RMP	Sediment							TBD
Manage DMMO database and develop online tools 1. Evaluate goals and refine database work tasks 2. Host/manage DMMO database (\$20-\$35k) 3. Make DMMO database accessible through CD3 (\$55k) 4. Develop online tool to compile "Tier I" track records for projects or project clusters using DMMO database and other relevant databases (\$60k)	1	RMP	Sediment				Initial discussion with PM funds	20	TBD	TBD
Identify appropriate reference sites for beneficial reuse projects	3	RMP	Sediment						TBD	
Monitoring of reuse, and climate change adaptation projects	3	RMP	Sediment							TBD
Participate in LTMS studies for beneficial reuse	3	RMP	Sediment							TBD
General Allocation		RMP	Sediment						100	100
Subtotal RMP Allocations				0	0	0	50	20	100	100
Relevant Studies in Other Workgroups										
Synthesis of DMMO dioxin data ¹	1	RMP	Dioxin							
Synthesis of DMMO data for PCB hot spots and mass removed	1	RMP	PCB					50		
Bioaccumulation Guidance 1. Guidance for evaluating bioaccumulation model results 2. Re-evaluate bioaccumulation screening levels for PAHs	1	RMP	EEWG					50	50	
Participate in LTMS studies for Essential Fish Habitat commitments	2	RMP / (LTMS)	EEWG	Benthic Recovery 50 (100)					50	50
Collect and synthesize data to evaluate indirect effects on eelgrass near dredging projects	2	RMP	EEWG							TBD
USGS Suspended Sediment Monitoring		RMP		250	250	250	250	250	250	250
Subtotal RMP Allocations – Other Workgroups				300	250	250	250	370	350	350+
Overall Total for RMP				300	250	250	300	390	450	400+
Overall Total for Non-RMP funding				100	0	0	238	0	TBD	TBD
Overall Total				400	250	250	538	390	450+	400+

1 – The synthesis of DMMO dioxin data (\$12k) will be considered for funding in 2017. This task would be combined with the approved synthesis of RMP dioxin data (\$40k), resulting in approximately \$8k in cost-savings compared to completing these two tasks separately.

STATUS AND TRENDS

Relevant Management Decisions

- Defining ambient conditions in the Bay
- Water Quality Assessment – 303(d) impairment listings or de-listings
- Determination of whether there is reasonable potential that a NPDES-permitted discharge may cause violation of a water quality standard
- Evaluation of water and sediment quality objectives
- Dredged material management
- Development and implementation of TMDLs for mercury, PCBs, and selenium
- Site-specific objectives and anti-degradation policies for copper and cyanide
- Development and evaluation of a Nutrient Assessment Framework (i.e., development of water quality objectives)

Recent Noteworthy Findings

- PBDE levels have declined in bivalves, bird eggs, sport fish and sediment following nationwide phase-outs and state bans of these toxic and persistent flame retardant chemicals.
 - Mercury concentrations in Bay sediment do not appear to be increasing or decreasing.
 - PAH concentrations in Bay sediment may be trending upward. Average concentrations of PAHs in sediment have been highest along the southwestern shoreline of Central Bay.
 - A sudden decrease in suspended-sediment concentrations occurred in 1999 and has persisted since that time.
- Nitrogen concentrations vary considerably by Bay segment and season. Late summer chlorophyll in South Bay increased from roughly 1995 to 2005 but has since leveled off. At the same time, decreasing chlorophyll concentrations have been observed in Suisun Bay and the Delta.

Priority Questions for the Next Five Years

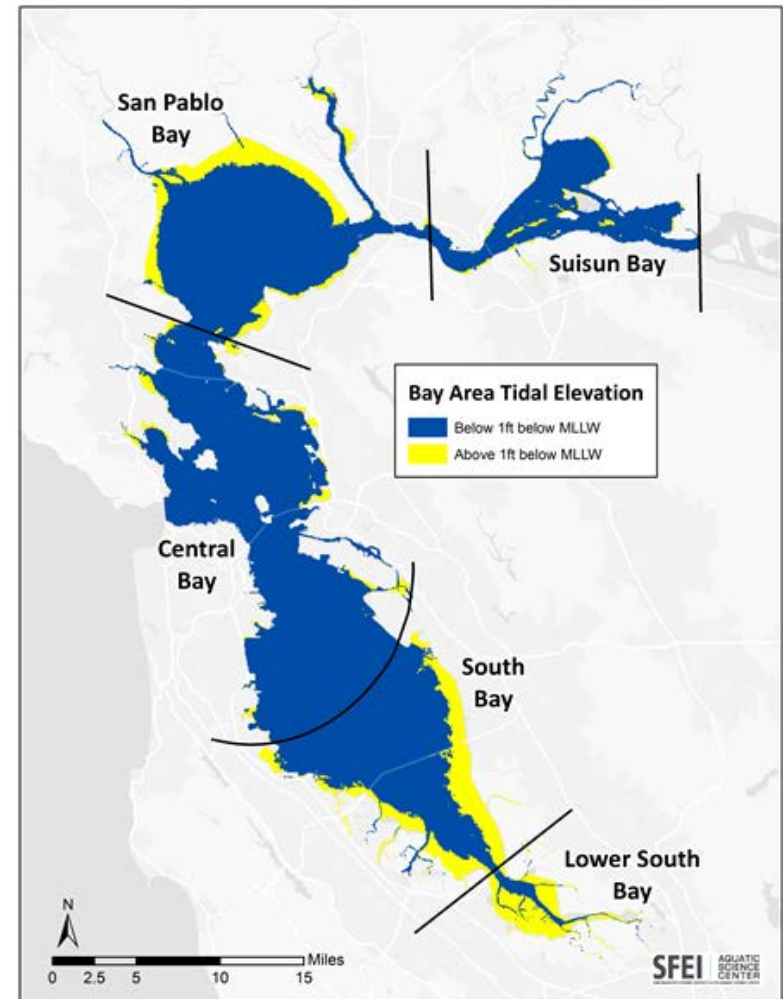
1. Are contaminants at levels of concern?
2. What are concentrations and masses of priority contaminants in the Bay, its compartments, and its segments?
3. Are there particular regions of concern?
4. Have concentrations and masses increased or decreased?

A CLOSER LOOK: BAY MARGINS

In 2015, the RMP began a pilot study of surface sediment contaminant concentrations in the mud flats and adjacent shallow areas of the Bay – the Bay margins. These margin areas are of interest because they are more productive and highly utilized by biota of interest than the open areas of the Bay, and often have a closer linkage with land-based sources. Monitoring status and trends in the margin areas has been adopted as part of a larger strategy to track ambient contaminant (particularly PCBs) concentrations, trends, and management activities in tributaries, margins, and the Bay as a whole. Margins contaminant data can also be used to facilitate and inform dredged material placement in margin areas by providing more accurate information about background contaminant levels in these areas.

Relevance to RMP Priorities and Management Decisions

- Stormwater management – Long-term monitoring in margins areas will help to identify further hot spots and track trends downstream of watersheds where management activities will be implemented.
- PCB management – Priority margin units are being characterized and monitored as part of the PCB strategy to track upstream management activities. Unbiased estimates of ambient concentrations in the margins will further inform this effort.
- Dredging – Having unbiased estimates of ambient contaminant concentrations in the margins will be useful to inform decisions about the placement of contaminated dredged materials in margin areas.
- Trends monitoring – Margins may have a closer linkage with watershed sources and therefore a higher potential for more clearly and rapidly showing responses to change that will ultimately impact the Bay.

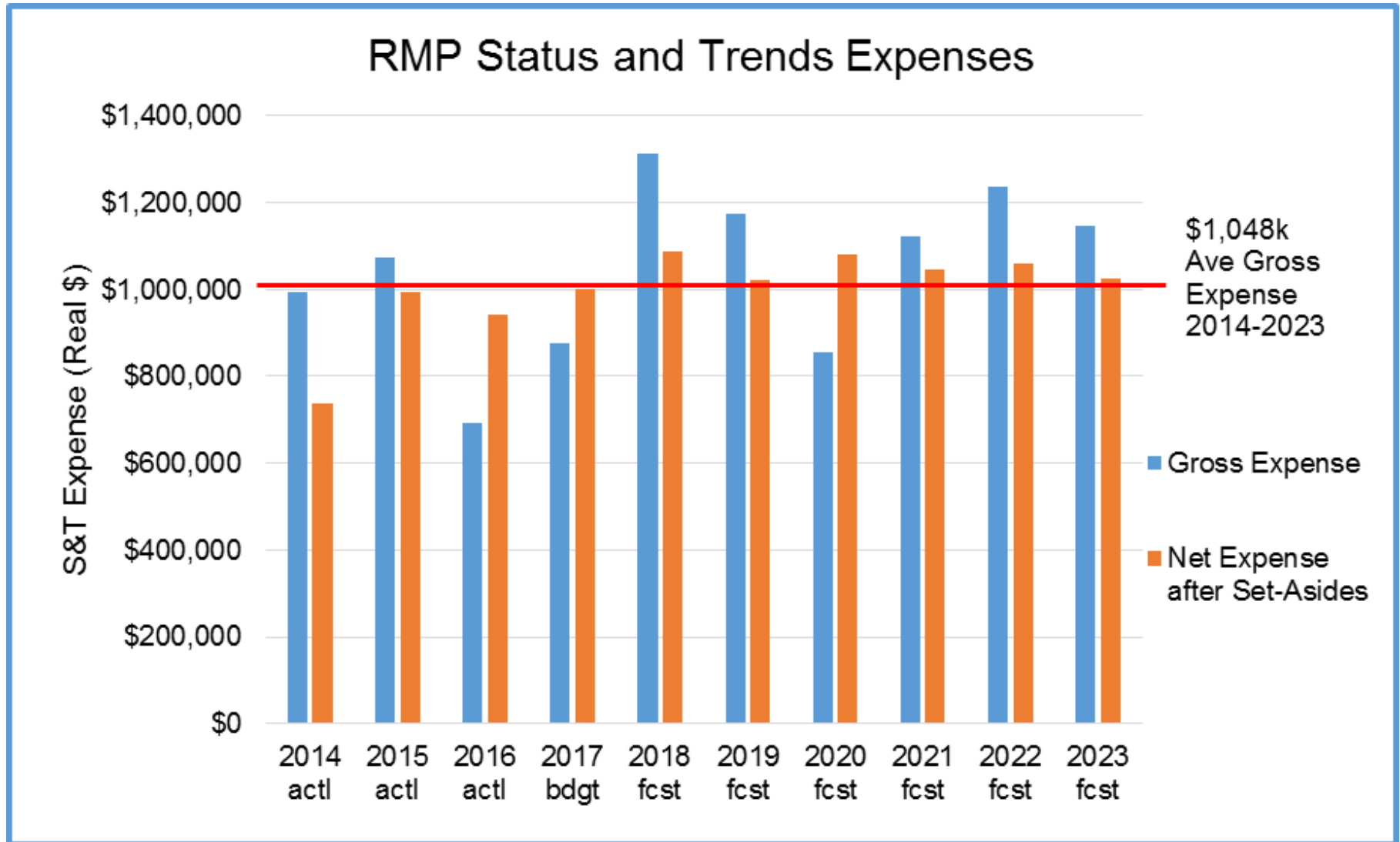


STATUS AND TRENDS: 10-YEAR STUDY DESIGN (2014-2023)

Study design and estimated cost of Status and Trends monitoring. Expenses are expressed as thousands of dollars accounting for inflation. The expense for continuous, sensor-based water quality monitoring by the USGS (top row) does not increase with inflation because these funds are transferred directly to USGS from the U.S. Army Corps. The amount has not changed since 1993. The bottom of the table shows the long-term plan for using set-aside funds to smooth out the cost of S&T between years.

Program	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Actual	Actual	Actual	Budget	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Continuous: Basic Water Quality (5 targeted sites)	250	250	250	250	250	250	250	250	250	250
Monthly: Basic Water Quality in Open Bay (38 targeted sites)	173	173	223	229	235	242	248	255	262	269
Every 2 Years: Priority Contaminants in Water (5 targeted sites and 17 random sites)	0	60	0	35	0	37	0	39	0	204
Every 2 years: Priority Contaminants in Bivalves (7 targeted sites)	18	0	14	0	16	0	16	0	26	0
Every 3 Years: Priority Contaminants in Bird Eggs	0	150	0	0	162	0	0	176	0	0
Every 4 Years: Priority Contaminants in Open Bay Sediment (7 targeted sites and 20 random sites)	94	0	0	0	222	0	0	0	224	0
Every 5 Years: Priority Contaminants in Sport Fish (7 targeted sites)	231	0	0	0	0	264	0	0	0	0
Bay Margins Studies	0	227	31	260	0	137	141	145	149	153
Field work, Vessel Costs, Archive	228	215	173	231	294	244	201	257	327	271
Gross S&T Total	993	1075	691	1105	1179	1173	856	1122	1236	1146
Set Aside Funds Used	417	79	0	0	225	150	0	75	175	120
Set Aside Funds Saved	161	0	250	125	0	0	225	0	0	0
Set Aside Funds Balance	297	218	468	593	368	218	443	368	193	73
Net S&T Funding Needed	738	995	941	1130	954	1023	1081	1047	1061	1026

Note: 2014-2016 values are actual costs. 2017 values are budgets. The budgets for Bay Margins Studies in 2017-2018 were combined and will be used in 2017; the additional funds used in 2017 will be drawn from the Undesignated Funds pool in 2017 and replaced in 2018. All other 2018-2023 values are forecast using the most recent actual cost and a 2.7% discount rate.

STATUS AND TRENDS: EXPENSES OVER 10-YEAR STUDY DESIGN (2014-2023)

PROGRAM MANAGEMENT

Average budget: ~12% of the total budget

Program management includes the following activities:

Program planning

- Preparing the Detailed Workplan and Multi-Year Plan

Contract and financial management

- Tracking expenditures versus budgets
- Developing and overseeing contracts, invoicing
- Providing financial updates to the RMP Steering Committee

Technical oversight

- Internal review by senior staff of reports, presentations, posters, workplans, memos, and other communications

Internal coordination

- Workflow planning
- Tracking deliverables and preparing RMP Deliverables Stoplight and Action items reports
- Staff meetings

External coordination

- 20 meetings with external partners (SCCWRP, Delta RMP, SWAMP, and others) to coordinate programs and leverage RMP funds

Administration

- Office management assistance

Program Review

Periodically, the RMP conducts an overall peer review of the Program as a whole. Two external Program Reviews have been conducted to date, in 1997 and in 2003. 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.

A review of RMP governance was conducted in 2014 and a charter for the Program was adopted in 2015. An internal program review was conducted in 2016, focused on identifying new high priority technical areas and issues for the program to address. New science advisors, program partners, and technical focus areas were identified and will be further developed with the Technical Review Committee and Steering Committee.

The timing and scope of Program Reviews are determined by the Steering Committee. The Steering Committee does not consider a further External Program Review necessary at this time, as ongoing review of critical elements is well established.

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.

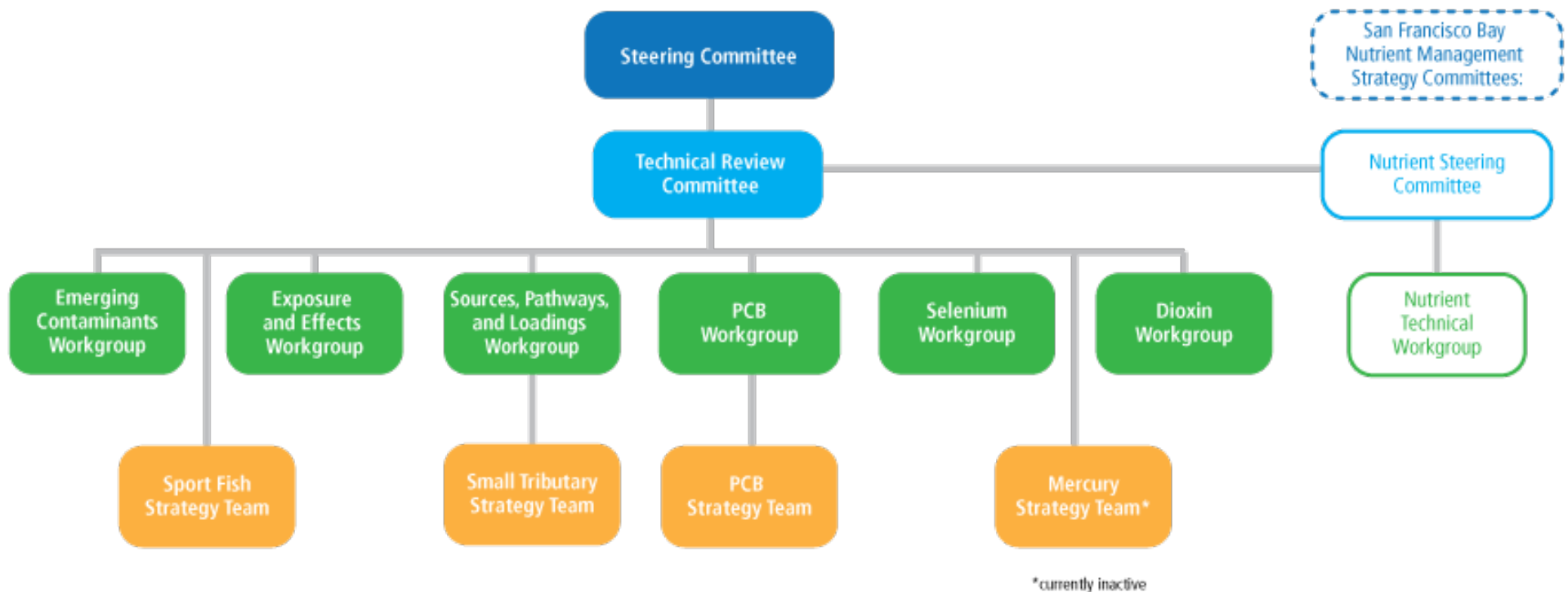
- **Workgroups** include leading external scientists that work with stakeholders to develop workplans and provide feedback on project planning, implementation, and reporting
- The **Technical Review Committee** provides general technical oversight of the Program.
- **Peer-reviewed publications** provide another layer of peer review for most significant RMP studies.

GOVERNANCE

Average budget: ~8% of the total budget

RMP meetings provide a collaborative forum for communication among regulators, regulated entities, and scientists. This forum is provided by regular meetings of organizational and technical committees to track progress and guide future work. Additional information about the function and activities of each governance group can be found in Figure 1 and 3 in this booklet.

- **Steering Committee** – quarterly meetings to track progress, provide management direction, and track financials
- **Technical Review Committee** – quarterly meetings to provide technical oversight
- **Workgroups** – annual meetings to develop multi-year work plans, guide planning and implementation of special studies and Status and Trends monitoring, and provide peer-review of study plans and reports.
- **Strategy Teams** - stakeholder groups that meet as needed to provide frequent feedback on areas of emerging importance, and develop long-term RMP study plans for addressing these high priority topics. The RMP currently has active strategy teams for sport fish monitoring, small tributary loadings, and PCBs.



ANNUAL REPORTING & COMMUNICATIONS

Average budget: ~10% of the total budget + \$50,000 in years when a full Pulse report is produced.

Includes the Pulse of the Bay, Annual Meeting, RMP Update, Multi-Year Plan, State of the Estuary report, RMP web site, Annual Monitoring Report, technical reports, journal publications, Estuary News, oral presentations and posters, and 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. A target audience for the Pulse, Multi-Year Plan, State of the Estuary report card, RMP web site, newsletter, fact sheets, media outreach.
 - **Managers and scientists from other regions.**

Highlights for the Next Five Years

- Pulse of the Estuary (2017)
- RMP Annual Meeting and State of the Estuary Conference (2017)
- RMP 25th Anniversary (2017)
- Continued partnership with SFEP to reach broader audience
- Continued website improvement



Home page for the new RMP website, released in 2015: www.sfei.org/rmp

QUALITY ASSURANCE AND DATA SERVICES

Average budget: ~10% of the total budget

■ Data Services

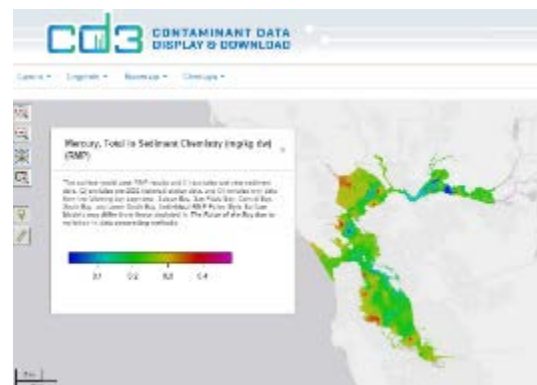
- The RMP dataset contains approximately 1.4 million records since the Program began in 1993. The data are stored in SFEI's Regional Data Center database and are comparable to statewide standards.
- Data management includes formatting, uploading, and reporting each year's Status and Trends data; managing, maintaining, and improving the RMP dataset to enable easy access to RMP data through CD3; coordinating with statewide data management initiatives (e.g., SWAMP and CEDEN); supporting 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 in multiple formats as a tabular (Excel, CSV) or spatial (KML or shapefile) file. 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 that can be customized and downloaded for use in reports and presentations.
- These platforms are used to make information from the RMP available to water quality managers, stakeholders, scientists, and the public.

■ Quality Assurance

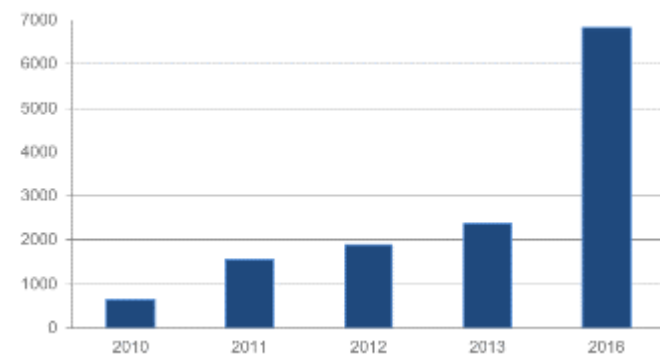
- Quality assurance includes QA review of the data that are submitted by the laboratories; development and application of the QAPP; review of data in comparison to data quality objectives and prior results; review of congener ratios; and troubleshooting any problems with the chemical analyses. Occasional special studies to assess sampling methods, analytical methods, or lab performance are conducted.

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 Environmental Informatics Program
- Hosting DMMO data



Data visualizations in CD3 Tool.



The number of external queries performed using CD3 continues to grow each year.

RMP STUDIES ASSISTING PERMITTEES WITH ADDRESSING SPECIFIC PERMIT CONDITIONS**Dredgers**

Policy	Provision	Study
2011 Programmatic Essential Fish Habitat Agreement, Measure 1	Conduct benthic recovery study in dredged areas	Benthos Recovery After Dredging, Benthic Assessment Tools
2011 Programmatic Essential Fish Habitat Agreement, Measure 7	Conduct bioaccumulation testing evaluations for in-Bay sediment disposal. Clearly define bioaccumulation triggers for testing and subsequent permitting decisions.	S&T Sediment Monitoring– determine ambient bay sediment concentrations for bioaccumulation testing thresholds
PCBs TMDL	Monitor PCB loads in dredged materials disposed in-Bay relative to TMDL allocation	S&T Sediment Monitoring – determine ambient bay sediment concentrations for in-Bay disposal limits
Mercury TMDL	Monitor mercury loads in dredged materials disposed in-Bay relative to TMDL allocation	S&T Sediment Monitoring– determine ambient bay sediment concentrations for in-Bay disposal limits
Long-Term Management Strategy	Establish how much dredged material can be disposed of in-Bay, and where	USGS Suspended Sediment Monitoring, Bay sediment budgets

RMP STUDIES ASSISTING PERMITTEES WITH ADDRESSING 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 ASSISTING PERMITTEES WITH ADDRESSING 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)
Nutrient Watershed Permit	Characterize nutrients and nutrient-related parameters in the Bay	Contributions to Nutrient Management Strategy studies

RMP STUDIES RELATED TO SPECIFIC PERMIT CONDITIONS**Urban Stormwater**MRP link: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/R2-2015-0049.pdf

Policy	Provision	Study or linkage
Municipal Regional Stormwater Permit (MRP)	C.8.f Pollutants of Concern Monitoring	Sources, Pathways, and Loadings Workgroup (SPLWG) / Small Tributary Loading Strategy (STLS) studies on PCBs and Hg and other POCs can fulfill a portion of requirement in conjunction with BASMAA efforts.
		ECWG in collaboration with SPLWG to conduct the required special study for emerging contaminants in stormwater to include at least PFOS, PFOA and alternative flame retardants.
MRP	C.8.g. iii Wet Weather Pesticides and Toxicity Monitoring	Possible linkage to STLS/ SPLWG studies but the details are still to be determined.
MRP	C.11/12.a Implement Control Measures to Achieve Mercury/ PCB Load Reductions	STLS/ SPLWG monitoring efforts will help identify priority watersheds / management areas where coordinated with stormwater program planning.
MRP	C.11/12.b. Assess Mercury/ PCB Load Reductions from Stormwater	STLS/ SPLWG information could be used by stormwater programs to help with refinements and documentation for methodology assessing load reductions
MRP	C.11/12.c. Plan and Implement Green Infrastructure to reduce mercury / PCB loads	STLS/ SPLWG information and the RWSM outputs can help stormwater permittees with quantifying relationships between areal extent of green infrastructure and load reductions.
MRP	C.11/12.d. Prepare Implementation Plan and Schedule to Achieve TMDL Allocations	STLS/ SPLWG information and the RWSM outputs can help stormwater permittees with the development of a reasonable assurance analysis.
MRP	C.12.g. Fate and Transport Study of PCBs: Urban Runoff Impact on San Francisco Bay Margins	PCB Strategy Team will implement required study via the multi-year Bay Margins project to develop Conceptual Models of Priority Margin Units
		STLS/ SPLWG concentrations and loads information is helping to complete the Bay margins mass balance pilot projects that aims to provide information on the fate of PCBs in Urban Runoff and impact on San Francisco Bay margins.