RMP
REGIONAL MONITORING
PROGRAM FOR WATER QUALITY
IN SAN FRANCISCO BAY

sfei.org/rmp

# MULTI-YEAR PLAN

# 2021 ANNUAL UPDATE

FINAL JANUARY 2021

Contribution Number: 1027

## 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 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 from 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 put forward recommendations for special studies to the Technical Review Committee (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 who then considers this recommendation and makes the final decision on the annual workplan.

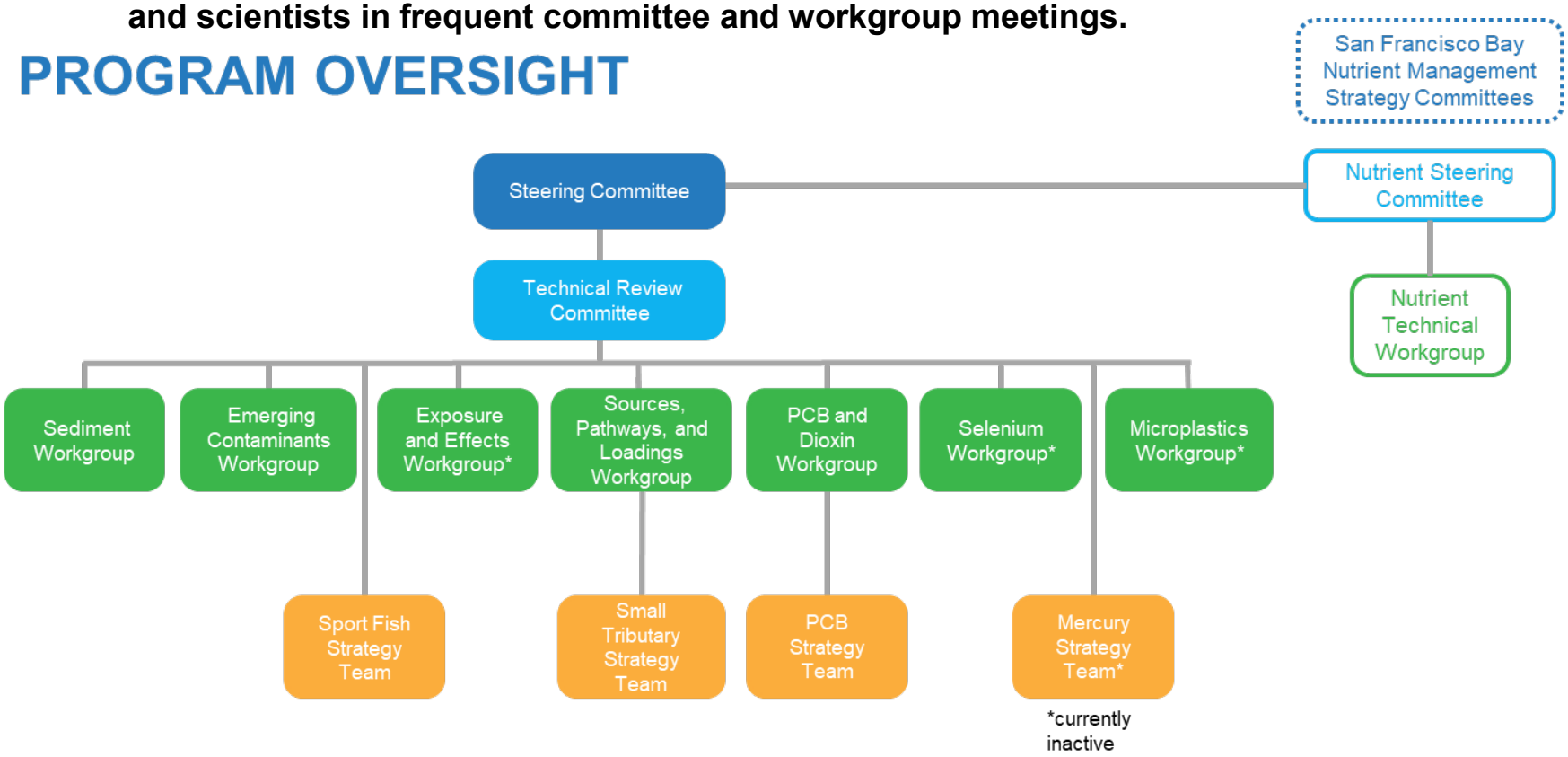
In order to fulfill the overarching goal of the RMP, the Program has to be forward-thinking and anticipate what decisions are on the horizon, so that when their time comes, the scientific knowledge needed to inform the decisions is at hand. Consequently, each of the workgroups and teams develops five-year 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 (Figure 2). In order to turn the plans into effective actions, the RMP distills prioritized lists of management questions that need to be answered (Page 8). The prioritized management questions then serve as a roadmap for scientists on the Technical Review Committee, workgroups, and 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 is achieved through the engagement of stakeholders and scientists in frequent committee and workgroup meetings.**



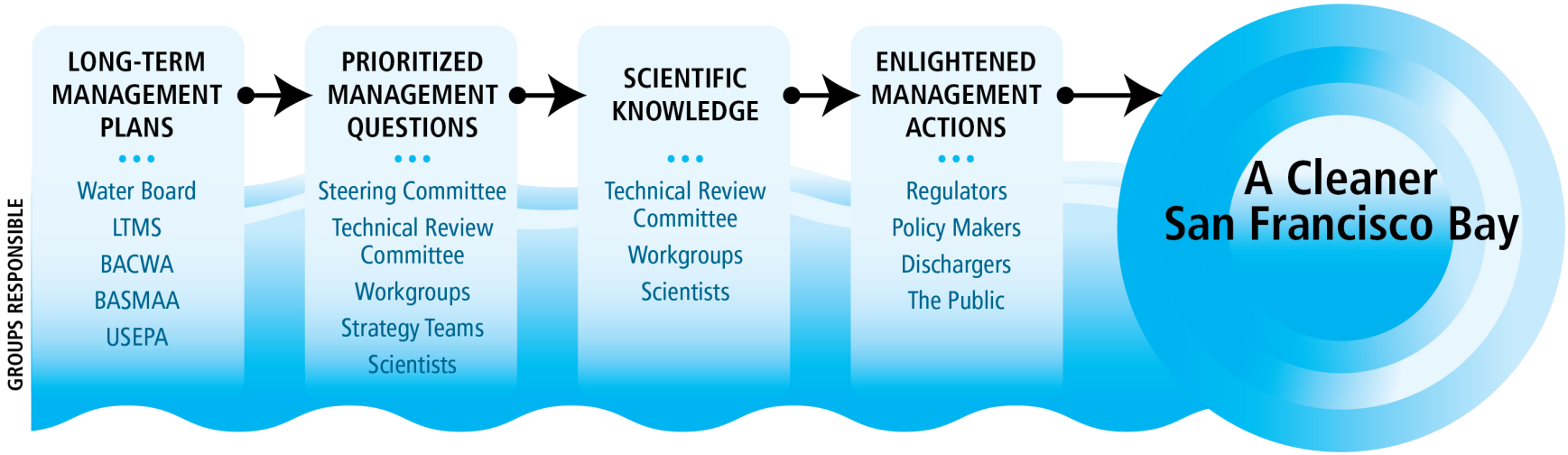

**The Steering Committee** consists of representatives from discharger groups (wastewater, stormwater, dredging, industrial) and regulatory agencies (Regional Water Board and U.S. Army Corps of Engineers). The Steering Committee determines the overall budget and allocation of program funds, tracks progress 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.

**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 the 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.

**Figure 2. Science in support of water quality management.**




Section 2 provides an overview of the RMP budget, 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: emerging contaminants, microplastics, nutrients, PCBs, sediment, selenium, and small tributary loads. Led by the stakeholder representatives that participate in these groups, each workgroup and strategy team develops 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 are 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 the 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 five 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, stormwater discharges, and municipal and industrial wastewater 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 incomplete projects from the previous year
  - Approve annual report outline
  - Pick date for Annual Meeting
- 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
  - Multi-Year Planning Workshop
  - Confirm chair(s) and Charter
  - Decision on fees for the year after next
  - Approve workplan and budget for next year
  - Decision on workgroups to be held next year
  - Discuss outcome of the Annual Meeting

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)
  - Review special studies to ensure coordination
  - Provide planning guidance to workgroups
- June
  - Recommend special studies for funding
  - Review SEP project list
  - Review S&T target analyte list, CEC tiers
  - Review plans for Annual Meeting and annual report
- September
  - Prepare for Annual Meeting
  - Review Status and Trends Monitoring Design
  - Discuss lab intercomparison studies
- December
  - Review annual report outline for next year
  - Informatics update
  - Present workplan for next year and outcome of Multi-Year Planning Workshop
  - Review intercalibration studies and plans

Each meeting includes feedback on proposed and ongoing studies.

### Annual Workgroup Calendar

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

**Multi-Year Calendar**: RMP fees are approved in 3-year increments. The most recent approval was for 2019-2021. The dredger fee schedule is reviewed every 3 years. The most recent approval was for 2020. The MOU between SFEI and the Water Board for administering the RMP is amended every two years. The most recent amendment was for 2021-2022.

**Current and anticipated management decisions, policies, and actions by the regulatory agencies that manage water quality in San Francisco Bay**

| Decisions, Policies, and Actions | Timing |
|---|---|
| BAY WATERSHED PERMITS (CURRENT & NEXT RENEWAL) | |
| Municipal Regional Stormwater Permit | 2015, 2021 |
| Mercury and PCBs Watershed Permit for Municipal and Industrial Wastewater | 2017, 2022 |
| Nutrient Watershed Permit for Municipal Wastewater | 2019, 2024 |
| CURRENT HIGH PRIORITY DRIVERS BY TOPIC | |
| *303(d) List and 305(b) Report*<br>Current listings and next cycle (Sediment Quality Objectives) | 2024 |
| *Beneficial Reuse*<br>Review sediment guidelines and testing criteria<br>Evaluate the effectiveness of strategic placement | Ongoing<br>Ongoing |
| *Chemicals of Emerging Concern*<br>Updates to CEC Tiered Risk-Based Framework<br>Opportunities to inform regional actions and state and federal regulations | Annual<br>Ongoing |
| *Determination of Wastewater Permit Limits*<br>pH, temperature, salinity, hardness, California Toxics Rule | Ongoing |
| *PCBs*<br>Review existing TMDL and establish plan to revise* | TBD |
| *Mercury*<br>Review existing TMDL and establish plan to revise* | TBD |
| *Nutrients*<br>Nutrient Management Strategy<br>Nutrient Monitoring Program<br>Nutrient Water Quality Objective | Ongoing<br>2019<br>2024 |
| OTHER DRIVERS BY TOPIC | |
| *Copper*<br>Site specific objectives triggers+ | Ongoing |

+ Comparisons to triggers will be updated on the RMP sampling frequency (every 4 years for sediment, every 2 years for water)
* The dates for reviewing the Mercury and PCB TMDLs coincide with the schedule for reissuing the Municipal Regional Stormwater Permit.

| Decisions, Policies, and Actions | Timing |
|---|---|
| OTHER DRIVERS BY TOPIC | |
| *Current Use Pesticides*<br>EPA Registration Review of fipronil and imidacloprid<br>DPR fipronil mitigation measures | Ongoing<br>Ongoing |
| *Cyanide*<br>Site specific objectives triggers+ | Ongoing |
| *Dioxins*<br>Review 303(d) listings and establish TMDL development plan or alternative | Ongoing |
| *Dredging Permits*<br>Bioaccumulation testing triggers and in-Bay disposal | Ongoing |
| *Legacy Pesticides (DDT, Dieldrin, Chlordane)*<br>Monitoring recovery | Ongoing |
| *Pathogens*<br>Amend Bay Beaches TMDL to add 2018 listings | 2022 |
| *Sediment Hot Spots*<br>Review 303(d) listings and establish TMDL development plan or alternative<br>Phase 2 Sediment Quality Objectives (Human Health) | 2018, 2022<br>TBD |
| *Toxicity*<br>New state plan on effluent and receiving water toxicity | TBD |
| POTENTIAL FUTURE DRIVERS | |
| *Effects of reduced wastewater and stormwater inputs to the Bay* | TBD |
| *Effects of Reverse Osmosis Concentrate discharge to the Bay* | TBD |
| *South Bay standards-related selenium assessment* | TBD |
| *Sea level rise adaptation and changes in salinity, temperature, pH, and dissolved oxygen due to climate change* | TBD |
| *Trash and Microplastics* | TBD |
| *Wetland Restoration Permits*<br>Regional wetland monitoring (under development) | TBD |

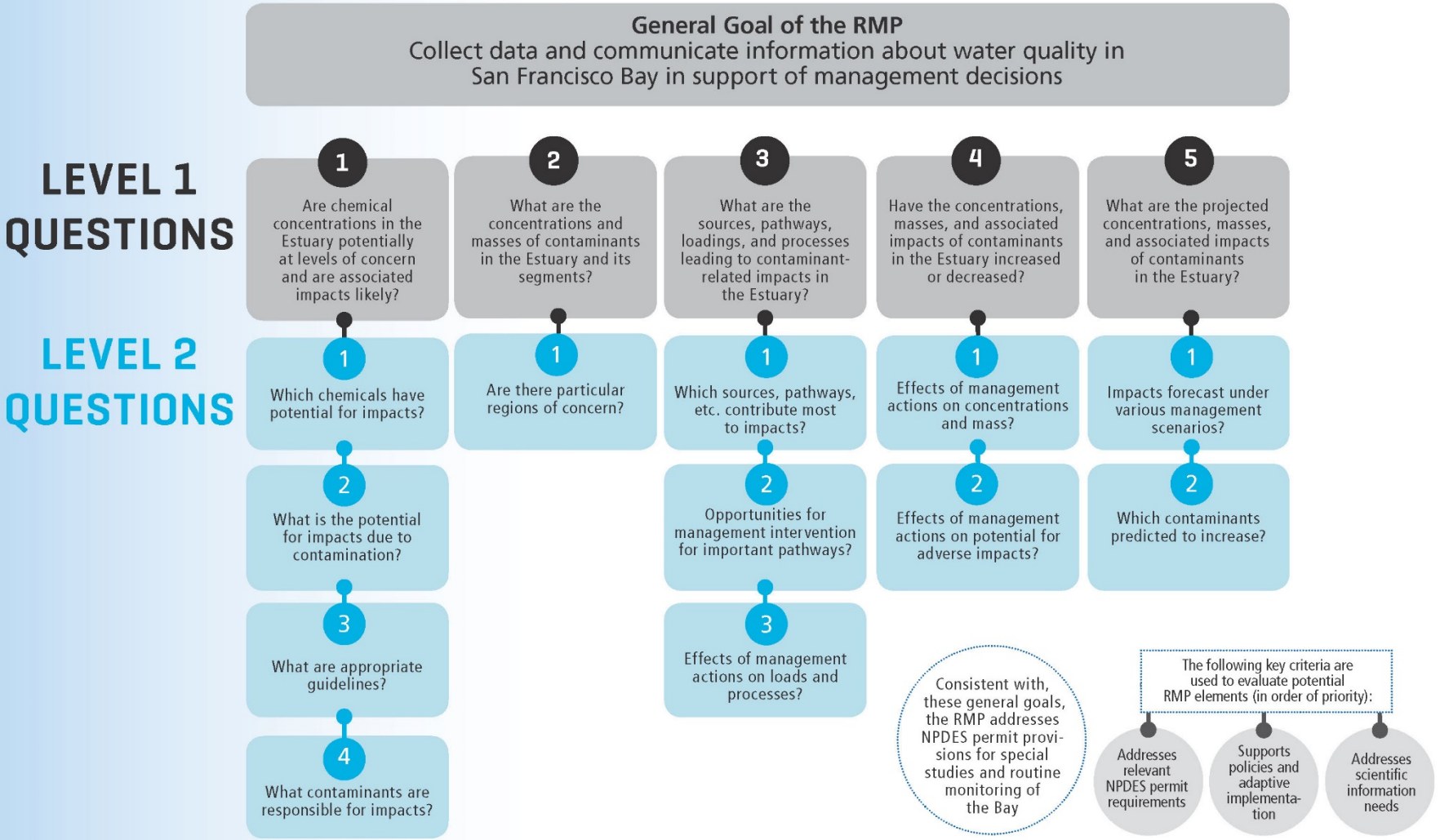
**Management Outcomes supported by or driving work by the Regional Monitoring Program**

| Water Quality Objectives | Year |
|---|---|
| Copper and Nickel (North of the Dumbarton Bridge) | 2010 |
| Copper and Nickel (South of the Dumbarton Bridge) | 2010 |
| Bacteria in Surface Water (REC-1) | 2019 |
| **TMDLs** | |
| Suisun Marsh – DO, mercury, nutrients, salinity | 2018 |
| Selenium (North Bay) | 2016 |
| PCBs | 2009 |
| Mercury | 2008 |
| Urban Creeks Diazinon and Pesticide-Related Toxicity | 2007 |
| **Regulations** | |
| CA Safe Consumer Products Regulations | Ongoing |
| CA Fipronil Applications | 2017 |
| CA Flame Retardants in Furniture | 2013 |
| CA Pyrethroid Application | 2012 |
| **Phase-Outs** | |
| US Voluntary Phase-out of PFAS (6:2 FTOH) (found in food contact substances used in packaging) | 2020 |
| US PFOA | 2015 |
| US Deca-BDE | 2013 |
| US PFOS | 2002 |

| Legislation | Year |
|---|---|
| CA and US Military Base PFAS Ban on Firefighting Foams | 2020, 2022 |
| CA Ban on 13 Specific PFAS, Phthalates, and Other Toxic Ingredients in Personal Care Products | 2020 |
| City of Berkeley Single Use Foodware and Litter Reduction Ordinance | 2019 |
| CA Safe Drinking Water Act: Microplastics | 2018 |
| CA Statewide Microplastics Strategy | 2018 |
| CA Flame Retardants in Consumer Products | 2018 |
| CA Pharmaceutical Stewardship | 2018 |
| San Francisco Flame Retardant Ordinance | 2017 |
| US Triclosan and Triclocarban in Antibacterial Hand Soaps Ban | 2016 |
| Palo Alto and San Francisco expanded polystyrene Ordinances | 2015, 2016 |
| CA Microbead Ban | 2015 |
| US Microbead Ban | 2015 |
| CA Plastic Bag Ban | 2014 |
| CA Copper in Brake Pads | 2010 |
| CA PBDE Ban | 2003 |
| **Fish Advisory** | |
| San Francisco Bay | 2011 |

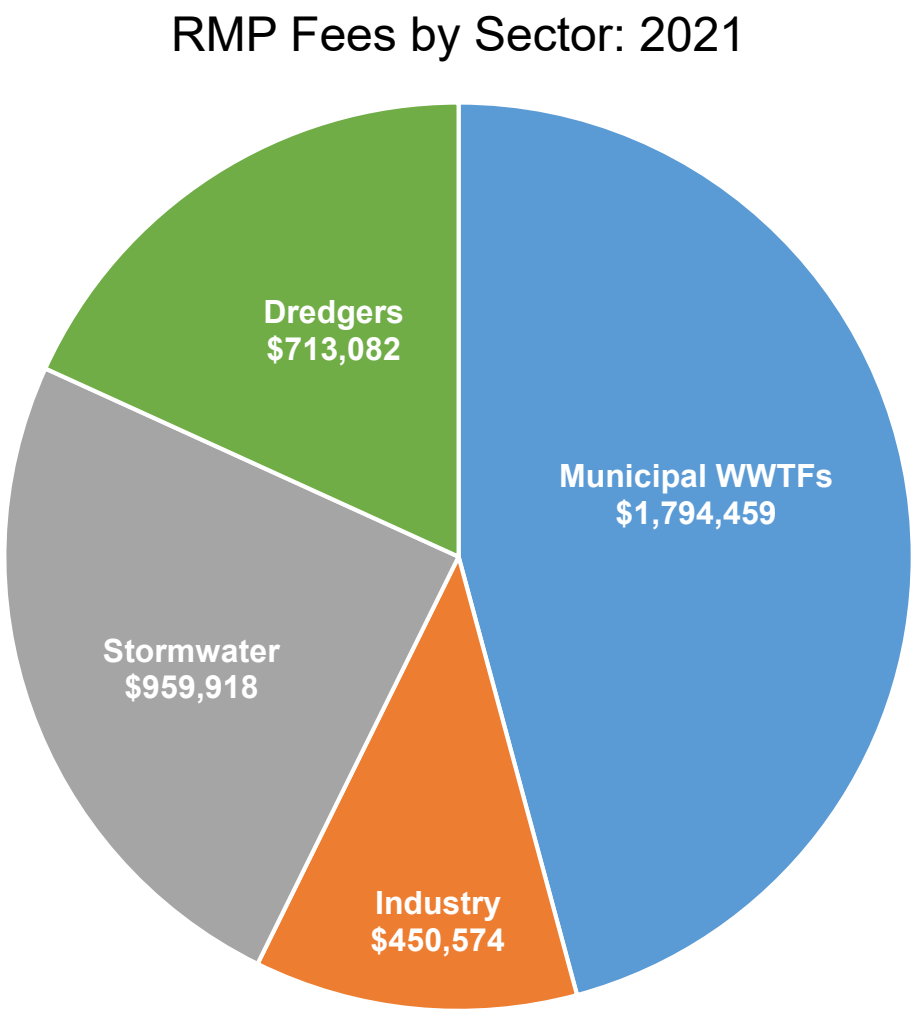
# RMP GOAL AND MANAGEMENT QUESTIONS

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.



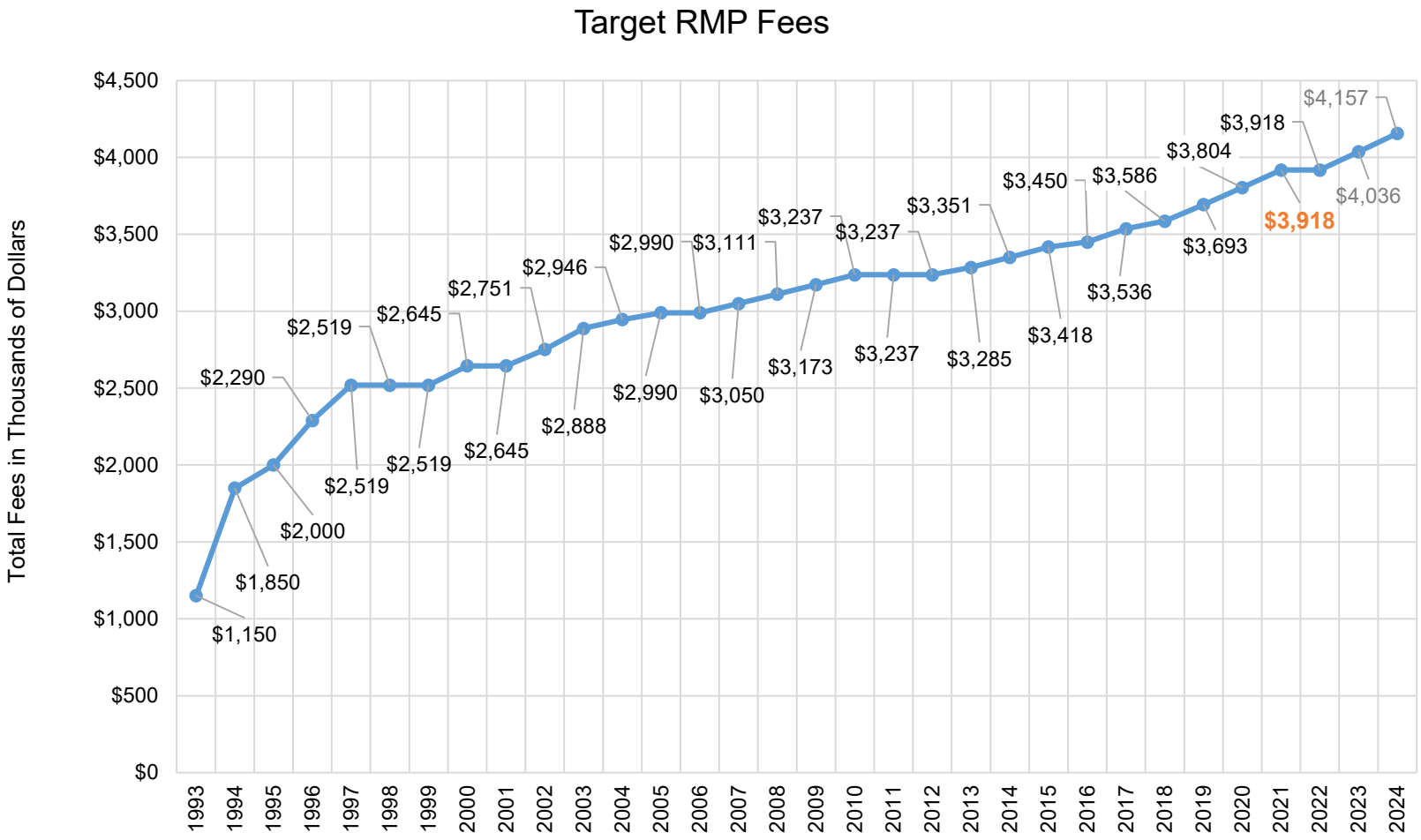
## BUDGET: Revenue by Sector

RMP fees are divided among four major discharger groups. Total fees in 2021 will be $3.918 million. Municipal wastewater treatment agencies are the largest contributor, and stormwater agencies are the second largest contributor. The contribution from dredgers includes $400,000 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. In addition to fees, the RMP also receives penalty funds for Supplemental Environmental Projects and Alternative Monitoring Requirement funds from municipal wastewater agencies.



## BUDGET: Revenue by Year

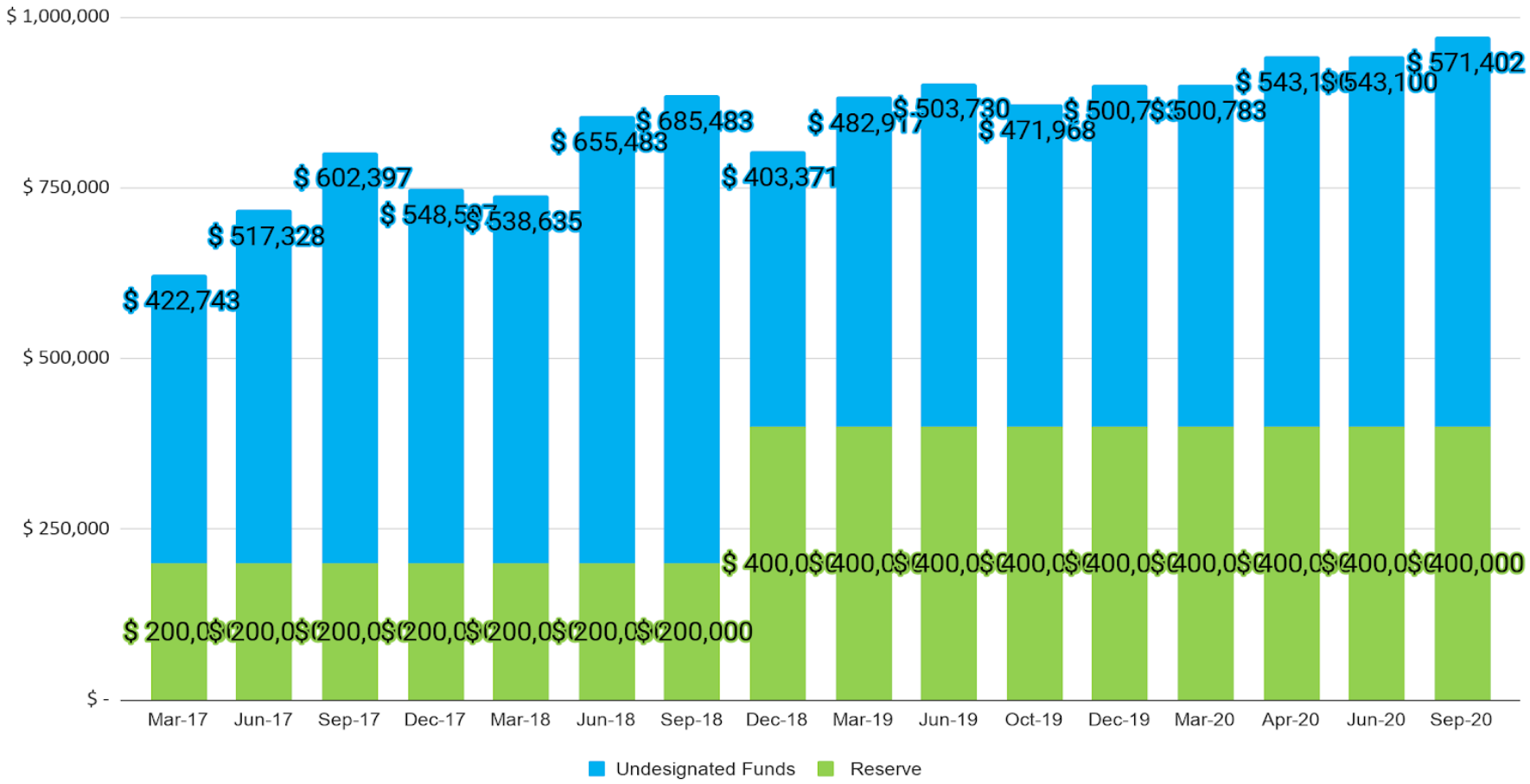
Target RMP fees in 2021 are $3.918 million. For 2022, the Steering Committee has approved a 0% increase in fees due to the economic downturn. Fee increases for 2023 and 2024 will be discussed at SC meetings to ensure the best long-term outcome for the Program. Revenue for 2023 and 2024 assume a 3% increase in fees, similar to previous years. Over the past 20 years, RMP fee growth has not kept up with inflation.



# BUDGET: Reserve Funds

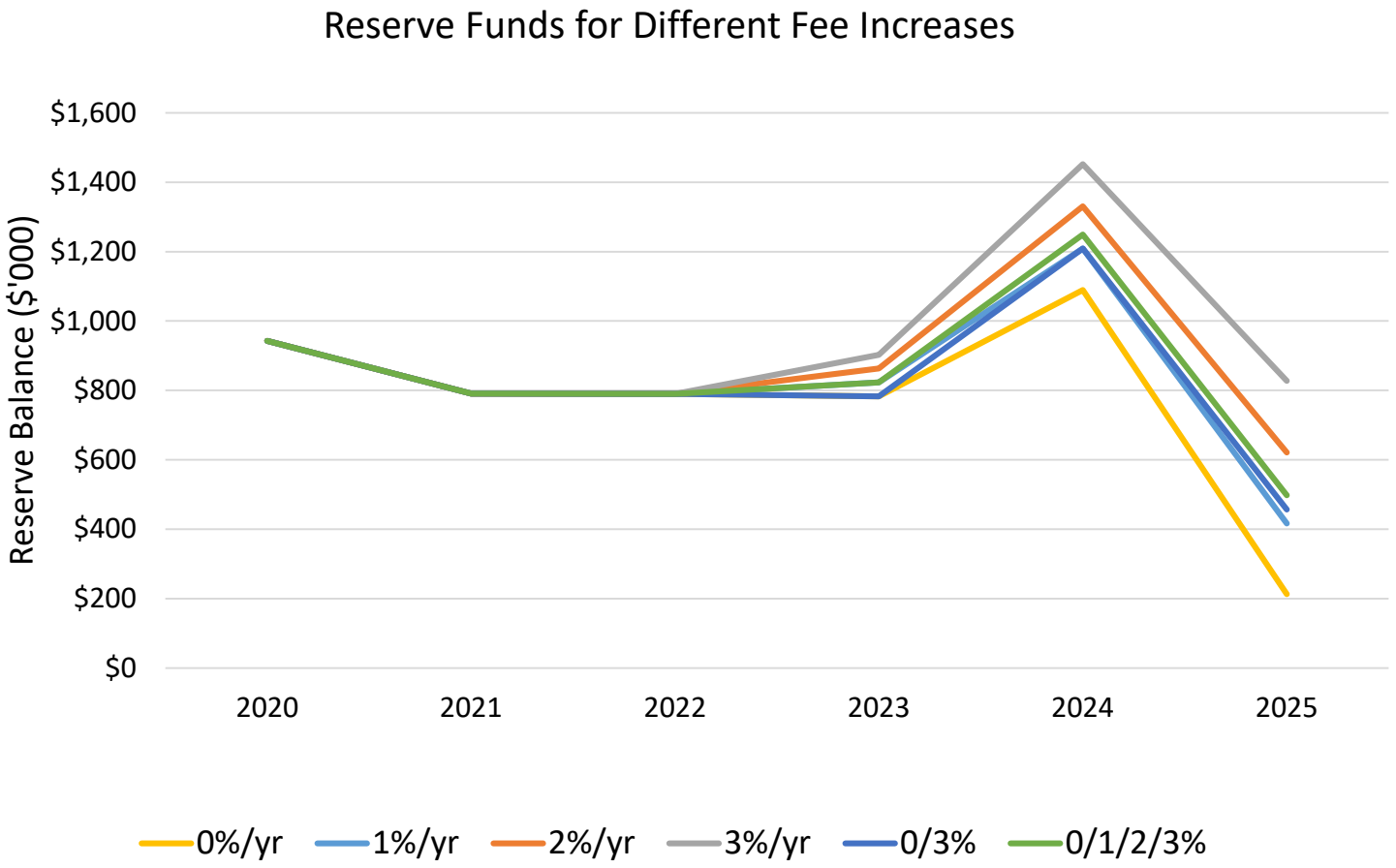
The RMP maintains a balance of Undesignated Funds for contingencies. Higher than anticipated revenues and elimination or reduction of lower priority elements sometimes leads to accumulation of funds that can be used for high priority topics at the discretion of the Steering Committee.

The Bay RMP Undesignated Funds balance over the past two budget years is shown below. The height of the bar shows the total balance of the Undesignated Funds. The bars are color coded to indicate the RMP policy that $400,000 of the Undesignated Funds should be held as a Reserve. The Steering Committee increased the Reserve amount from $200,000 to $400,000 in 2018 so that it is now approximately 10% of the annual Program budget.



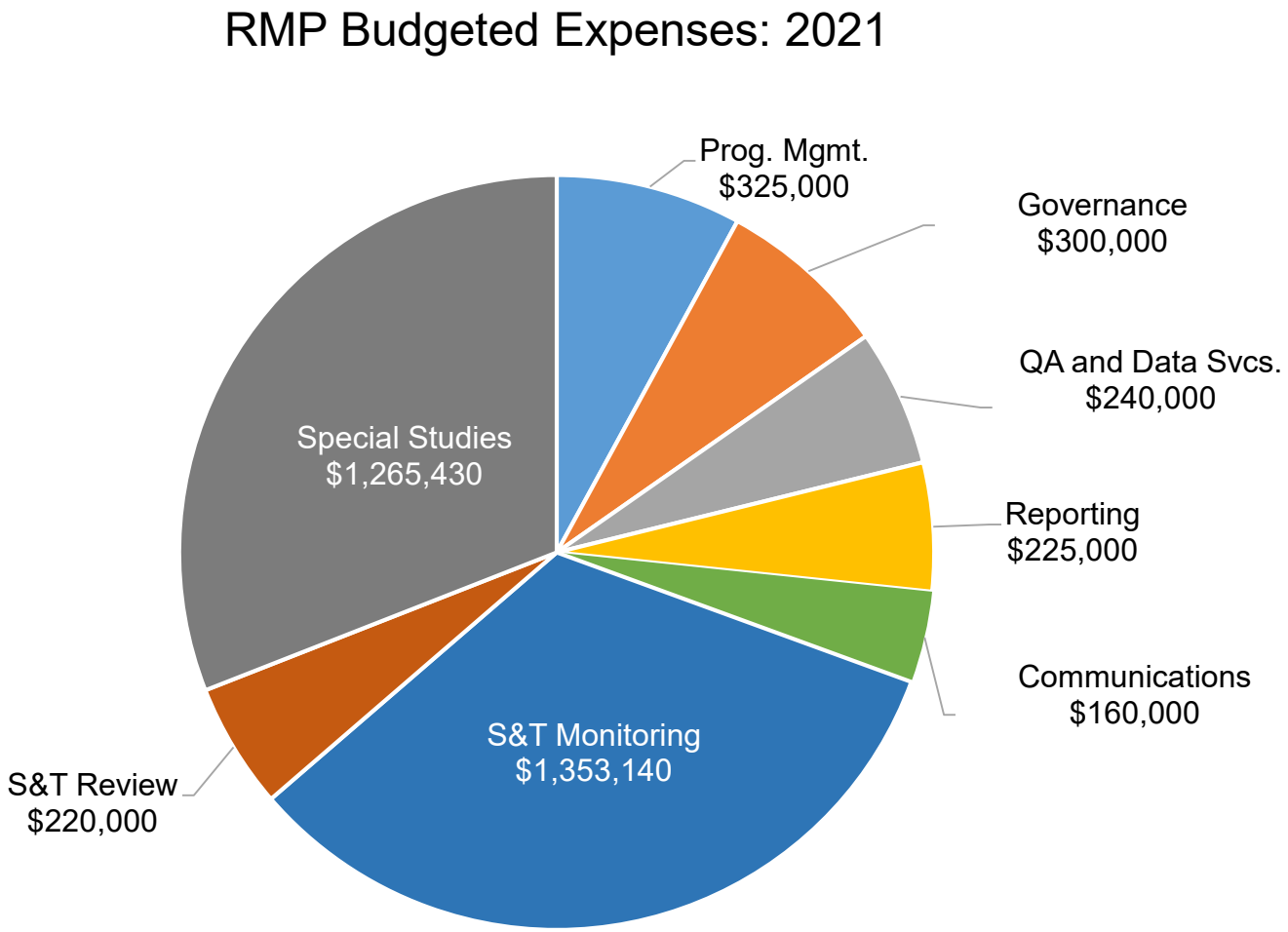
## BUDGET: Projections

With no increase in fees for 2022 and an uncertain budget for 2023 and 2024, the RMP will need to focus on its priorities in the coming years to ensure the Program remains fiscally solvent. The figure below shows how the RMP Undesignated Reserve balance fluctuates under different fee scenarios (fee increases start in 2023 except for the 0/3% scenario where increases start in 2024). These scenarios assume a Program budget that is similar in scope to 2021 with a 3% increase every year for inflation. In the 0% scenario, reserves drop below the $400k reserve in 2025, while the other scenarios remain above the reserve. These scenario budgets assume a Status & Trends Program funded at similar levels forecasted using the current sampling regime. Changes to the S&T Program could change those budget forecasts.



## BUDGET: Expenses

Each year, approximately 70% of the budget is spent on monitoring and special studies. Quality assurance and data systems, reporting, and communications are each approximately 5% of the budget. Governance meetings (8%) are critical to ensure that the RMP is addressing stakeholder needs and conducting studies that include peer-review from project planning through report preparation. Finally, 12% of the budget is needed for program management, including fiduciary oversight of contracts and expenditures.



# ACTUAL AND FORECAST BUDGETS: Special Studies 2016-2024

RMP actual and planned expenditures on special study topics. Costs for 2016-2021 are the approved budgets. Costs for 2022 and beyond are estimates for planning based on the most recent input from the Workgroups and Strategy Teams. The funds available for 2021-2024 were estimated by assuming RMP revenue will increase by 0% for 2022 through 2024, subtracting estimated programmatic expenses (page 13), and subtracting estimated Status and Trends monitoring costs based on the current program (page 40).

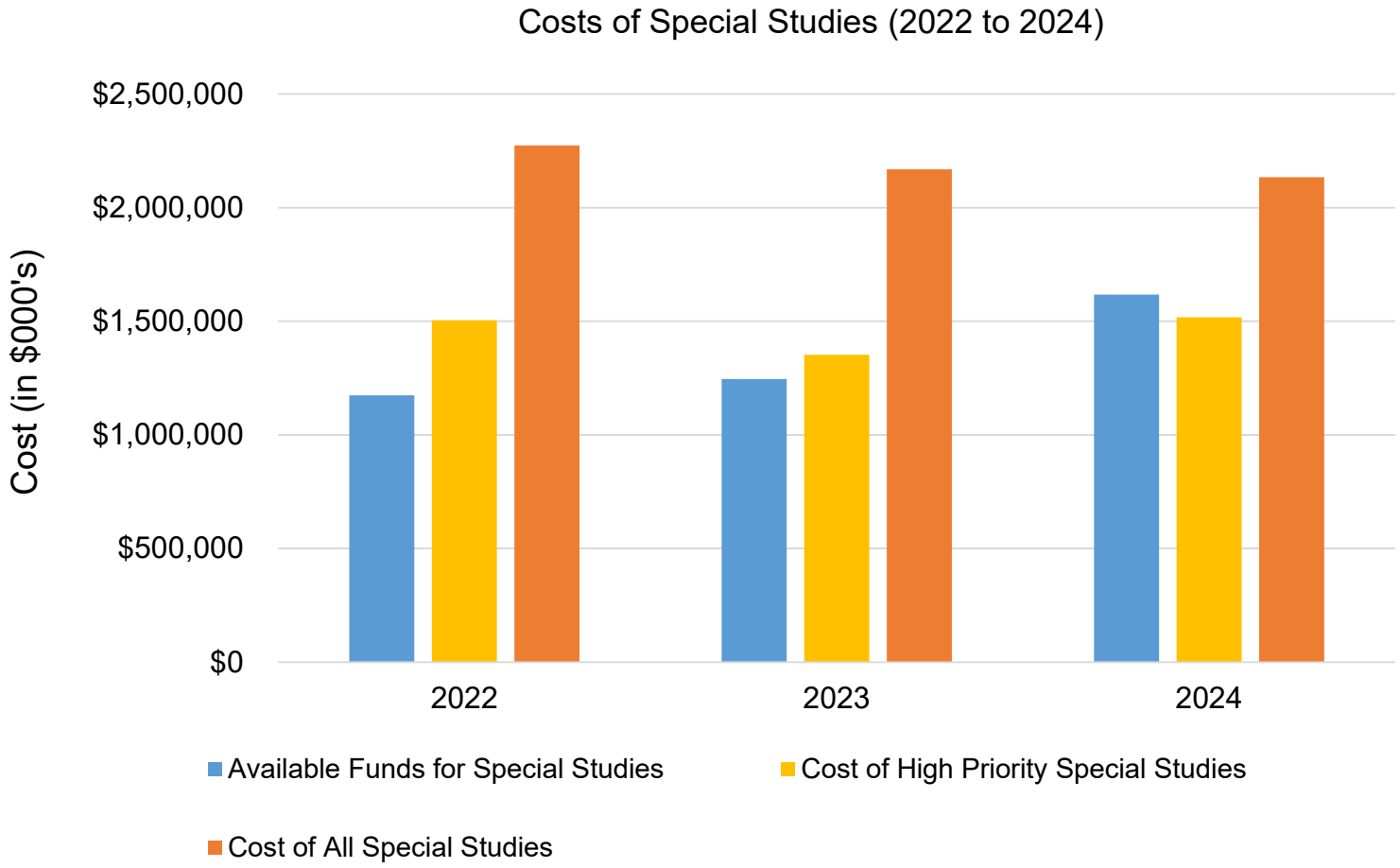
| FOCUS AREA | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|
| | *Budget* | *Budget* | *Budget* | *Budget* | *Budget* | *Budget* | *Forecast* | *Forecast* | *Forecast* |
| **Emerging Contaminants** | $130,000 | $284,835 | $366,000 | $325,000 | $327,900 | $258,000 | $475,000 | $530,000 | $510,000 |
| **Microplastic** | $25,000 | $75,000 | $46,000 | $30,000 | $50,000 | $61,500 | $20,000 | $75,000 | $110,500 |
| **Nutrients** | $300,000 | $373,000 | $350,000 | $250,000 | $250,000 | $250,000 | $400,000 | $400,000 | $400,000 |
| **PCBs** | $40,000 | $70,000 | $31,000 | $40,000 | $101,000 | $131,880 | $162,000 | $125,000 | $189,000 |
| **Sediment** | $33,000 | $90,000 | $215,000 | $215,000 | $180,500 | $214,050 | $550,000 | $590,000 | $495,000 |
| **Selenium** | $47,000 | $106,000 | $10,000 | $107,000 | $84,000 | $0 | $0 | $0 | $0 |
| **Small Tributaries** | $311,000 | $410,000 | $277,000 | $275,000 | $300,000 | $290,000 | $476,000 | $448,000 | $449,000 |
| **SPECIAL STUDIES TOTAL** | **$886,000** | **$1,408,835** | **$1,295,000** | **$1,242,000** | **$1,293,400** | **$1,305,430** | **$2,273,000** | **$2,168,000** | **$2,133,500** |
| **PREDICTED SPECIAL STUDIES BUDGET TOTAL** | | | | | | | **$1,173,867** | **$1,245,346** | **$1,617,407‡** |
| *Predicted RMP Core Budget for Special Studies* | | | | | | $1,012,082 | $894,566 | $966,045 | $1,338,106 |
| *Predicted AMR Funds* | | | | | | $279,301 | $279,301 | $279,301 | $279,301 |

*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.
‡This budget assumes $650k will be used from the S&T Reserves in 2024. A change in that number will change the amount of money available for Special Studies.

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. The AMR funds are tied to a permit condition so the amount is predictable. The SEP funds are not predictable. Therefore, only AMR funds have been included in the predicted special studies budget total in the table above.

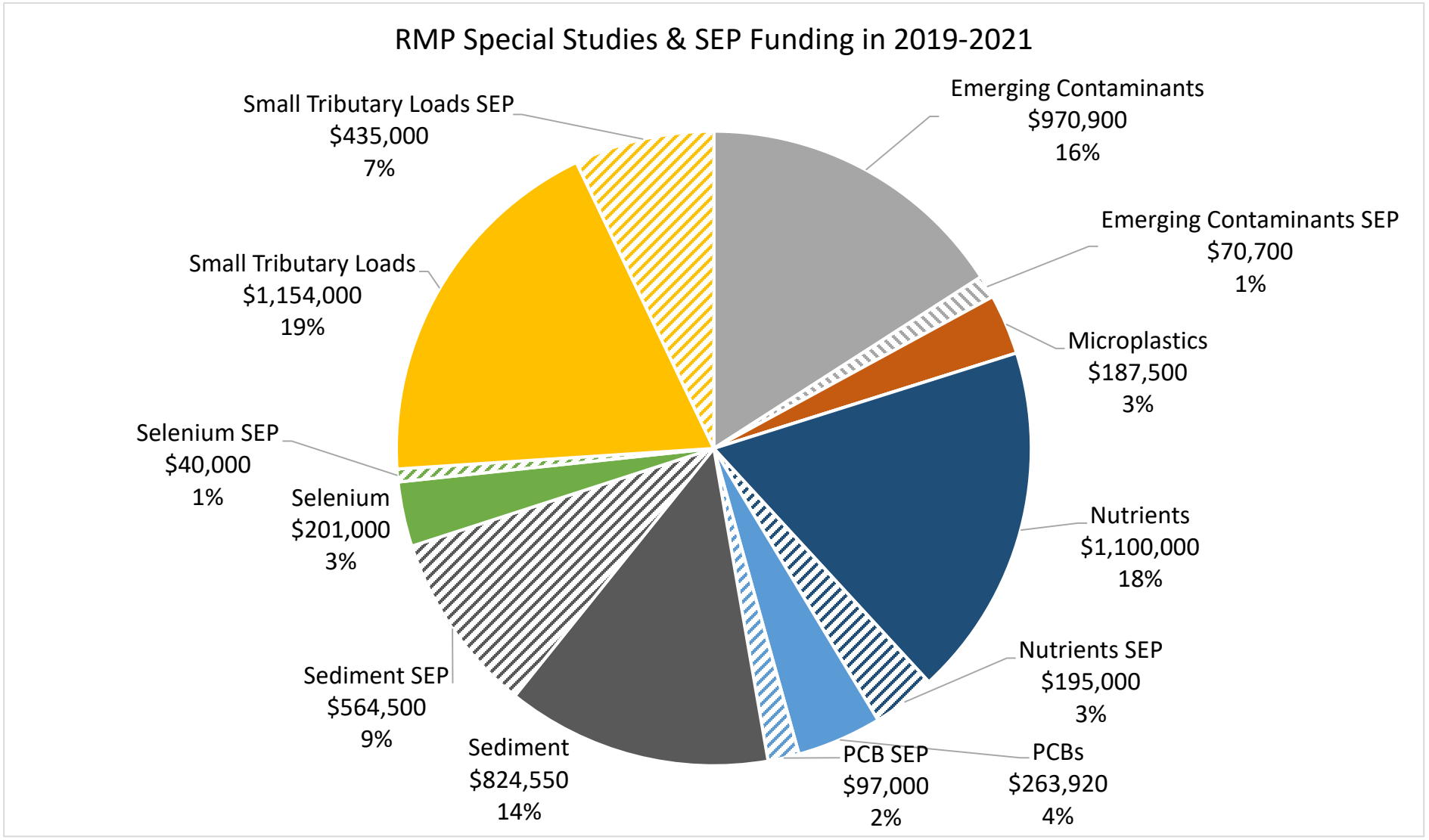
# PROJECTED BUDGET: SPECIAL STUDIES 2022 to 2024

Projected funds available for special studies for 2022-2024 (blue), the cost of high priority studies identified for 2022 (yellow), and the cost of all special studies in the preliminary plans for each workgroup (orange). High priority studies for 2023 and 2024 are estimates because studies have not yet been selected by the workgroups.



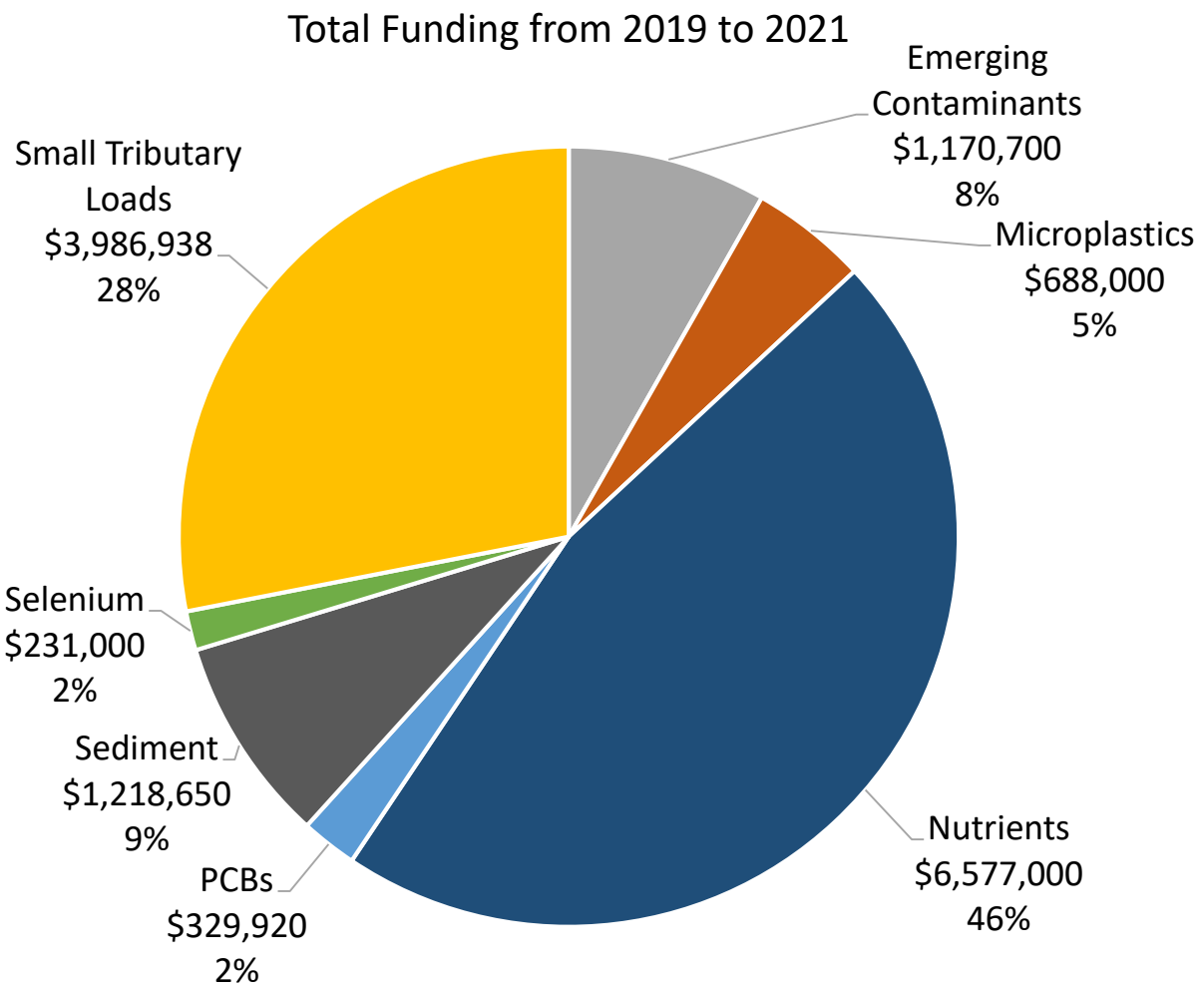
# BUDGET: Special Studies 2019-2021

Special Studies and Supplemental Environmental Projects funds over the past three years. Total funds: $6,104,070



## BUDGET: Special Studies 2019-2021

Total funding for Special Studies over the past three years, including Supplemental Environmental Projects, Alternative Monitoring Requirements, RMP partner funding, and external funding. Total funds: $14,202,208



Fishing on the Bay. Photograph by Shira Bezalel.

# 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

State Water Board CEC Initiative

DTSC Safer Consumer Products program

**Recent Noteworthy Findings**

In 2020 the RMP completed an update of its CEC Strategy. The update outlines an approach for evaluating the potential toxicological risks of data-poor contaminants. Identifying toxicological thresholds for CECs should first use the best available in vivo data, then in vitro data when in vivo data are unavailable, and model predictions when in vitro data are unavailable. Predictive in vitro screening of environmental samples may help identify when mixture effects or additional, unmeasured contaminants are a concern for aquatic life.

A recent pro bono investigation of quaternary ammonium compounds (QACs) in Bay sediment found detectable levels of several QACs, which are commonly used antimicrobials. Notably, the highest concentrations were found in Grizzly Bay, suggesting a localized source, and Lower South Bay, an embayment impacted by municipal wastewater discharges. A sediment core from Central Bay, spanning roughly 60 years of sediment deposition (1951-2009), had QACs in each of the seven layers tested, with concentrations suggesting declines over time. However, the COVID-19 pandemic has likely led to significantly increased use of QACs as antimicrobials. The RMP has launched a special study analyzing QACs in wastewater, stormwater, and sediment.

An evaluation of RMP monitoring data on per- and polyfluoroalkyl substances (PFAS) with respect to both toxicity and persistence in the environment led to the elevation of this class to Moderate Concern in the Bay. To date, much of the regulatory focus for PFAS has been on drinking water; however, the State Water Board, in coordination with Regional Water Boards, recently released interim final Environmental Screening Levels for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonate (PFOS) for both aquatic habitat ecotoxicity and human exposure risk. These screening levels will allow better assessment of the risks posed by Bay water concentrations. The RMP and others are conducting PFAS monitoring in multiple matrices to develop the data needed to inform management.

**Priority Questions for the Next Five Years**

1. Which CECs have the potential to adversely impact beneficial uses in San Francisco?
2. What are the sources, pathways and loadings leading to the presence of individual CECs or groups of CECs in the Bay?
3. What are the physical, chemical, and biological processes that may affect the transport and fate of individual CECs or groups of CECs in the Bay?
4. Have the concentrations of individual CECs or groups of CECs increased or decreased in the Bay?
5. Are the concentrations of individual CECs or groups of CECs predicted to increase or decrease in the future?
6. What are the effects of management actions?

# MULTI-YEAR PLAN FOR EMERGING CONTAMINANTS

**Special studies and monitoring in the RMP from 2015 to 2024.** Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external sources (e.g., SEP funds). Budgets that are starred represent funding that has been allocated for the given study within other workgroups. Bold boxes indicate multi-year studies. Items shaded in yellow are considered high priority for 2022 funding and beyond. Dollar signs indicate projected future priorities for RMP special studies funding. Budgets marked with ‡ have been designated as matching funds for non-RMP funded projects.

| Element | Study | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy | CEC Strategy[1] (not a Special Study after 2020) | RMP | 1-6 | 20 | 48 | 50 | 65 | 70 | 75 | *60‡* | *80* | *60* | *60* |
| | Stormwater Monitoring Strategy | RMP | 1,2 | | | | | | | | 50 | 50 | |
| **MODERATE CONCERN CECs** | | | | | | | | | | | | | |
| PFAS | CECs in Municipal Wastewater[2] | RMP | 1,2,4 | 27.5 | | | | | | | | | |
| | Effluent TOP Analysis | DTSC | 1,2,4,6 | (50) | | | | | | | | | |
| | PFAS: Synthesis and Strategy | RMP | 1-6 | | | 56 | | | | | | | |
| | Margin Sediment Archiving | RMP | 1 | | | | 2.5 | | | | | | |
| | PFOS/PFOA Bay Model | Interwaste | 1,2,3,5 | | | | (7) | | | | | | |
| | Stormwater PFAS[3] | RMP | 1,2 | | | | | 33 | 40 | 29.6 | 25 | | |
| | North Bay Margin Sediment PFAS ($40-$125k) | SEP proposal | 1,2,4,6 | | | | | | | | | | |
| | PFAS in Ambient Bay Water | RMP | 1,4,6 | | | | | | | 50 | | | |
| | PFAS in Influent, Effluent, Biosolids; Study TBD, est. value | BACWA | 1,2,4,6 | | | | | | | (365) | | | |
| | PFAS Wet Season Water Screen | RMP | 1,2 | | | | | | | | 40 | | |
| | Harbor Seal (PFAS and Nonpolar NTA; SEP proposal, ~$100k)[4] | SEP or RMP | 1,4,6 | | | | | | | | | | 100 |
| | RMP Status and Trends[5] | RMP S&T | 1,4 | | E 4* | | E 4* | F 9* | | E 4* | | | E, F 13* |
| Alkyl-phenols and Alkyl-phenol Ethoxylates | Margin Sediment Archiving | RMP | 1,4 | | | | 2.5 | | | | | | |
| | Stormwater Ethoxylated Surfactants[3] | RMP | 1,2 | | | | | 33 | 40 | 29.6‡ | 25 | | |
| | Ethoxylated Surfactants in Water, Margin Sediment, and Wastewater | RMP | 1,2,4 | | | | | 123 | | | | | |

| Element | Study | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trends Analysis (Sediment Core) | RMP | 1,4 | | | | | | | | 70 | | |
| Bisphenols | Bisphenols in Bay Water | RMP SIU | 1 | (25) | | 50 | | | | | | | |
| | Bisphenols in Stormwater | RMP | 1,2 | | | | | | 21 | 29.6‡ | 25 | | |
| | Bisphenols in Wastewater, Sediment | RMP | 1,2 | | | | | | 72 | | | | |
| | Bisphenols in Sport Fish, Bivalves | RMP | 1 | | | | | | | | | | 80 |
| | RMP Status and Trends[5] | RMP S&T | 1,4 | | | | | | | W 13* | wet 9* | W 13* | |
| Organo-phosphate Esters | Organophosphate Ester Flame Retardants in Ambient Bay Water | RMP ECCC | 1,4 | | | 47 | | | | | | | |
| | Stormwater Organophosphate Ester Flame Retardants[3] | RMP | 1,2 | | | | | 33 | 40 | 29.6‡ | 25 | | |
| | OPE Air Monitoring | RMP | 1,2,3,6 | | | | | | | | | 50 | |
| | RMP Status and Trends[5] | RMP S&T | 1,4 | | | | | | | W 16* | wet 12* | W 16* | |
| Fipronil | CECs in Municipal Wastewater[2] | RMP | 1,2,3 | 27.5 | | | | | | | | | |
| | Fipronil, Degradates, Imidacloprid in Wastewater and Biosolids | RMP ASU | 1,2,3 | | 30 (8) | | | | | | | | |
| | RMP Status and Trends[5] | RMP | 1,3,4 | | | | S 12* | | | | | | |
| Imida-cloprid | Imidacloprid, Degradates, and other Neonicotinoids in Bay Water | RMP | 1 | | | 40 | | | | | | | |
| **LOW or POSSIBLE CONCERN CECs** | | | | | | | | | | | | | |
| PBDEs | RMP Status and Trends[5] | RMP S&T | 1,3,4 | | B, E 24* | | S, E 42* | F 24* | | E 18* | S 24* | | F 24* |
| Alt. Flame Retardants | Brominated Flame Retardants in Bay Sediment and Tissue | RMP | 1,4 | | | | | | | | 80 | | |
| Pharma-ceuticals | Pharmaceuticals in Wastewater | RMP POTWs | 1,2,4 | | (68) | | 30 | | | | | | |
| | Antibiotics and QACs in Surface Sediment and Cores | U Minn | 1,3,4 | | | | (8) | | | | | | |
| | Pharmaceuticals in Wastewater, Water & Archived Sediment | RMP | 1,2,4 | | | | | | | | | 180 | |
| Plastic Additives | Phthalates and Replacements in Archived Sediment | RMP | 1,4 | | | | | | | | | | 70 |

| Element | Study | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Personal Care/ Cleaning | Triclosan in Small Fish | RMP | 1 | | | 41 | | | | | | | |
| | Musks in Water & Sediment[6] | RMP | 1 | | | | 64.5 | | | | | | |
| | Siloxanes in Sediment and Effluent | SWEAM DTSC | 1,2 | | | | (15) | | | | | | |
| | Sunscreens in Wastewater | MMP | 1,2 | | | | | | (36.5) | | | | |
| | New Concerns in Bay Water, Wastewater[7] | RMP | 1,2 | | | | | | | | | 30 | |
| | QACs in Wastewater[7] | MMP | 1,2,4 | | | | | | | (58.2) | | 30 | |
| Pesticides | DPR Priorities in Water & Sediment[6] | RMP USGS | 1,2,3 | | | | 64.5 (6.8) | | | | | | |
| | Ag Pesticides in Water & Sediment of North Bay Margins (~$100k) | SEP proposal | 1,2 | | | | | | | | | | |
| | Antimicrobials in Bay Water, Wastewater[7] | RMP | 1,2 | | | | | | | | | 30 | |
| PHCZs | Sediment, Tissue | SIU | 1 | (15) | (20) | (40) | | | | | | | |
| Brominated Azo Dyes | Archived Sediment (~$60k) | SEP proposal | 1 | | | | | | | | | | |
| Building Materials | Isothiazolinone Biocides and Other Contaminants in Stormwater (~$50k) | U Iowa SEP Proposal | 1,2 | | | | | (2) | | | | | |
| | New concerns | RMP | 1 | | | | | | | | | | 50 |
| Chlorinated Paraffins | Chlorinated Paraffins (medium-long) in Sediment (~$60k, 2022) | SEP proposal | 1 | | | | | | | | | | |
| Vehicles, Roadways | Tire, Roadway Contaminants Follow-up from NTA, Stormwater[3] | RMP | 1,2 | | | | | 33 | 40 | 29.6 | 25 | | |
| | Tire Contaminants Wet Season Water Screen | RMP | 1,2 | | | | | | | | 50 | | |
| **NON-TARGETED & OTHER STUDIES** | | | | | | | | | | | | | |
| Non-targeted | Non-targeted Analysis of Water-soluble CECs | RMP / Duke / AXYS | 1,2 | | 52 (10) (6) | | | | | | | | |
| | Non-targeted Analysis of Sediment | RMP | 1,2 | | | | 101 | | | | | | |
| | Non-targeted Analysis of Runoff from North Bay Wildfires | RMP DTSC Water Brd | 1,2 | | | | 36 (20) | | | | | | |

| Element | Study | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Duke | | | | | (27)<br>(3) | | | | | | |
| | Harbor Seal (PFAS and Nonpolar NTA; SEP proposal, ~$100k)[4] | SEP proposal | 1,4,6 | | | | | | | | | | 100 |
| | Follow-up Targeted Study (2018 sediment results) | RMP | 1 | | | | | | | | | 100 | |
| | Microplastic Additives NTA Study[8] | RMP | 1 | | | | | | | | | | 50 |
| Other | Toxicology | RMP | 1 | | | | | 15 | | 60 | 60 | 60 | 60 |
| **RELEVANT STUDIES IN OTHER WORKGROUPS** | | | | | | | | | | | | | |
| Bioassay (EEWG) | Linkage of In Vitro Estrogenic Assays with In Vivo End Points | RMP SCCWRP UF | 1,2 | | | 45 | | | | | | | |
| Modeling (SPLWG) | Integrated Monitoring and Modeling Strategy - CEC Conceptual Model | RMP | 1,2,4 | | | | | | | 50 | | | |
| **RMP-funded Special Studies Subtotal - ECWG** | | | | **75** | **130** | **284** | **366** | **325** | **328** | **258** | **475** | **530** | **510** |
| **High Priority Special Studies for Future RMP Funding** | | | | | | | | | | | **355** | **300** | **310** |
| **RMP-funded CEC Strategy** (not a Special Study after 2020) | | | | | | | | | | **60** | **80** | **60** | **60** |
| **RMP Status and Trends Analytical Costs for CECs** | | | | **0** | **28** | **0** | **58** | **33** | **0** | **51** | **45** | **29** | **37** |
| **RMP-funded Special Studies Subtotal – Other Workgroups** | | | | **0** | **0** | **45** | **0** | **0** | **0** | **50** | | | |
| **MMP & Supplemental Environmental Projects Subtotal** | | | | **0** | **0** | **0** | **0** | **0** | **36.5** | **58.2** | | | |
| **Pro-Bono & Externally Funded Studies Subtotal** | | | | **90** | **112** | **90** | **37** | **2** | **0** | **365** | | | |
| **OVERALL TOTAL** | | | | **165** | **270** | **419** | **461** | **360** | **514.5** | **842.2** | **600** | **619** | **607** |

1 – The CEC Strategy funds preparation of RMP CEC Strategy Revisions, Updates, and Memos; it also funds literature review, scientific conference attendance, and responses to information requests from RMP stakeholders. A Revision to the CEC Strategy is planned for 2022, resulting in a higher funding request than in the prior years. While previously considered a Special Study, as of 2021 the CEC Strategy is considered part of program management.
2 – The 2015 CECs in Municipal Wastewater study ($55k) included analyses of PFAS and fipronil; the budget has been split between these two groups.
3 – The multi-year (2019-2022) stormwater study includes five groups of analytes: PFAS, ethoxylated surfactants, organophosphate esters, bisphenols (added year 2), and targeted stormwater analytes identified via non-targeted analysis. The total projected cost ($586k) is spread across five groups and three years.
4 – The proposed non-targeted analysis of harbor seal tissues includes investigations of PFAS ($100k) and nonpolar compounds ($100k).
5 – When a CEC may be included in the the RMP Status and Trends monitoring, there is a code in the cell denoting the matrix for which monitoring is proposed: W = water; S = sediment; B = bivalve; E = eggs; F = fish. Approximate analytical costs are provided to indicate CECs resources provided by Status and Trends monitoring. A new designation, “wet,” indicates trial wet season water monitoring, which may be funded in 2022.
6 – This 2018 special study ($129k) included analyses of pesticides and fragrance ingredients; the budget has been split between these two groups.
7 – A special study suggested for 2023 could analyze cleaning product ingredients including QACs and other antimicrobials; costs are split among these three groups.
8 – A suggested special study that uses non-targeted analysis to identify additives in microplastics is listed as potentially co-funded via both ECWG and MPWG.

# MICROPLASTIC

## Relevant Management Policies and Decisions

State-wide microplastic strategy and state-wide drinking water monitoring

Regional bans on plastic bags, foam packaging materials, plastic straws, and proposed bans on single-use plastic

State and Federal bans on microbeads

State-wide trash amendments and requirements

Municipal pollution prevention strategy using green stormwater infrastructure

Potential for public outreach and education regarding pollution prevention for microplastics and macroplastics that can disintegrate to microplastics

### Microplastics

Commonly defined as plastic particles smaller than 5 mm. Microplastics include fragments, fibers or fiber bundles, pellets or spheres, films, and foam.

## Recent Noteworthy Findings

Microplastics have been evaluated in Bay surface water, sediment, prey fish, bivalves, and coastal ocean waters for microplastics. Two pollution pathways have also been evaluated, urban stormwater runoff and treated wastewater effluent. Recent investigations provide one of the first comprehensive regional studies of microplastics published to-date, and was made possible with a generous grant from the Gordon and Betty Moore Foundation ($968,000) and additional financial support from the RMP, EBMUD, City of Palo Alto, Patagonia, the Virginia Cabot Wellington Foundation, and the Ocean Protection Council.

Microplastics were detected in all matrices. In comparison to the literature, elevated concentrations were observed in surface water and sediment. Microplastics were detected in prey fish, suggesting they are entering Bay food webs.

Nearly half of the particles identified in stormwater were black fragments that had a distinctive rubbery texture when handled with tweezers. Spectroscopic analysis and secondary characteristics suggested these particles may be synthetic or natural rubber. This identification is not definitive, as other techniques beyond the scope of this project are needed to confirm the particle composition. The literature suggests that one potential source of these particles is vehicle tire wear. Analysis of a small subset of these particles using pyrolysis has indicated that they were tire tread particles, supporting this hypothesis.

Using the Regional Watershed Spreadsheet Model, the annual discharge via stormwater from small tributaries was estimated to be 7 trillion microplastics. This estimated load is greater than 300 times the estimated annual effluent load from all wastewater treatment plants discharging into the Bay.

Key data gaps remain, including additional information on sources and pathways of microplastics, fate and transport, the exposure of Bay aquatic organisms and risk for adverse impacts, and the effects of current and future solutions implemented to reduce microplastic pollution. These information gaps are articulated in the Microplastic Strategy Update (2019).

## Priority Questions for the Next Five Years

1. How much microplastic pollution is 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 could be effective in reducing microplastic pollution?

# MULTI-YEAR PLAN FOR MICROPLASTICS

**Microplastic studies and monitoring in the RMP from 2016 to 2024.** Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external partners. Italicized dollar amounts indicate external funds that are needed but not yet secured. Items included in planning budget are shaded in yellow. Bold boxes indicate multi-year studies.

| Element | Study | Funder | Questions Addressed | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Strategy** | Microplastic Strategy | RMP<br>Patagonia | 1,2,3,4,5 | 25 | | | 15 | 20<br>(30) | 10 | 10 | 10 | 10 |
| | Additional funding for the Moore Foundation SF Bay Microplastics Project | RMP<br>Others* | 1,2,3,4,5 | | 75<br>(40) | | (50) | | | | | |
| **Monitoring biota** | Bivalves | RMP | 1,2,4 | | | 46 | | | | | | |
| | Sport Fish | RMP | | | | | 15 | | | | | 50.5 |
| | Prey Fish | RMP<br>Moore Foundation | | | (130) | | | | | | | |
| | Assessing Information on Ecological Impacts | RMP<br>NSF/CCCSD/External | 1,2 | | | | | (50) | 18<br>(7.5+50) | 10 | 50 | |
| **Monitoring water and sediment** | Open Bay and Margins Sediment | Moore Foundation | 1,3,4 | | (100) | | | | | | | |
| | Surface Water: Bay and Sanctuaries | Moore Foundation<br>Bay Keeper | | | (238) | | | | | | | |
| | Status & Trends Monitoring (sediment core) | RMP<br>External | | | | | | | 3.5 | | | *(47)* |
| **Characterizing sources, pathways, loadings, processes** | Wastewater | Moore/SCCWRP | 1,3,5 | | | (45) | | | (26) | | | |
| | Stormwater | Moore/TBD | | | | (45) | | | | *(80)* | | |
| | Stormwater Conceptual Model | RMP<br>OPC | | | | | | 30<br>(30) | 30<br>(90) | | 15 | |
| | Green stormwater infrastructure: Evaluating the efficacy of rain gardens | External | | | (10) | | | | (62) | (62) | (62) | |
| | Model transport in Bay & ocean | Moore/External | | | | (80) | | | | | | *(80)* |
| | Evaluate microplastics in biosolids | RMP | | | | | | | | | *(75)* | |
| | Monitoring air deposition | External | | | | | | | | | | *(100)* |
| **Evaluating control options** | Options for source control | Moore Foundation | 1,5 | | | (40) | | | | | | |
| | Characterize microplastic additives to assess exposure and identify sources | RMP | | | | | | | | | | 50<br>*(50)* |
| **Synthesis** | Synthesize findings (e.g., report, factsheet, video, symposium | Moore Foundation | 1,3,5 | | | | (290) | | | | | |
| **RMP-funded Special Studies Subtotal – MPWG** | | | | **25** | **75** | **46** | **30** | **50** | **61.5** | **20** | **75** | **110.5** |
| **High Priority Special Studies for RMP Funding** | | | | | | | | | | | | |
| **RMP-funded Special Studies Subtotal – Other Workgroups** | | | | **0** | **0** | **0** | **0** | **0** | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **RMP Supplemental Environmental Projects Subtotal** | **0** | **0** | **0** | **0** | **0** | | | | |
| **Externally-funded Special Studies Subtotal** | **0** | **518** | **210** | **340** | **110** | **120.5** | **142** | **137** | **176.5** |
| **OVERALL TOTAL** | **25** | **593** | **256** | **370** | **160** | **182** | **162** | **212** | **287** |

# NUTRIENTS

**Relevant Management Policies and Decisions**

Developing nutrient numeric endpoints and assessment framework

Evaluating need for revised objectives for dissolved oxygen and other parameters

Assessing water quality impairment status

Implementing NPDES permits for wastewater and stormwater

**Recent Noteworthy Findings**

In 2016, the NMS finished a 10-year Science Plan for addressing monitoring and research needs.

Major progress on numerical models has been made in the first two years of the program. A major validation report was produced in 2017 that showed the hydrodynamic model in its current state sufficiently represents transport in South Bay to support water quality studies with a South Bay focus.

Data from high-frequency sensors and fish trawls in Lower South Bay are being synthesized to explore the issue of where and when there is adequate dissolved oxygen to support resident fish species. The report, which was completed in 2018, was a collaboration between SFEI and the University of California Davis.

Funding for a Supplemental Environmental Project is being used for a major study on harmful algae and toxins. The study will investigate whether toxins are accumulating in small fish and mussels. The use of new molecular techniques to identify harmful algae will also be tested. A report on this study will be prepared in 2019.

**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?

3A. To what extent is nutrient over-enrichment, versus other factors, responsible for current impairments?

3B. What management actions would be required to mitigate such impairments & protect beneficial uses?

4A. Under what future scenarios could nutrient-related impairments occur and which of these scenarios warrant pre-emptive management actions?

4B. 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?

The Nutrient Management Strategy (NMS) is a major collaborative regional science program. The RMP funds monitoring and special studies that are complementary to the studies funded by the NMS.

# MULTI-YEAR PLAN FOR NUTRIENTS

**Special studies and monitoring in the RMP from 2013 to 2022.** Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external sources. The projects funded by non-RMP sources are not specified; only general allocations are indicated. This table does not show nutrient monitoring done for Status & Trends. Items included in the planning budget are shaded in yellow. Bold boxes indicate multi-year studies.

| Element | Study | Funder | Questions Addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy | Program coordination | RMP | 1-5 | | | | | | | | | | |
| Monitoring | Moored sensors | RMP | 1 | 190 | 39.3 | 220 | 230 | 250 | 250 | 250 | 400 | 400 | 400 |
| | Ship-based channel monitoring | RMP | 1 | | | 153 | 120 | | | | | | |
| | Algal biotoxins | RMP SEP | 1 | | | | (195) | | | | | | |
| | Stormwater loads | RMP | 3 | | | | | | | | | | |
| | Monitoring program development | RMP | 1,3 | | 20 | | | | | | | | |
| | Dissolved oxygen | RMP | | | 200 | | | | | | | | |
| | HF mapping | RMP | | 115 | | | | | | | | | |
| | Chl-a analysis | RMP | | | 15.7 | | | | | | | | |
| | Data management | RMP | | | 25 | | | | | | | | |
| Modeling | Modeling | RMP SEP | 4,5 | 165 | | (240) | | | | | | | |
| Synthesis | Conceptual model report | RMP | 1-5 | | | | | | | | | | |
| | Synthesis: nutrient loads and data gaps | RMP | 3 | | | | | | | | | | |
| **RMP-funded Special Studies Subtotal** | | | | **470** | **300** | **373** | **350** | **250** | **250** | **250** | **400** | **400** | **400** |
| **High Priority Special Studies for RMP Funding** | | | | | | | | | | | **400** | | |
| **RMP Supplemental Environmental Projects Subtotal** | | | | **0** | **0** | **240** | **195** | **0** | | | | | |
| **Pro-Bono & Externally-funded Special Studies Subtotal[1]** | | | | **1010** | **880** | **1437** | **1952** | **1480** | **2200** | **2200** | **2200** | **2200** | **2200** |
| **OVERALL TOTAL** | | | | **1652** | **1372** | **2022** | **2537** | **1730** | **2450** | **2450** | **2600** | **2600** | **2600** |

[1] Funding provided by BACWA, CCCSD, DSP, Regional San, City of Palo Alto, City of Sunnyvale, State Water Resources Control Board, and DWR-EMP for a range of studies that support the Nutrient Management Strategy. The descriptions of these projects are not included here for simplicity. More details about the projects being funded by the Nutrient Management Strategy can be found here: http://sfbaynutrients.sfei.org/books/nutrient-strategy-goals-and-work-elements

# PCBs

**Relevant Management Policies and Decisions**

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

**Recent Noteworthy Findings**

Shiner surfperch have a Bay-wide average concentration nine times higher than the TMDL target, and these concentrations have resulted in an advisory from the Office of Environmental Health Hazard Assessment (OEHHA) recommending no consumption for all surfperch in the Bay. Concentrations in shiner surfperch and white croaker show no clear sign of decline. Average concentrations in Suisun Bay sediments are lower than in the other Bay segments, indicating a lower degree of impairment in this region.

Urban stormwater is the pathway carrying the greatest PCB loads to the Bay and with the greatest load reduction goals. Concentrations of PCBs and mercury on suspended sediment particles from a wide range of watersheds are being measured as an index of the degree of watershed contamination and potential for effective management action. Stormwater samples from Pulgas Creek Pump Station North and South, Industrial Road Ditch, an outfall to Colma Creek, and Gull Drive Storm Drain in San Mateo County; Santa Fe Channel in Contra Costa County; Line 12H at Coliseum Way, and Outfall at Gilman Street in Alameda County; and Outfall to Lower Silver Creek in Santa Clara County had the highest concentrations of PCBs on suspended sediment particles measured to date.

An assessment of the Emeryville Crescent established a conceptual model as a foundation for monitoring response to load reductions and for planning management actions. The key finding was that PCB concentrations in sediment and the food web could potentially decline fairly quickly (within 10 years) in response to load reductions from the watershed.

A conceptual model and extensive field studies in San Leandro Bay have documented persistent sediment contamination that is likely due to continuing inputs from the watershed.

**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?

# MULTI-YEAR PLAN FOR PCBs

**Special studies and monitoring in the RMP from 2015 to 2024.** Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external sources. Items included in planning budget are shaded in yellow. Bold boxes indicate multi-year studies.

| Element | Study | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **General** | Develop and update multi-year workplan and continued support of PCB Workgroup meetings | RMP | | 10 | 10 | 10 | 10 | 10 | 10 | Covered by core workgroup funding | | | |
| **PMU** | Prioritize Margin Units | RMP | 1, 4, 5, 6 | 30 | | | | | | | | | |
| | Develop Conceptual Site Models and Mass Balances for PMUs (4 PMUs) | RMP SEP | 1, 4, 5, 6 | 45 | 30 (30) | 60 | | | | | | | |
| | PMU Field Studies to Support the Development of Conceptual Site Models and Monitoring Plans | RMP SEP | 1, 4, 5, 6 | | (202) | | 51[a] | (40)[b] | 91[d] | | 90[e] | 98[f] | |
| | PMU Trend Monitoring (4 PMUs) | SEP | 1, 4, 5, 6 | | | | | (60)[c] | | | 64[g] | | 50[c] |
| **DMMO** | Synthesis of DMMO data for PCB hot spots and mass removed | SEP | 1 | | | | (45) | | | | | | |
| **General** | Updated Fate and Food Web Model | RMP | 1,3,5,6 | | | | | | | 100 | | | 100 |
| | PCB Synthesis | RMP | 1,2,3,4,5,6 | | | | | | | | | | |
| | Strategy for In-Bay Modeling of PCBs and Other Contaminants | RMP | | | | | | | | 45 | | | |
| | Monitoring the Impact of Remediation Actions on San Leandro Bay Recovery from PCB Contamination | RMP | 1,5,6 | | | | | | | 86 | | | |
| **RMP-funded Special Studies Subtotal – PCBs** | | | | **85** | **40** | **70** | **31** | **40** | **101** | **231** | **154** | **98** | **150** |
| **High Priority Special Studies for RMP Funding** | | | | | | | | | **101** | **231** | **154** | **98** | **150** |
| **RMP-funded Special Studies Subtotal – Other Workgroups** | | | | **0** | **0** | **0** | **0** | **0** | **0** | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **RMP Supplemental Environmental Projects Subtotal** | **0** | **232** | **0** | **45** | **97** | **0** | | | | |
| **Pro-Bono & Externally Funded Studies Subtotal** | **0** | **0** | **0** | **0** | **0** | **0** | | | | |
| **OVERALL TOTAL** | **85** | **272** | **70** | **76** | **137** | **101** | **231** | **154** | **98** | **150** |

[a] San Leandro Bay gut contents ($21K) and PMU Stormwater sampling ($30K); [b] PMU stormwater sampling; [c] Shiner surfperch; [d] Steinberger Slough passive sampling and cores; [e] SLB PSDs; [f] Steinberger prey fish ($48K) and Steinberger sediment ($50K); [g] SLB prey fish

# SEDIMENT

The mission of the Sediment Workgroup is to provide technical oversight and stakeholder guidance on RMP studies addressing questions about sediment delivery, sediment transport, dredging, and beneficial reuse of sediment.

**Relevant Management Policies and Decisions**

Long-Term Management Strategy for Dredged Material in SF Bay (LTMS) to comply with the Basin Plan

NOAA 2011 Programmatic Essential Fish Habitat Agreement & 2015 LTMS Amended Programmatic Biological Opinion

PCB TMDL

Mercury TMDL

Regional Restoration Plans[1]

**Recent Noteworthy Findings**

In water years (WY) 2016 and 2017, the USGS monitored the sediment flux through the Golden Gate. This flux is the largest unknown in the sediment budget for the Bay. Results indicate that sediment from the Delta during winter storms was mostly retained in San Pablo Bay, even during the historically high floods of WY2017. Based on recommendations in the study report[2], the RMP funded a modeling study in 2020 that evaluates cumulative fluxes at the Golden Gate over longer periods, using the monitoring data for calibration.

USGS monitoring of suspended sediments at the Dumbarton Bridge in WY2016 indicated that particle flocculation is an important factor for accurately calculating the sediment flux into Lower South Bay. Based on these findings, the RMP allocated funds for additional studies in the Lower South Bay and Benicia Bridge to investigate the importance of flocculation in sediment flux estimates.

A synthesis report estimated that net average annual sediment supply to San Francisco Bay from terrestrial sources during the most recent 22-year period (WY1995-2016) was 1.95 million metric tons. Approximately 63% of the sediment supply was estimated to be from small tributaries that drain directly to the Bay. Net supply from the Delta was approximately 37% of the total supply. Recent data do not indicate any trends other than the step decrease in supply from the Delta in 1999. The report contains initial recommendations for improvements in sediment supply monitoring.

**Priority Questions for the Next Five Years**

1. What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?

2. Are there effects on fish, benthic species, and submerged habitats from dredging or placement of sediment?

3. What are the sources, sinks, pathways and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?

4. How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?

5. What are the concentrations of suspended sediment in the Estuary and its segments?

[1] San Francisco Bay Restoration Authority Goals, Baylands Goals Update for Climate Change, Subtidal Habitat Goals Project, and Action 13 “Manage sediment on a regional scale and advance beneficial reuse” from the Comprehensive Conservation and Management Plan.

[2] https://www.sfei.org/documents/water-and-suspended-sediment-flux-measurements-golden-gate-2016-2017.

# MULTI-YEAR PLAN FOR SEDIMENT

**Workgroup special studies for 2016 to 2024.** Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external sources (e.g., SEP funds). Budgets that are starred represent funding that has been allocated for the given study within other workgroups. This table does not show suspended sediment monitoring done for Status & Trends. Bold boxes indicate multi-year studies. Items shaded in yellow are considered high priority for the 2022 funding cycle. Dollar signs indicate projected future allocation of RMP funds for special studies.

| Element | Study | Funder | Questions addressed | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strategy | Sediment Monitoring Strategy | RMP WQIF | 1,3,4 | | 50 (238) | | 78 | | | | | 15 |
| | Strategy/Workgroup Support | RMP | 1,2,3,4 | | | 10 | | 10 | Workgroup support covered by core program | | | |
| | Sediment Modeling Strategy | RMP | 1,2,3,4 | | | | | 26 | | | | 15 |
| | Sediment Conceptual Model | SEP | 1,2,3,4 | | | | | (142) | | | | |
| Screening Values | Sediment Bioaccumulation Guidance | RMP | 1 | | | 30* | | 23 | | | | |
| | Benthic Index Development | RMP | 1 | | | 21* | | | | | | |
| | Toxicity Reference Value Refinement | RMP | 1 | | | | | | | 40 | | |
| Dredging Impacts on Essential Fish Habitat | Benthic Invertebrate Assessment | RMP LTMS | 2 | | | | | | | | | |
| | Light Attenuation Near Dredging | RMP LTMS | 1,2 | | | | | | | | 40 | |
| Data Mining | DMMO Database and Online Tools | RMP | 1 | | | 55 | Database maintenance costs covered by core program | | | | | |
| | DMMO Data Synthesis | RMP SEP | 1,2 | | 12* | (45) | | | | | 50 | |
| | DMMO Database Enhancement | RMP | 1,2 | | | | | | 40 | | | |
| Beneficial Reuse | Beneficial Reuse | RMP | 1,2 | | | | 30 | | 34 | | | 40 |
| | Sediment Placement Projects or Planning | RMP | 2 | | | | | | | 75 | | |

| Element | Study | Funder | Questions addressed | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Loading to the Bay | Sediment Supply Synthesis | RMP USGS | 3,4 | | 40 (40) | | | | | | | |
| | Maintain Stream Gages and Add New Ones | RMP SEP | 3,4 | | | (115) | | | | | | |
| | Monitor Mallard Island Suspended Load and Bedload Flux | RMP | 3,4 | | | 30 | | | | | 50 | |
| | Monitor Tributary Suspended Load and Bedload Flux | RMP | | | | | | | | 75 | | 75 |
| | Model Tributary Suspended Load and Bedload Flux | RMP | | | | | | | | | 100 | |
| | Monitor Sediment Flux at Key Locations in the Bay (e.g., major creek mouths downstream of head of tide, mudflats/shallows, major bridges, Golden Gate) | RMP SEP | 3,4 | 33 (98) | (69) | 120 | (158) | | | 100 | | 100 |
| | Model Current and Future Sediment Flux at Key Locations throughout the Bay | RMP | 3,4 | | | | | 45 | | | 100 | |
| Sinks & reservoirs | Monitor Sediment Deposition at Key Locations in the Bay (e.g., creek reaches downstream of head of time, mudflats/shallows) | RMP | 3,4 | | | | | | 140 | 60 | | 100 |
| | Model Current and Future Sediment Deposition Dynamics throughout the Bay | RMP | 3,4 | | | | | | | 100 | 100 | |
| | Bathymetric Change Studies | RMP USGS | 3,4 | | | | 77 (5) | 77 (5) | | | | |

| Element | Study | Funder | Questions addressed | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bathymetric Data Collection | RMP | 3,4 | | | | | | | | | 75 |
| Sediment characteristics | Bulk Density of Sediment Types | RMP | 4 | | | | 30 | | | | | |
| | Mapping Bed Sediment Characteristics for Model Calibration | RMP | 3,4 | | | | | | | | | 75 |
| | Characterizing Impacts of Flocculation on Settling Velocity | RMP SEP | 3,4 | | | | | (228, 36) | | | 75 | |
| Bay water column characteristics | Using Satellite Imagery to Analyze Turbidity and Suspended Sediment Concentration | RMP | 5 | | | | | | | | 75 | |
| **RMP-funded Special Studies Subtotal – Sediment** | | | | **33** | **90** | **215** | **215** | **181** | **214** | **450** | **590** | **495** |
| ***High Priority Special Studies for RMP Funding*** | | | | | | | | | | ***375*** | ***300*** | ***390*** |
| **RMP-funded Special Studies Subtotal – Other Workgroups** | | | | **0** | **12** | **51** | **0** | **0** | | | | |
| **RMP Supplemental Environmental Projects Subtotal** | | | | **98** | **69** | **160** | **158** | **406** | | | | |
| **Pro-Bono & Externally Funded Studies Subtotal** | | | | **0** | **278** | **0** | **50** | **5** | | | | |
| **OVERALL TOTAL** | | | | **131** | **449** | **426** | **423** | **592** | **214** | **450** | **590** | **495** |

# 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 particulate concentrations, the highest PCBs in stormwater occur in watersheds draining to Pulgas Creek Pump Station in Redwood City, a ditch on Industrial Rd. in San Carlos, Line 12H at Coliseum Way in Oakland, Santa Fe Channel in Richmond, and a storm drain on Gull Dr. in South San Francisco. PCBs and Hg only weakly correlated but Line 12H also ranks in the top 20 for mercury and the outfall at Gilman Street in Berkeley currently ranks highest for mercury and 15$^{th}$ for PCBs. Sampling during the 2020/21 winter includes industrial sites for stormwater PCB characterization, PMU watershed sites, and sites selected for CECs.

Results from the remote sampler pilot study indicated reasonable comparability to manually collected sample concentrations. Remote sediment sampling devices were deployed for characterizing three new sites in winter 2019/20.

Two new methods for interpreting stormwater data were developed in 2018. The first method used indicator congeners to identify the dominant Aroclor mixtures in stormwater and sediment. Results of the pilot study indicated a unique profile in stormwater samples from Pulgas Creek Pump Station South that was traced to one source area using sediment samples. A second method was developed to estimate watershed yields for a standard sized storm. These two methods are being used to compare ~140 sites and provide additional evidence to support management decisions.

A new modeling and trends strategy has also been developed for PCBs, Hg and the needs of the emerging contaminants, sediment, and nutrient workgroups. In 2020 work has begun on the regional hydrology model using LSPC and will progress in 2021 with sediment, and then pollutants with broad multiple workgroup oversight as a new integrated monitoring and modeling strategy and CECs conceptual models are developed.

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

Special studies for this focus area assess contaminant loading to the Bay from these small tributaries.

## Priority Questions for the Next Five Years

1. What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
2. Which are the “high-leverage” small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
3. How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?
4. Which sources or watershed source areas provide the greatest opportunities for reductions of pollutants of concern in urban stormwater runoff?
5. What are the measured and projected impacts of management action(s) on loads or concentrations of pollutants of concern from the small tributaries, and what management action(s) should be implemented in the region to have the greatest impact?

Screening and characterization to identify high-leverage watersheds for PCBs, Hg, and contaminants of emerging concern (CECs) will be the major emphasis for the next several years, along with an increasing effort to develop a regional dynamic model for loads and trends.

# MULTI-YEAR PLAN FOR SMALL TRIBUTARY LOADING STRATEGY

**Small tributaries loading studies in the RMP from 2015 to 2023**. Numbers indicate budget allocations in $1000s. Budgets in parentheses represent funding or in-kind services from external partners. Items included in the planning budget are shaded in yellow. Bold boxes indicate multi-year studies.

| Element | Funder | Questions addressed | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coordination and management | RMP | | 26 | 26 | 30 | 32 | 40 | 40 | *25* | *26* | *28* | *29* |
| Source Area Monitoring/EMC development and RAA | BASMAA | 1,2,3,4 | (450) | (350) | (450) | (950) | (1000) | (750) | (500) | (500) | (500) | (500) |
| Regional Watershed Spreadsheet Model: Water, Sediment, PCBs and Mercury | RMP | 1,2,4 | 35 | 35 | 40 | 7 | | | | | | |
| POC Reconnaissance Monitoring | RMP | 1,2,3,4 | 374 | 150 | 200 | 125 | 125 | 110 | 65 | 120 | | |
| POC Reconnaissance Monitoring | BASMAA | 1,2,3,4 | (200) | (200) | (200) | | | | | | | |
| Advanced Data Analysis | RMP | 1,2,3,4 | | | | 100 | 50 | 50 | | | | |
| Modeling to support regional loads and trends | RMP | 3,5 | 35 | 100 | 100 | | 60 | 100 | 150 | 150 | 150 | 150 |
| Monitoring to support regional loads and trends | RMP | 1,3 | | | | | | | | 180 | 150 | 150 |
| Integrated Monitoring and Modeling Strategy – CEC Conceptual Model | | | | | | | | | 50 | | | |
| AFR conceptual model development | RMP | 1,4 | | | | 13 | | | | | | |
| BMP effectiveness monitoring in support of modeling | RMP | 3,5 | | | | | | | | | 120 | 120 |
| Guadalupe River Hg loads | RMP | 1,3,4,5 | | | 40 | | | | | | | |
| Stream gaging and suspended sediment monitoring in support of modeling | SEP | 2,3,4 | | | | | 100 | 120 | 160 | | | |
| Update land-use maps for the San Francisco Bay region | SEP proposal | 2,4,5 | | | | | | 15 | 35 | | | |
| **RELEVANT STUDIES IN OTHER WORKGROUPS** | | | | | | | | | | | | |
| PCB priority margin units (PMU) Trend Monitoring | SEP | 1,2,4 | | | | | (60) | | | | | |
| Emerging Contaminants Stormwater Monitoring | RMP | 1,2,4 | | | | | 132 | 181 | 148 | | | |
| **RMP-funded Special Studies Subtotal – STLS** | | | **470** | **311** | **410** | **277** | **275** | **300** | **290** | **476** | **448** | **449** |
| **High Priority Special Studies for RMP Funding** | | | | | | | | | | **330** | **300** | **300** |
| **Small Tributary Loading Strategy** (not a special study after 2020) | | | | | | | | | | **26** | **28** | **29** |
| **RMP-funded Special Studies Subtotal – Other Workgroups** | | | | | | | **132** | **181** | **148** | | | |
| **RMP Supplemental Environmental Projects** | | | | | | | **100** | **135** | **195** | | | |
| **Pro-Bono & Externally Funded Studies Subtotal** | | | **650** | **550** | **650** | **950** | **1000** | **750** | **500** | **500** | **500** | |
| **Overall Total** | | | **1120** | **861** | **1060** | **1227** | **1507** | **1366** | **1133** | **976** | **948** | **449** |

# STATUS AND TRENDS PROGRAM REVIEW

The Status and Trends (S&T) Program is a vital component of the RMP. The S&T Program represents a large annual investment and a huge investment over the long term. The RMP spends about one third of its annual $4 million budget on the S&T Program every year, and $30 million has been spent on the S&T Program over the last 20 years. Monitoring in the current S&T Program is almost exclusively focused on legacy contaminants, including mercury, PCBs, PAHs, dioxins, copper, and selenium. While these contaminants are still of concern in the Bay and important to monitor, contaminants of emerging concern (CECs) are becoming a higher priority for the RMP based on the growing list of CECs that have been classified as Moderate Concern (due to a high probability of some impact on Bay aquatic life) using the tiered risk-based framework and a desire on the part of managers to focus on a more proactive approach to protecting Bay water quality.

Peer review is essential to the success of the RMP, ensuring the Program is technically sound and obtaining the greatest value for the funds that are invested.

The last full review of the S&T Program was completed in 2002, and resulted in fundamental changes to the spatial distribution of stations, as well as the timing and frequency of sampling for water and sediment.

**Goals of the Review and Redesign**

1. Ensuring the Program is generating information that is relevant to management needs;
2. Evaluating the power of the current and revised sampling design to inform management decisions; and
3. Developing an optimized design that prioritizes informing management decisions for CECs.

**Review Process**

The S&T Program Review, which started in April 2020, is being conducted by the S&T Workgroup that includes eight external science advisors with extensive expertise in long-term monitoring programs, CECs and legacy contaminants, and statistical analysis. The advisors are working in collaboration with RMP staff and stakeholders to review the existing Program, perform statistical analyses, and define sampling priorities to inform the updated design. The S&T Program will be reviewed by matrix: water, sediment, and biota.

The S&T Workgroup will meet five times over the next year to develop the revised S&T design. One meeting will be devoted to each matrix, with the last two meetings reserved for synthesizing the recommendations and developing an integrated design for the Program as a whole. The review is expected to be completed by December 2021. In 2022 a new chapter of RMP Status and Trends monitoring will begin, with a design that enhances the ability of water quality managers to proactively detect and prevent emerging threats while maintaining our ability to track progress on the persistent problems of the past.

# STATUS AND TRENDS MONITORING

**Relevant Management Policies and Decisions**

Define ambient conditions in the Bay

Water Quality Assessment – 303(d) impairment listings or de-listings

Determination if there is a 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

**Recent Noteworthy Findings**

In 2017, the RMP monitored PCBs, mercury, and other contaminants in sediment in the margin areas of South Bay. Contaminant concentrations were lower in South Bay margins than Central Bay margins, likely due to fewer industrialized areas in South Bay. There was also less of a difference between the margins and open Bay sites in South Bay than Central Bay. The final Bay segment—North Bay—was sampled in 2020. A full report comparing all three margin areas will be completed in 2021.

Bird egg monitoring in 2018 showed that mercury concentrations were high relative to previous years in Forster's Tern eggs in South Bay. Concentrations in 85% of the eggs were above the benchmark value of 0.75 µg/g fresh wet weight, indicating likely breeding impairment. Mercury concentrations (µg/g dry weight) in Double-crested Cormorant eggs were lower in 2018 than 2016, but both years were significantly higher than 2012. Selenium concentrations (µg/g dry weight) in Cormorant eggs were also lower in 2018 than 2016.

Copper concentrations in water, last monitored in 2019, remain below trigger levels.

Sport fish samples were collected in the summer of 2019 and are currently being analyzed. The coronavirus pandemic slowed processing; results are anticipated in early fall.

Bivalve monitoring was suspended for 2020 pending further discussion of this element during the Status and Trends Review. The data generated were not addressing priority management information needs.

**Priority Questions for the Next Five Years**

1. What are concentrations and masses of priority contaminants in the Bay, its compartments, and its segments?

2. Are contaminants at levels of concern?

3. Are there particular regions of concern?

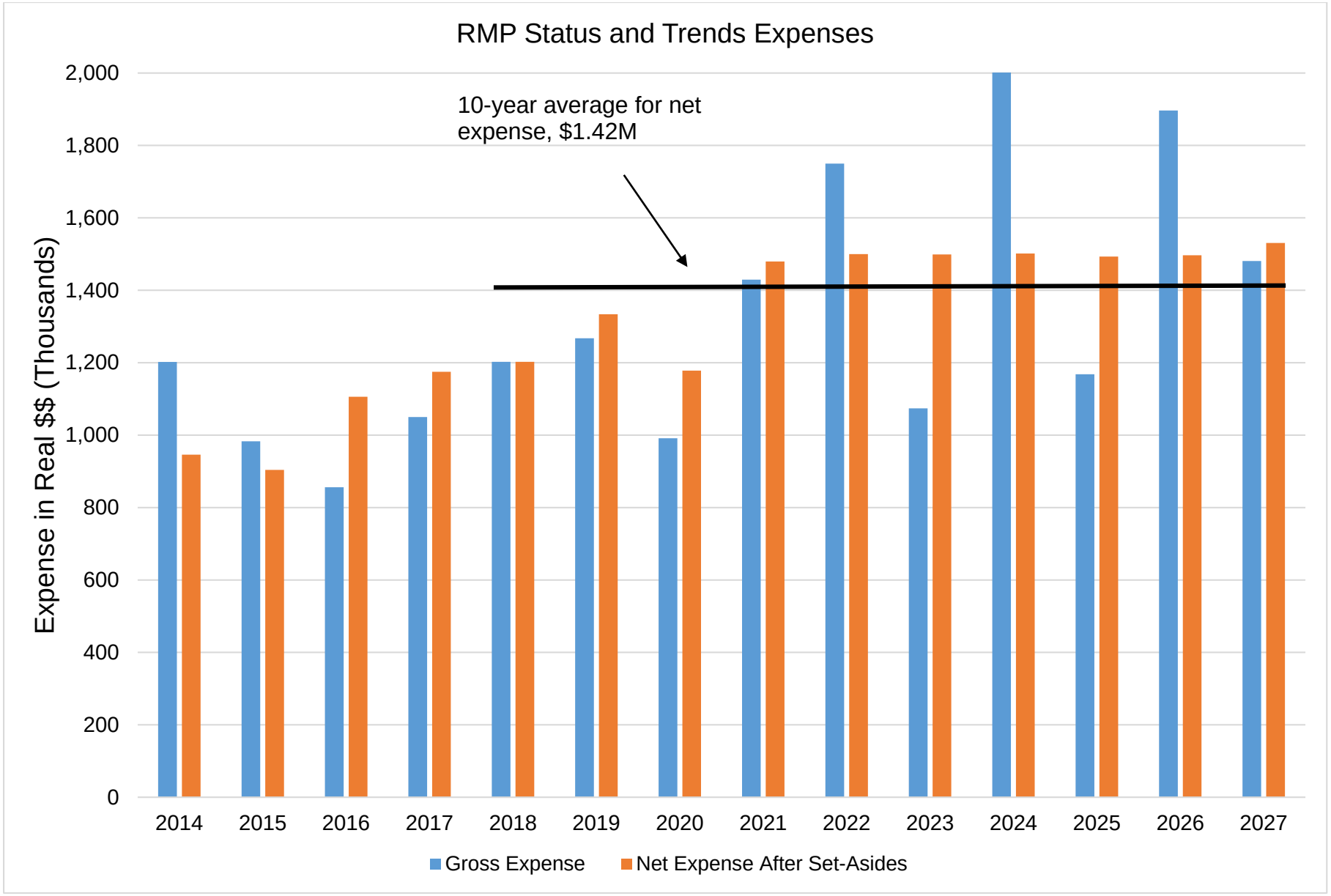
4. Have concentrations and masses increased or decreased?

When recommending addition of any analyte to S&T, the following details need to be specified: relevance of the analyte to a management question, the matrix to be monitored, the frequency of monitoring, the minimum duration of the monitoring, and the spatial extent (e.g., all sites or a subset).

# MULTI-YEAR PLAN FOR STATUS AND TRENDS MONITORING

**Status and Trends Monitoring in the RMP from 2014 to 2027.** Numbers indicate budget allocations in $1000s.

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Type | *Actl* | *Actl* | *Actl* | *Actl* | *Actl* | *Actl* | *Actl* | *Bdgt* | *Fcst* | *Fcst* | *Fcst* | *Fcst* | *Fcst* | *Fcst* |
| **USGS Moored Sensor Network for Suspended Sediment** | 250 | 250 | 250 | 250 | 250 | 250 | 300 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| **USGS Monthly Cruises for Nutrients and Phytoplankton** | 173 | 173 | 223 | 229 | 235 | 242 | 250 | 250 | 264 | 272 | 281 | 289 | 298 | 307 |
| **S&T Selenium clams & water** | | | | | | | | 80 | | | | | | |
| **S&T Water** | | 179 | | 221 | | 216 | | 243 | | 257 | | 273 | | 290 |
| Water-Organics | | | | | | | | 0 | | | | | | |
| Water-CTR | | 40 | | | | | | | | | | 53 | | |
| **S&T Bivalves** | 136 | | 144 | | 118 | | | | 147 | | 156 | | 165 | |
| Bivalves-PCBs | | | | | | | | | 20 | | | | | |
| **S&T Bird Eggs** | | | 198 | | 222 | | | 256 | | | 277 | | | 303 |
| Bird Egg Report | | | | | | | | | | | 54 | | | |
| **S&T Margins Sediment** | | 233 | | 231 | | | 254 | | 267 | | 284 | | 301 | |
| Margins Report | | 42 | | 50 | | | 65 | | | | | | | |
| **S&T Sediment** | 251 | | | | 291 | | | | 356 | | | | 400 | |
| Tox/Benthos | | | | | | | | | 135 | | | | 152 | |
| **S&T Sport Fish** | 311 | | | | | 355 | | | | | 448 | | | |
| Sport Fish Report | 41 | | | | | 50 | | | | | 60 | | | |
| **Archives** | 20 | 48 | 22 | 51 | 47 | 62 | 62 | 60 | 62 | 64 | 66 | 68 | 70 | 72 |
| NIST Contract | | | | | | 22 | | 24 | | 26 | | 27 | | 29 |
| **Reporting** | 19 | 18 | 19 | 8 | 10 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 |
| **Lab Intercomp Studies** | | | | 10 | 30 | 55 | 37 | 43 | 73 | 29 | 100 | 30 | 82 | 52 |
| | | | | | | | | | | | | | | |
| **Grand Total** | **1,202** | **983** | **856** | **1,050** | **1,203** | **1,273** | **991** | **1,427** | **1,750** | **1,074** | **2,151** | **1,168** | **1,897** | **1,481** |
| | | | | | | | | | | | | | | |
| **Set-Aside Funds Used** | **417** | **79** | **0** | **0** | **0** | **0** | **88** | **0** | **250** | **0** | **650** | **0** | **400** | **0** |
| **Set-Aside Funds Saved** | **161** | **0** | **250** | **125** | **0** | **66.5** | **275** | **50** | **0** | **425** | **0** | **325** | **0** | **50** |
| **Set-Aside Funds Balance** | **297** | **218** | **468** | **593** | **593** | **659.5** | **846.5** | **896.5** | **646.5** | **1071.5** | **421.5** | **746.5** | **346.5** | **396.5** |
| **Net S&T Funding Needed** | **946** | **904** | **1,106** | **1,175** | **1,203** | **1,340** | **1,178** | **1,477** | **1,500** | **1,499** | **1,501** | **1,493** | **1,497** | **1,531** |


RMP Status and Trends Expenses
10-year average for net expense, $1.42M
Expense in Real $$ (Thousands)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
Gross Expense
Net Expense After Set-Asides

**Regional Monitoring Program for Water Quality in San Francisco Bay**
**Current Monitoring Design for the Status and Trends Monitoring Program (2014-2027)**

| Program | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **USGS Moored Sensor Network for Suspended Sediment (5 targeted sites)[1]** | | | | | | | | | | | | | | |
| Parameters: SSC, Water temperature, Salinity | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **USGS Monthly Cruises for Nutrients and Phytoplankton in Deep Channel (38 targeted sites)** | | | | | | | | | | | | | | |
| Parameters: CTD profiles, light attenuation, SSC, DO, Chl-a, Phytoplankton speciation, Nutrients ($NO_2$, $NO_3$, $NH_4$, $PO_4$, Si)[2] | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Every 2 Years: Toxic Contaminants in Water (5 targeted sites and 17 random sites)** | | | | | | | | | | | | | | |
| MeHg, Cu, Se (dissolved & particulate fractions in 2017 and onwards, dissolved & total fractions measured in 2015) | | X | | X | | X | | X | | X | | X | | X |
| CN, Hardness, SSC, DOC, POC | | X | | X | | X | | X | | X | | X | | X |
| Aquatic Toxicity (9 stations)[3] | | X | | X | | X | | | | X | | | | X |
| Chl-a | | | | X | | X | | X | | X | | X | | X |
| CTR parameters (10 samples at 3 targeted stations)[4], including PCBs, PAHs, and legacy pesticides | | X | | | | | | | | | | X | | |
| **Every 2 years: Toxic Contaminants in Bivalve Tissue (7 targeted sites)[5]** | | | | | | | | | | | | | | |
| Se, PAHs | X | | X | | X | | | | ? | | ? | | ? | |
| PBDEs | X | | X | | | | | | | | | | | |
| PCBs | X | | | | | | | | ? | | | | | |

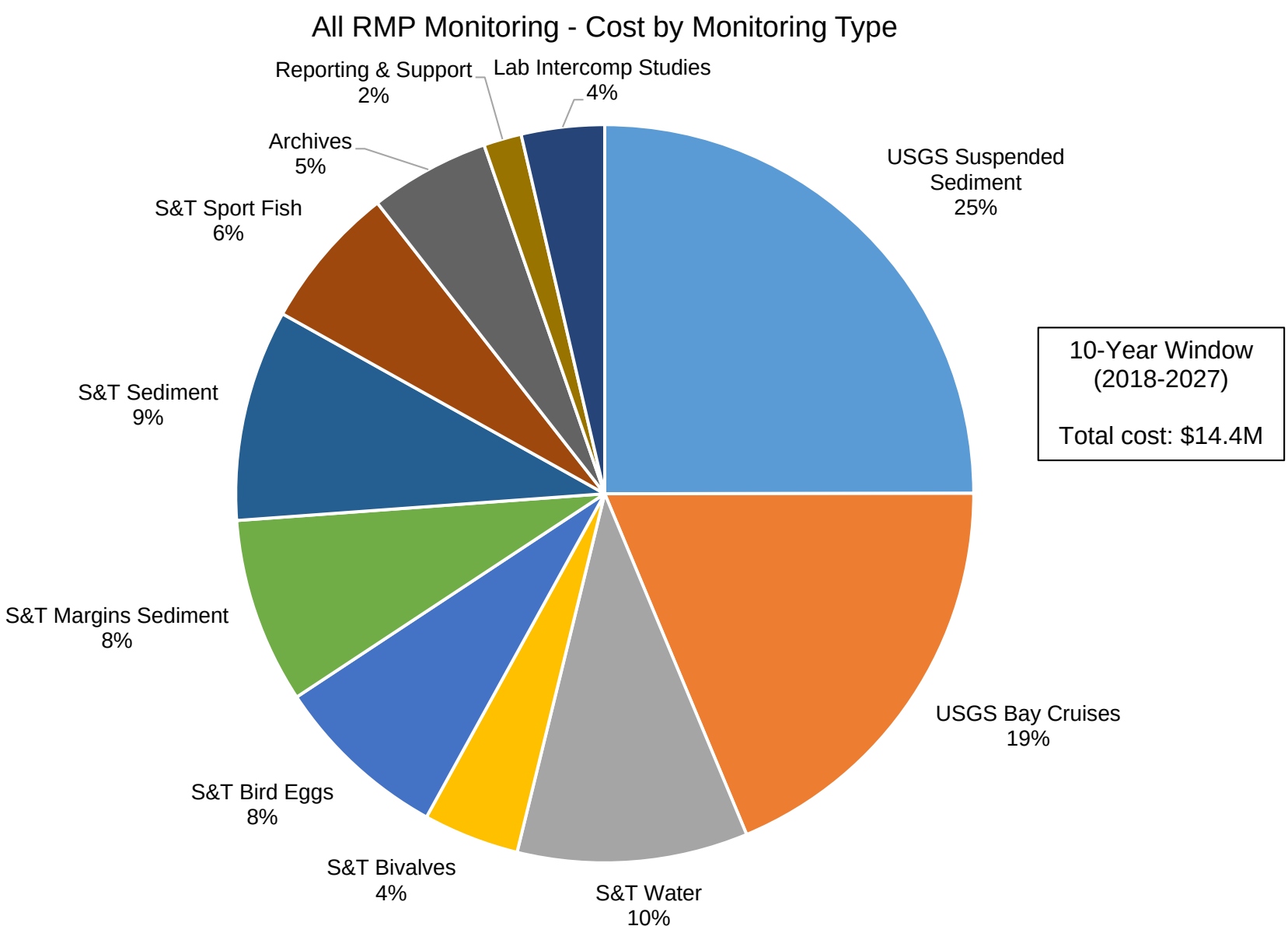
| Program | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Every 3 Years: Toxic Contaminants in Bird Egg Tissue** | | | | | | | | | | | | | | |
| Cormorant Eggs: Hg, Se, PCBs, PBDEs, PFCs (3 targeted sites)[6] | | | X | | X | | | X | | | X | | | X |
| Tern Eggs: Hg, Se, PBDEs (variable fixed sites)[7] | | | X | | X | | | X | | | X | | | X |
| **Every 2 Years: Toxic Contaminants in Bay Margin Sediments (40 random sites)** | | | | | | | | | | | | | | |
| Ag, Al, As, Cd, Cu, Fe, Hg, MeHg, Mn, Ni, Pb, Se, Zn, PCBs, TOC, N, % Solids, Grain Size | | X | | X | | | X | | ? | | ? | | ? | |
| **Every 4 Years: Toxic Contaminants in Sediment (7 targeted sites and 20 random sites)** | | | | | | | | | | | | | | |
| Ag, Al, As, Cd, Cu, Fe, Hg, MeHg, Mn, Ni, Pb, Se, Zn, PAHs, PCBs, TOC, N, % Solids, Grain Size | X | | | | X | | | | X | | | | X | |
| PBDEs | X | | | | X | | | | X | | | | | |
| Fipronil | X | | | | X | | | | X | | | | X | |
| Legacy Pesticides[8] | X | | | | | | | | ? | | | | ? | |
| Sediment Toxicity[9] | | | | | | | | | ? | | | | ? | |
| Benthic Macroinvertebrates[10] | | | | | | | | | ? | | | | ? | |
| **Every 5 Years: Toxic Contaminants in Sport Fish Tissue (7 targeted sites)** | | | | | | | | | | | | | | |
| Hg, Se, PCBs, PBDEs, PFCs, Dioxins | X | | | | | X | | | | | X | | | |
| Fipronil | | | | | | X | | | | | ? | | | |

**Notes:**
"X" = Planned sampling event. “?” = Event that is planned but must be approved by the RMP Steering Committee before implementation.
Additional parameters can be added to sampling events to support RMP Special Studies.

1. The RMP Status and Trend Program provides direct support to the U.S. Geological Survey (PI: Maureen Downing-Kunz) for four SSC stations (Richmond Bridge, Pier 17, Alcatraz Island, Dumbarton Bridge). However, this contribution leverages SSC data at two more stations and salinity at eight stations funded by other partners.
2. Monthly cruises are completed by the U.S. Geological Survey (PI: Tara Schraga). Phytoplankton speciation and nutrient samples are collected at 14 stations.
3. Aquatic Toxicity is measured following EPA Method 1007.0 (*Americamysis bahia*).
4. CTR sampling occurs at the Sacramento River, Yerba Buena Island, and Dumbarton Bridge sites.
5. Mussels (*Mytilus californianus*) are collected from Bodega Head State Marine Reserve, an uncontaminated "background" site of known chemistry, and are transplanted to seven targeted locations in the Bay. After ~100 days, mussels from the transplanted sites and a sample from Bodega Head are collected for analysis. Three of the seven transplant sites serve as back-ups in case something goes wrong with the transplants at the four primary sites. At the same time, resident clams (*Corbicula fluminea*) are collected from two sites in the Sacramento River and San Joaquin River.
6. Double-crested Cormorant (*Phalacrocorax auritus*) eggs are collected at three sites: Don Edwards National Wildlife Refuge, the Richmond-San Rafael Bridge, and Wheeler Island.
7. Forster's Tern (*Sterna forsteri*) eggs are typically collected from multiple sites in the Don Edwards National Wildlife Refuge and the Hayward Shoreline Regional Park.
8. "Pesticides" includes the suite of legacy pesticides that has been routinely measured by the RMP: Chlordanes (Chlordane, cis-; Chlordane, trans-; Heptachlor; Heptachlor Epoxide; Nonachlor, cis-; Nonachlor, trans-; Oxychlordane); Cyclopentadienes (Aldrin; Dieldrin; Endrin); DDTs (DDD(o,p'); DDD(p,p'); DDE(o,p'); DDE(p,p'); DDT(o,p'); DDT(p,p')); HCHs (HCH, alpha-; HCH, beta-; HCH, delta-; HCH, gamma-); Organochlorines (Hexachlorobenzene; Mirex).
9. Sediment toxicity is measured using the following methods: EPA 600/R-94-025 (*Eohaustorius estuaries*), EPA 821/R-02-012M (*Ceriodaphnia dubia*), EPA 600/R-99-064 (*Hyalella azteca*), and EPA 600/R-95-136M (*Mytilus galloprovincialis*)
10. Benthic macroinvertebrates are measured during dry-season sediment sampling events. Sediment samples are sieved through nested 1.0 and 0.5 mm sieves. Organisms are sorted into major taxonomic categories and taxonomy and abundance are determined to the lowest practical taxonomic level.

**Abbreviations:**

Ag: Silver
Al: Aluminun
As: Arsenic
Cd: Cadmium
Chl-a: Chlorophyll-a
CTD: Conductivity, Temperature, and Depth
CTR: California Toxics Rule, see http://water.epa.gov/lawsregs/rulesregs/ctr/
Cu: Copper
DO: Dissolved Oxygen
DOC: Dissolved Organic Carbon
Fe: Iron
Hg: Mercury
MeHg: Methylmercury
Mn: Manganese
$NH_4$: Ammonia (dissolved)
Ni: Nickel
$NO_2$: Nitrite (dissolved)
$NO_3$: Nitrate (dissolved)
PAHs: Polynuclear Aromatic Hydrocarbons
Pb: Lead
PBDEs: Polybrominated Diphenyl Ethers
PCBs: Polychlorinated Biphenyls
PFCs: Perfluorinated Compounds
$PO_4$: Phosphate (dissolved)
POC: Particulate Organic Carbon
Se: Selenium
Si: Silica (dissolved)
SSC: Suspended Sediment Concentration
TN: Total Nitrogen
TOC: Total Organic Carbon
TP: Total Phosphorus
Zn: Zinc


All RMP Monitoring - Cost by Monitoring Type
Reporting & Support 2%
Lab Intercomp Studies 4%
Archives 5%
S&T Sport Fish 6%
USGS Suspended Sediment 25%
S&T Sediment 9%
S&T Margins Sediment 8%
USGS Bay Cruises 19%
S&T Bird Eggs 8%
S&T Bivalves 4%
S&T Water 10%
10-Year Window (2018-2027)
Total cost: $14.4M

# PROGRAM MANAGEMENT

**Approximately 9% 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 and 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**
- Twenty 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

### Approximately 9% 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 Figures 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

**Approximately 8% of the total budget (+$85,000 in years when a full Pulse report is produced)**

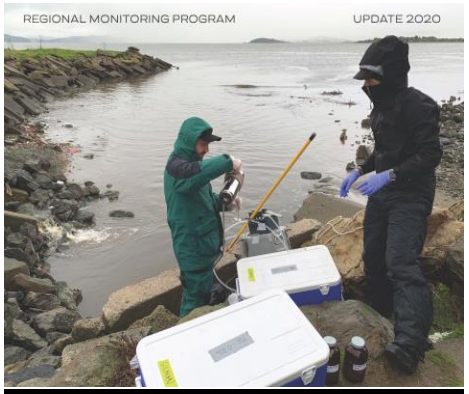
Includes the Pulse of the Bay, Annual Meeting, RMP Update, Multi-Year Plan, State of the Estuary report card, RMP website, Annual Monitoring Report, technical reports, journal publications, Estuary News, oral presentations, posters, & media outreach.

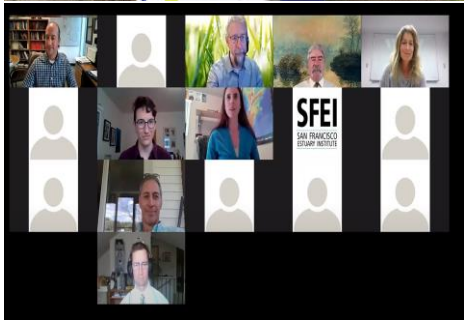
These platforms are used to make information from the RMP available to the following target audiences:

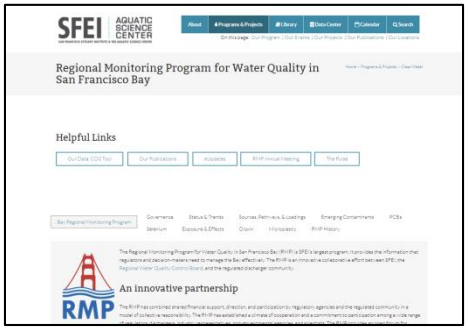
- Primary Audience
  - **RMP Participants**. Need information to encourage support for the RMP and water quality programs in the Bay. The Pulse, Annual Meeting, Multi-Year Plan, State of the Estuary report card, RMP website, newsletter, fact sheets, oral presentations, media outreach.
- Secondary Audiences
  - **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**

- RMP Update (2020)
- Pulse of the Bay (2021)
- Continued partnership with SFEP's "Estuary News" to reach broader audience
- Continued website improvement




www.sfei.org/rmp

# QUALITY ASSURANCE AND DATA SERVICES

**Approximately 6% of the total budget for general support, plus funding in Status and Trends for handling S&T datasets**

### Data Services

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 (cd3.sfei.org); coordinating with statewide data management initiatives (e.g., SWAMP and CEDEN); and supporting quality assurance evaluation, data analysis, and RMP report production.

### Quality Assurance

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

### Online Data Access

CD3 (cd3.sfei.org) is an online visualization tool that makes the RMP data available to water quality managers, stakeholders, scientists, and the public. A data download tool allows users to customize their queries and easily download large quantities of data.

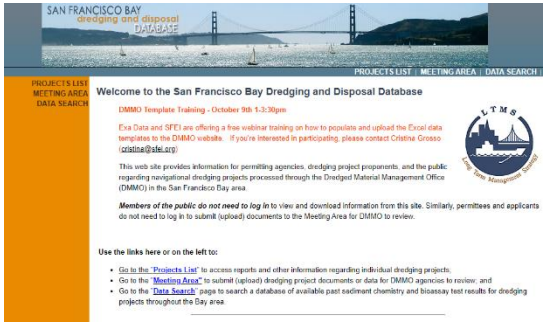
### Recent Noteworthy Findings

The RMP's over 25-year dataset contains more than 3.5 million records standardized across all years. All data are stored in SFEI's Regional Data Center database, are comparable to statewide standards, and are regularly exchanged with CEDEN.

CD3 provides public access and visualizes RMP data along with relevant datasets from other programs.

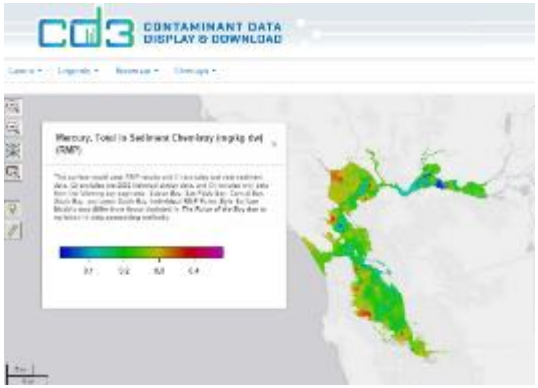
### DMMO Database and Website

In 2018, the DMMO database and website were transferred to SFEI's Regional Data Center. Costs for the first few years include upgrading outdated technology, training SFEI staff, developing standard operating procedures, uploading a backlog of data to the database, and integrating DMMO data into CD3. After completing these security and backlog tasks, annual costs can be reduced to uploading data and hosting and maintaining the system.




### Priority Initiatives for the Next Five Years

- Efficiencies in Data Uploading and Formatting
- Enhancement of Data Access and Visualization Tools
- Coordination with SFEI's Environmental Informatics Program
- Hosting, managing, enhancing, and providing access to DMMO data




# 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; review sediment guidelines for the beneficial reuse of dredged sediment | USGS Suspended Sediment Monitoring, Bay sediment budgets, Beneficial Reuse workshop |

## 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) |
| North Bay Selenium TMDL | Monitor selenium in food web to inform TMDL | North Bay selenium in water, clams, and sturgeon |

## 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. |