REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY

sfei.org/rmp

RMP Microplastics Workgroup Meeting

April 30, 2024

8:30 AM – 2:30 PM

HYBRID IN-PERSON and REMOTE OPTION
REMOTE ACCESS
https://us06web.zoom.us/j/83852120735

Meeting ID: 838 5212 0735
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AGENDA

1.	**Introductions and Goals for This Meeting** The goals for this meeting: ● Provide updates on recent microplastic work ● Discuss future direction of RMP microplastic work ● Recommend and prioritize study proposals for RMP funding in 2025and provide advice to enhance proposals Meeting Materials: Guidelines for Inclusive Conversation, page 5 2023 MPWG Meeting Summary, pages 6-22	8:30 Amy Kleckner

2.	**Information: Quantifying Tire Wear Particles** The Norwegian Institute for Water Research (NIVA) is the leading research institute in Norway for water-related topics. NIVA has been working with tire wear particles since 2018, and especially focused on the development of mass-based quantification methods for tire wear particles through pyrolysis-GC/MS and tire leachates through LC/MS. NIVA has an in-house tire database of more than 40 tires, representing Norwegian tire use, which is incorporated in quantification methods for tire wear particles in environmental samples. In this presentation, NIVA will describe their work related to tires and tire wear particles, share their current efforts in analyzing tire wear particles in environmental samples, and highlight some of the challenges the research community is facing related to tires. Desired Outcome: Informed Workgroup	8:45 am (5:50 pm Norway) Elisabeth Rødland (NIVA)
3.	**Information: Microplastics Studies Updates** The MPWG science lead will present a brief update on current microplastics work led by SFEI, as well as relevant work led by collaborators. Desired Outcome: Informed Workgroup	9:15 Diana Lin
4.	**Information: Developing a Statewide Plastics Monitoring Strategy** The workgroup will hear an update on the California Ocean Protection Council's ongoing project to develop a Statewide Plastics Monitoring Strategy and Plan. The project recently finalized priority management questions that will guide the development of the strategy and priority monitoring goals and approaches. Desired Outcome: Informed Workgroup	9:40 Christine Sur (OPC)
	Short Break	10:00
5.	**Information: Fate and Effects of Microplastics in Fish** The workgroup will hear an update on recent investigations to unravel the toxicokinetics of microplastics in fish. **Desired Outcome:** Informed Workgroup	10:10 Chelsea Rochman (U. Toronto)

6.	**Discussion: Multi-Year Planning** The workgroup will provide feedback on microplastic monitoring priorities that will guide the MPWG Multi-Year Plan, should additional funding become available in the future. Meeting materials: MPWG Multi-Year Plan, page 23-24 Desired Outcome: Feedback on management drivers, priority information needs.	10:40 Diana Lin
7.	**Summary of Proposed MPWG Studies for 2025** SFEI staff will present microplastic proposals. 2025 Proposals include: ● Microplastics in Urban Stormwater Runoff Pilot Year 2 $100,500 ● Size Distribution of Microplastic Particles in San Francisco Bay $202,100 Tier Two Proposals include: ● Microplastics in San Francisco Bay Sport Fish $130,000 Tier Two Proposals reviewed through ECWG that are also relevant to MPWG (informational only): ● Tire Rubber Marker Analysis - $105,000 ● Tire Wear Emissions and Washoff Estimates Journal Paper - $15,000 Meeting materials: 2025 Special Studies Proposals, pages 25 - 43	11:00 Diana Lin, Kayli Paterson, Ezra Miller, Alicia Gilbreath, Lester McKee
	Lunch	11:45
8.	**Discussion of Recommended Studies for 2025** The workgroup will discuss and ask questions about the proposals presented. The goal is to gather feedback on the merits of each proposal and how they can be improved.	12:15 Rebecca Sutton
9.	**Closed Session - Decision Recommendation for 2025 Special Study Funding** RMP Special Studies are identified and funded through a three-step process. Workgroups recommend studies for funding to the Technical Review Committee (TRC). The TRC weighs input from all the workgroups and then recommends a slate of studies to the Steering Committee (SC). The SC makes the final funding decision.	1:30 Amanda Roa

	For this agenda item, the MPWG is expected to decide (by consensus) whether to recommend the special studies to the TRC and to rank them in order of priority. To avoid an actual or perceived conflict of interest, the Principal Investigators for proposed special studies are expected to leave the meeting during this agenda item. Desired Outcome: Recommendations from the MPWG to the TRC on whether special study proposals should be funded in 2025, and the relative priority of each study.	
10.	**Report Out on Recommendations**	2:15 Amanda Roa
	Adjourn	

Bay RMP Stakeholder and Workgroup Meetings

Guidelines for Inclusive Conversations

This document is intended as a guideline for engagement at Bay RMP Technical Review Committee, Steering Committee, and Workgroup meetings. This is a living document. If you have input on what could be added, please email Amy Kleckner (amyk@sfei.org).

Zoom Etiquette

- Rename yourself - consider adding your name, organization, preferred pronouns and whose native land you are on.
- "Raise your hand" virtually if you wish to speak.
- In the case of a land acknowledgement, take the time to determine whose native land you are on at the time of your meeting (https://native-land.ca/). People may be invited to share the name in the chat.

Meeting Agreements[1]

- TRY IT ON: Be willing to "try on" new ideas, or ways of doing things that might not be what you prefer or are familiar with.
- PRACTICE SELF FOCUS: Attend to and speak about your own experiences and responses. Do not speak for a whole group or express assumptions about the experience of others. Work on examining your default assumptions about another person's identity or lived experience.
- UNDERSTAND THE DIFFERENCE BETWEEN INTENT AND IMPACT: Try to understand and acknowledge impact. Denying the impact of something said by focusing on intent is often more destructive than the initial interaction.
- PRACTICE "BOTH / AND": When speaking, substitute "and" for "but." When used to connect two phrases in a sentence, the word "but" essentially dismisses the first phrase altogether. Using "and" acknowledges multiple realities and promotes inclusion.
- REFRAIN FROM BLAMING OR SHAMING SELF & OTHERS: Practice giving skillful feedback.
- MOVE UP / MOVE BACK: Encourage full participation by all present. Take note of who is speaking and who is not. If you tend to speak often, consider "moving back" and vice versa.
- PRACTICE MINDFUL LISTENING: Try to avoid planning what you'll say as you listen to others. Be willing to be surprised, to learn something new. Listen with your whole self.
- RIGHT TO PASS: You can say "I pass" if you don't wish to speak.
- AVOID JARGON: Try to avoid using jargon and/or acronyms.
- IT'S OK TO DISAGREE: Not everyone will be in agreement all of the time, and that's ok!

[1] Adapted from Visions, Inc. Guidelines for Productive Work Sessions found at: https://www.emergingsf.org/wp-content/uploads/2017/08/EBMC_AgreemntsMulticulturalInteractions15.09.13-copy.pdf.

RMP Microplastic Workgroup Meeting

April 10, 2023 (Hybrid Meeting)

Meeting Summary

Advisor

Name	Affiliation/Roles	Present
Chelsea Rochman	University of Toronto	Yes (Remote)
Barbara Beckingham	College of Charleston	Yes

Attendees:

Adam Wong (SFEI)
Alicia Gilbreath (SFEI)
Amy Kleckner (SFEI)
Barbara Baginska (SFB Water Board)
Biruk Imagnu (SFEI)
Bushra Khan (UC Davis MPSL)
Carlie Herring (NOAA)
Carolynn Box (NOAA)
Chris Sommers (EOA)
Diana Lin (SFEI)
Don Yee (SFEI)
Eric Dunlavey (SJSC)
Ezra Miller (SFEI)
Jay Davis(SFEI)
Jennifer Dougherty (SFEI)
Jeremy Conkle (DRBC)
June-Soo Park (DTSC)
Kaitlyn Kalua (OPC)
Kelly Moran (SFEI)
Lara Dronjak (TecnATox URV)
Leah Hampton (SCCWRP)
Lorien Fono (BACWA)
Luisa Valiela (EPA Region 9)
Marta Schumacher (SCCWRP)
Martin Trinh (SFEI)
Mary Lou Esparza (CCCSD)
Miriam Diamond (U. Toronto)
Monica Arienzo (DRI)
Rebecca Sutton (SFEI)
Ryan Batjiaka (SFPUC)
Scott Coffin (SWB)
Shelly Walther (LACSD)
Simret Yigzaw (City of San Jose)
Steve Weisberg (SCCWRP)
Sutapa Ghosal (CDPH)
Tom Mumley (SFB Water Board)
Tony Hale (SFEI)
Valerie Hanley (DTSC)
Violet Renick (OC San)
Xin Xu (EBMUD)
Tan Zi (SFEI)

1. Introductions and Goals for This Meeting

Amy Kleckner began the meeting by highlighting remote meeting tips, reviewing the Zoom platform functionalities, and giving a land acknowledgment to the Native peoples of the San Francisco Bay Area (Ohlone, Patwin, Coast Miwok, and Bay Miwok). She also introduced the guidelines for inclusive conversations. Amy then introduced the Workgroup's advisors, Dr. Chelsea Rochman and Dr. Barbara Beckingham. After a brief roll call, Amy reviewed the day's agenda and communicated the goals for the day, emphasizing the roles of advisors, experts, and stakeholders in finalizing the priority management questions that will guide future multi-year planning and recommending special study proposals for funding in 2024. Updates will also be shared on ongoing state-funded activities and relevant microplastic findings, particularly those involving the San Francisco Bay.

2. Information: Update on Microplastics in Bay Sediment

Lara Dronjack, Ph.D candidate at the Universitat Rovira i Virgili, presented a pro-bono study on Microplastics in Bay Sediment conducted in collaboration with SFEI, Department of Toxic Substances Control (DTSC), and TecnATox research group at the Universitat Rovira i Virgili through an interwaste exchange program between TecnATox and DTSC.

Lara proceeded to detail the pilot study conducted to evaluate the use of sediment as a matrix for monitoring microplastics temporal and spatial trends in the San Francisco Bay. Lara worked with SFEI and DTSC to identify and prioritize samples for microplastics analysis. She acknowledged the study had a limited sample size due to the limited time frame that she had to process and analyze samples at DTSC during her exchange program visit to California, which also limited the study to archived sediment samples. Sediment could be a suitable matrix for monitoring microplastic baseline concentration trends as sediment is a sink for microplastics. The goals of the study were to analyze the spatial trends of microplastics in Bay sediment by analyzing the archived surface sediments from different locations in the Bay, as well as to see temporal trends by analyzing microplastics in two archived sediment core samples.

There are no standardized methods for microplastics analysis, but general recommendations were followed. Archived samples were collected by SFEI in 2018. For the extraction procedures, Lara removed organic and inorganic matter from sediment samples using advanced oxidation, alkaline and enzymatic digestion, and density separation. Density separation was done using $ZnCl_2$ (1.9 g/cm^3 density solution) in order to improve methods to capture tire wear particles, which are typically denser than other microplastics. An additional density separation step using NaCl (1.2 g/cm^3 density solution) was also applied.

Characterization was later performed in Spain using spectroscopic analysis. A total of eight ambient Bay surface sediment samples were analyzed; two from each of the following subembayments: Lower South Bay, South Bay, Central Bay, and two river sites near Suisun Bay. The two sediment core samples were from Site 1 and Site 4 from Steinberger Slough/Redwood Creek. Sediment cores were sliced into 5 cm segments, and a total of 10 segments analyzed. Reported sample concentrations were blank subtracted by measuring background microplastic deposition rates in the laboratories in the U.S. and Spain.

Lara proceeded to review the spatial trends observed in the Bay from the surface sediment samples. Sediment concentrations varied greatly across the subembayments, with lowest concentrations observed in the river sites near Suisun Bay (2.1- 2.3 microplastics/gram, n=2) and highest concentrations observed in the Lower South Bay (9.7-11.9 microplastics/gram, n=2) with average Bay-wide concentrations at 6.2 microplastics/gram. Overall, microplastic concentrations increase as you move south from the North Bay to the Lower South Bay. This may be because the Lower South Bay area is heavily influenced by urban runoff as well as wastewater treatment plants.

Expanding on the morphology of the microplastics collected, Lara classified the plastics as either fibers, films, or fragments, with fibers accounting for more than 60% of all surface sediment samples. Lara compared SFEI's study with another study the TecnATox group has published previously on in the Mediterranean on the Tarragona coasts, that found average concentrations of 32.4 microplastics per kilogram. Compared to the Mediterranean study, this study indicated microplastic concentrations in the San Francisco Bay are higher. Similar in both studies, fibers were the most abundant class of microplastics found. Lara showed pictures of various fibers found in the Bay, which were often attached to organic and inorganic matter Fifteen different polymers were identified in surface sediment samples, of which synthetic cellulose, polypropylene (PP), and polyamide were the most abundant.

For the second part of this study, Lara explained the analysis conducted on two sediment cores taken from Steinberger Slough, one from Redwood Creek marina and the other at Pulgas Creek discharge to the Bay. Higher microplastic concentrations were observed closer to the surface, with lower concentrations found at lower depths. However, microplastics were found in all layers. Similarly, fibers were most abundant, followed by fragments. Possible sources include clothing, outdoor textiles, fishing nets, and airborne fibers. 131 particles were identified across both sites. Eight different polymers were detected in the Redwood Creek core, with synthetic cellulose being the most abundant.. Thirteen different polymers were detected in the sediment core near Pulgas Creek, with synthetic cellulose and PE being the most abundant.

In conclusion, this study detected microplastics in all sediment samples, however, their concentration varied greatly depending on the sample location and depth. Microplastics detected in surface sediment ranged from 2.20 MPs/g d.w. to 12.02 MPs/g d.w., with a mean value of 6.38 MPs/gd.w. The highest concentrations were found in the Lower South Bay and the lowest concentrations in the North Bay. Microplastics detected in core sediments ranged from 1.37 MPs/ g d.w. to 5.86 MPs/g d.w. with increasing trend from bottom to top layers. Across the Bay, the most abundant morphology is fibers followed by fragments.

To open discussion, Lara clarified that selection of subsamples were not random, but selected after seeing patterns during microplastic quantification. Lara also noted that it was difficult to distinguish between synthetic cellulose and natural cellulose, but expected that natural cellulose would degrade in pretreatment, leaving behind just synthetic cellulose. The research group is conducting additional studies to confirm synthetic fibers by establishing a new methodology based on examination and comparison with reference materials (visual inspection with SEM) such as cotton, linen, polyester, cellulose acetate etc. They all have very different morphologies under SEM. Lara clarified that cotton and linen were not classified as synthetic cellulose, although Susanne Brander mentioned that her lab classified those materials as ‘anthropogenic’, since they differ from natural cellulose and are often chemically modified.

Lorien asked about efforts to date the sediment cores, with Diana explaining that the cores have not been dated, but PCB analysis on sediment cores from the same location will be used to benchmark trends (expected PCB peak in the 1970s).

3. Information: Developing a Statewide Plastics Monitoring Strategy

Kaitlyn Kalua, the Water Quality Program manager of Ocean Protection Council (OPC), updated the workgroup on the ongoing development of a statewide plastics monitoring strategy. As a non-regulatory body, OPC collaborates with state agencies to coordinate research and provide policy recommendations. Kaitlyn expanded on OPC’s Strategic Plan Goal 3 to Enhance Coastal and Marine biodiversity, through Objective 3.4 Improve Coastal and Ocean Water Quality by achieving Target 3.4.2 achieve zero trash entering state waters by 2030, Target 3.4.3 advance development of a baseline of plastic pollution monitoring data and standardized approach to track state progress in reducing plastic pollution, and Target 3.4.4 develop and implement a Statewide Microplastics Strategy. Some examples of work funded by OPC include the “Synthesis of Microplastics Sources and Pathways to Urban Runoff” report and “California Trash Monitoring Methods and Assessments Playbooks” authored by SFEI and the “Microplastic Pollution in California: A Precautionary Framework and Scientific Guidance to Assess and Address Risk to the Marine Environment” authored by a Science Advisory Team.

OPC also published a Statewide Microplastics Strategy (2022), which describes a two-track approach with Track 1 focusing on current early action solutions and Track 2 emphasizing promoting science to inform future action.

Kaitlyn detailed Track 2’s four major research priorities: monitoring, risk thresholds and assessment, sources and pathways prioritization, and evaluating new solutions. In 2022, the Statewide Microplastics Strategy was adopted and the state legislature also passed the Comprehensive Plastic Source Reduction Requirements (Senate Bill 54). OPC is required to report back to the legislature regarding the status of the implementation of the Statewide Microplastics Strategy and new findings. OPC’s projected timeline for implementing the Statewide Microplastics Strategy includes 2026 goals to standardize methods and initiate a pilot monitoring program to establish baseline occurrence data.

OPC recently approved funding for two foundational projects to pursue statewide plastics monitoring. The Southern California Coastal Water Research Project was funded to implement “Microplastics Sample Collection Method Evaluation & Standardization”, which will include sediment, biota (fish tissue, shellfish), stormwater, and surface water (which is jointly funded by the State Water Resources Control Board). Additionally, OPC plans to develop a phased, multi-year Statewide Plastics monitoring plan in collaboration with SFEI. Kaitlyn outlined the three priority science questions that came out of the Science Advisory Team report on microplastics: 1) understanding the highest emitting sources of macro- and microplastics to the marine environment in California, 2) understanding microplastics concentration trends,3) link microplastics in the marine environment to sources of concern.

Kaitlyn proceeded to review a list of regulatory drivers including but not limited to Trash amendment Resolution No. 2015-0019 that prohibits discharge of trash larger than 5 mm to state waters and Senate Bill 54, which imposes source reduction and recyclability /compostability requirements for single-use plastics. The bill also establishes the California Plastic Pollution Mitigation Fund (projected $500M annually beginning 2027) to "monitor & reduce environmental impacts of plastics on terrestrial, aquatic, and marine life and human health". 60% of these funds will go to the Strategic Growth Councils and state agencies to "monitor and reduce the historical and current environmental justice."The other 40%, which equates to $200 million annually, will go to the state agencies "to monitor and reduce the environmental impacts of plastics on terrestrial, aquatic, and marine life and human health."

Kaitlyn emphasized the discussions to implement statewide plastics monitoring are just at the beginning. She outlined the goals of statewide monitoring are to understand the extent of macro- and micro-plastics contamination, inform and update risk assessments, and allow water quality managers to track progress in reducing plastic pollution. To implement a statewide plastics monitoring network, OPC outlined a goal to build and leverage existing programs. Preliminary considerations for this effort are motivated by the overarching need for consistent high quality data. Kaitlyn outlined a timeline to implement monitoring that begins with current conversations to identify management questions and monitoring objectives for the monitoring effort. Following a fairly robust engagement process to develop the monitoring strategy and plan, the timeline anticipates pilot monitoring to begin in 2025.

Chris Sommers encouraged Kaitlyn to include municipalities as technical advisors for macroplastic and trash related issues. Chelsea Rochman inquired where these earmarked funds would go as well as what monitoring programs the macro and microplastics efforts would fit under. Kaitlyn clarified monitoring would be informed by various state agencies' needs and SWAMP could also be consulted for monitoring. Tom Mumley stressed that method standardization will be key as well as ensuring the capability of agencies to support the monitoring effort. Tom has reservations about SWAMP as it is currently underfunded. Tom emphasized the RMP's willingness ability and willingness to expand current RMP MPWG scope by working collaboratively with state efforts.

4. Discussion: MPWG Management Questions

Diana Lin opened a discussion to review and revise the current MPWG management questions, which will guide the Multi-Year Plan. All workgroups are going through a similar process. Three weeks prior to this workgroup, a smaller meeting was convened with key leaders, including science advisors, representatives from the Water Board, POTW and stormwater agencies as well as representatives from key state agencies to kickstart this conversation about revising the microplastic workgroup management questions with the goal to reach consensus. With regard to management drivers, there are no regulations or deadlines for the Bay but there is much discussion around microplastics now as agencies, policy makers and water policy managers are concerned about the impact of microplastics.

Diana began by reviewing the first two management questions together because they are linked. She proposed linking the first two questions; MQ1: “What are concentrations of microplastics in the Bay?” and MQ2: “What are the health risks?” into one question: “What are levels of microplastics in the Bay? What are the risks of adverse impacts?”. The change from “concentrations” to “levels” is purposeful because microplastics can be described in different ways, including mass, particle counts. When using the term microplastics, the different types of microplastics must be accounted for, which could refer to different source, sizes, or morphology. Bay matrices include surface water, water column, sediment, biota. The second question about risks is framed from the water quality manager’s perspective. They need to know how to interpret the levels measured, which requires a separate analysis from the occurrence monitoring in the first question. Here the focus is primarily on ecological health, with evaluation of human exposure concerns more limited to ingestion of fish and shellfish from the Bay. The RMP’s role is to evaluate the microplastic levels in the Bay, by comparing measured levels with available ecological thresholds. This is a science evaluation, and is not a regulatory decision or risk management decision. Luisa supported changing “concentrations” to “levels”, but found “risks of adverse impacts' ' difficult to interpret, wondering if it sets the RMP to just keep studying microplastics until an adverse impact is found. Tom Mumley finds the wording appropriate.

Susanne Brander understood that shellfish and fish were the primary exposure pathways being examined by the RMP but inquired whether the RMP would investigate air deposition or other foods that could impact human health. Diana explained the RMP would be focused on levels in the Bay levels with Tom agreeing that a cumulative impact analysis is beyond the capacity of the RMP. Kelly noted that the RMP has traditionally been more focused on health risks to aquatic organisms. Eric also liked the broad interpretation of risk, which allowed the RMP to prioritize studies. Chris also supported the change to “levels” as it provides more flexibility. He also supported using the term risk broadly and not including the "adverse impact", which is implicit. However, Tom disagreed and thinks it’s appropriate to include “adverse impact”. Diana clarified that “health risk” is meant to refer to ecological health as well as human health, but the RMP is focused on ecological health. Diana will keep the revisions and include more context in a short text form.

The third management question – MQ3: “What are the sources, pathways, loadings, and processes leading to microplastic pollution in the Bay?” has been proposed to change to “What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?”. Here the MPWG seeks to gather information about the sources, pathways, and processes to develop our conceptual model of microplastics entering the Bay. Processes for this workgroup refers to breakdown of microplastics into smaller microplastics, which could be more harmful and lead to different impacts. These breakdown processes should be considered in pathways and the Bay.

Additionally, the MPWG is specifically using the term “relative loadings” to avoid confusion with how loadings has previously been used to refer to TMDLs, which is not the context for the MPWG. Instead, the MPWG seeks to understand the relative importance of different sources and pathways and processes, so that the group can prioritize investigations on the most important sources, pathways, and processes. Lorien, Chris, and Eric voiced approval for this change.

The fourth management question – MQ4: “Have the concentrations of microplastics in the Bay increased or decreased?” was revised to “Are microplastics levels changing over time? What are potential drivers contributing to changes?”. This question is about what the monitoring record can indicate (looking at historical record) and covers measured changes in both pathways and the Bay. This reframing better acknowledges that concentrations may not be increasing or decreasing. The second question was added to help understand how to best inform management. However, this question may require different studies or approaches. Kaitlyn appreciates the inclusion of the second question.

The fifth management question – MQ5: “What management actions could be effective in reducing microplastic pollution?” was revised to “What are the anticipated effects of management actions”. This question is asking about forecasting future changes based on anticipated management actions that are being discussed by water quality managers and policy-makers as it is not RMP’s role to recommend management actions. The group supported this change.

The group reached consensus, voicing support for all of Diana’s suggested revisions. Ryan Batjiaka inquired if costs would be considered as a factor in constructing these management questions, with Diana clarifying this is traditionally not the role of the RMP. Kelly further expanded that the RMP does not advise on financial outlooks or what measures to ultimately take. Chris emphasized that the paragraph contextualizing each question will be very important and should prioritize the right things. Diana will share these paragraphs with the MPWG once completed.

5. Discussion: MPWG Strategy Revision Process

In this agenda item, Diana sought feedback from the Microplastics workgroup regarding the MPWG strategy revision process. Following the finalization of the management questions today, Diana outlined the proposed timeline for the completion of the MPWG strategy revision. Diana recommended a a subgroup review of the report outline and draft Multi-Year Plan through a planned subgroup meeting in the summer; followed by a draft report and Multi-Year Plan that will be reviewed by the subgroup and full MPWG before being submitting to the Steering Committee (SC) in October 2023. The OPC-funded statewide plastics monitoring strategy and plan is also a consideration for this timeline as an early report will help the RMP inform the statewide strategy. After another subgroup and MPWG review, a final report is planned for completion February 2024. The SC has already allocated funds for this strategy revision. Tom stated there is a challenge into putting sufficient effort now while proactively associating this with statewide strategy which will take a while to come to fruition while still leaving time and flexibility once the statewide strategy is implemented. In the short term, it is important to consider the MYP while setting priorities for forthcoming and subsequent years. At the moment, the MPWG should prioritize what is most important for 2025 and 2026 and anything further will be re-evaluated. Chris asked how RMP should coordinate feedback on the OPC statewide strategy, and Jay Davis emphasized the importance of RMP stakeholder engaging with OPC in this process. Diana suggested a separate meeting to coordinate.

Last year, the MPWG identified MQ2 as the highest priority question. This year, the subgroup indicated that MQ1 and MQ2 should both be emphasized. The MPWG also voiced strong consensus that both MQ1 and MQ2 should be the focus of the MPWG as they need to be answered first to inform the other questions, are the most actionable, and most align with state strategies. Lorien inquired what actionable information would be achieved from MQ1. Chelsea emphasized the importance and need to support more monitoring.

6. Information: Microplastics Monitoring in Southern California Bight and Sample Collection Standardization

Leah Hampton, the Microplastics lead at the Southern California Coastal Water Research Project (SCCWRP), presented on SCCWRP's efforts monitoring microplastics in the Southern California Bight and their efforts to standardize field sampling methods. Leah referred to OPC's Track 2 (Research to help inform management decisions) and emphasized the need for monitoring.. The first step of understanding exposure is measuring microplastics and Leah mentioned SCCWRPS's Interlaboratory Method Comparison Study, which sought to standardize the processing and analysis methods for measuring microplastics in a variety of matrices, including drinking water, surface water, sediment, and biota, along with accrediting laboratories. This effort was driven by Senate Bill 1422 that mandated the standardization of a method to measure microplastics in drinking water. Samples were artificially spiked and SOPs were given to microplastic analytical laboratories across the world. Time and costs were considered. The method for drinking water was adopted one year ago with method reviews for sediment and tissue coming soon. The sediment method was not part of the core method evaluation, and is led by the EPA.

Currently, microplastic sample collection methods have not been evaluated or standardized. Different approaches can lead to results orders of magnitude different with no mechanism to compare or translate results from different sampling approaches. For example, manta trawls would miss small particles and fibers while grab samples only allowed for the collection of low volumes. The goal of SCCWRP's Microplastics Sample Collection Method

Evaluation is to evaluate sample collection methods for monitoring and create a non-prescriptive suite of sampling methods. This would standardize operating procedures and allow SCCWRP to evaluate the advantages and disadvantages of various methods and the comparability of those methods. SCCWRP hosted a workshop in March with invited experts. Over the course of two days, invited experts identified methods ready for evaluation for each matrix: stormwater, surface water, sediment, biota. They created draft study designs to evaluate method performance, considering accuracy, precision, and cost. Proposed study approaches were prioritized by group vote. Stormwater studies ranked as the highest priority by far due to large uncertainty in how to collect samples. Collection methods for other matrices are much further along. The second step of this study is to implement a sample collection method evaluation study to understand the performance, uncertainties, and limitations of these methods, leveraging existing monitoring efforts (e.g., Bight '23). Sample collection methods will be refined based on the evaluation study results and SCCWRP will generate formal guidance documents. Participants in the SCCWRP workshop were organized into working groups for each matrices, and will continue to refine study designs and draft SOPs, with the goal of completing a workplan this summer.

Leah then transitioned to describe planned microplastics monitoring through the Bight Regional Monitoring Program, which has a long history of monitoring macrodebris in marine trawls and streams. Some preliminary work had been done on microplastics as part of Bight, but nothing large-scale due to uncertainty in methods. Expanding more on this year's Bight collection, Leah shared that planned macrodebris assessments are largely the same as previous Bight surveys to look at temporal trends. Epibenthic marine trawls will be used and stream surveys conducted along with the addition of estuarine sampling adapted from stream methods. Largely a sediment-based program, this year's Bight will seek to address the question "What is the extent and magnitude of microplastic contamination in sediment in the Southern California Bight?". Leah hypothesized that contamination is likely highest in nearshore habitants. SCCWRP plans to collect and analyze 30 sediment samples from each of the following stratum: estuaries; ports, bays, marinas; and the Inner Shelf. The other matrix planned for 2023 is shellfish, which seeks to answer a similarly framed question: "What is the extent and magnitude of microplastic contamination in shellfish in the Southern California Bight?" SCCWRP plans to collect and analyze shellfish collected from 30 sites along the coast: Pacific oyster in the dry season (September – October) and Pacific oyster and mussels in the wet season (January-February). These Bight microplastic sampling collection and analysis efforts will be leveraged as part of the Microplastics Sample Collection Method Evaluation study described earlier. This will be the first large-scale occurrence data set for microplastics in Southern California for sediments and shellfish in near shore habits.

Shelly Walther inquired if a biosolids collection method is included, which could inform the OPC CA POTW study. Leah clarified that biosolids will most likely not be addressed. Kelly noted that SCCWRP's analytical methods do not include tires and mentioned this is a huge gap in the study because tires are the most common microplastics in the world. Over half of the microplastics SFEI measured are tire wear particles. Leah clarified that SCCWRP's method for drinking water did not include tires. Additionally, in the interlap comparison study on analytical methods, reported analytical results did not perform well under 50 microns.

Leah admitted these are analytical data gaps that could potentially be added on. Shelly Walther agreed with Kelly that there are concerns about analytical method applicability to quantify tire particles. Tom inquired why wastewater was not included as a matrix for analysis with Leah clarifying that ASTM has a wastewater method. Tom noted that aerial deposition was also not included.

Tom advised being careful about using the term stormwater as it is being used to refer to urban municipal runoff, not agricultural runoff. Leah clarified for the group that SCCWRP had no plans to deploy shellfish, only collected what is already out there. Chris closed the discussion by emphasizing the importance of looping in stormwater representatives to help with terminology from a permitting and regulatory standpoint. He noted there are many different inputs to urban stormwater runoff and suggested for SCCWRP and the RMP to consider “sub”pathways

7. Information: Microplastics Transport in Stormwater

Barbara Beckingham, an associate professor at the College of Charleston, presented work conducted by her research group in Charleston, South Carolina on the type, density, and size of microplastics transported through stormwater infrastructure. These efforts were conducted in collaboration with partners at the Citadel, Clemson University, and Sea Grant who have been studying chronic toxicity in tirewear particles. These studies were driven by a need to assess and reduce aquatic inputs after ecosystem exposures were discovered in coastal South Carolina. Over the last eight years, the region’s monitoring programs have shifted from monitoring wastewater utilities to prioritizing stormwater pathways, which are discharged without treatment. The degradation of microplastics litter in saltmarshes has also been prioritized. Barabara continued to provide background on Charleston, South Carolina, highlighting its rapid development, tourism industry, and the recent deepening of its shipping port. Charleston has high water tables, so stormwater ponds are often the best management practice in the SC low country. Most are detention basins. Barbara provided background on stormwater manufacturing treatment devices (MTDs) that had been installed in the region to catch sediment and debris between street drains and tidal creeks. She expanded on two different methods, the baffle box separator (a 5 cm stainless steel mesh that slows down the velocity of water) and the hydrodynamic vortex separator that uses centrifugal flow (often used to remove SSC).

Past evaluations of MTDs by industry studies show that suspended solids are typically removed, while fines and zinc are not as effectively removed. . A USGS study indicates that these MTDs are better at removing coarser material. Barbara moved on to the work conducted by her group: sampling and processing using stormwater MTDs catchment transects and roadsweeps. Six catchments in residential and commercial areas were sampled, looking through sediment using 63-500 micron sieves (60% of material resided in this range). Microplastics and tirewear participles were separated using a two stage density separation, followed by digestion, stereomicroscopy, and µRaman. Barbara proceeded to detail the results found at three locations. Notably, at the Mt. Pleasant Visitor Center, foams were observed in higher quantities, which can be explained by upstream plastic debris and breakdown through aging and transformation into microplastics (there is a six month period between clean up of devices). Preliminary µRaman results from pooled urban samples showed that polyethylene and polypropylene were the most abundant particles, along with cellulose acetate and cigar butt fiber filters. The study found that MTDs accumulated tirewear particles when sited and maintained properly. Tirewear particles were observed at 10-100x higher concentrations than other particles with 90-92% of particles being tirewear particles. The Whipple Road MTD was incorrectly installed next to a tidal creek. This caused a frequent backflow due to high-tides issue within the Whipple Road MTD. This frequent resuspension and discharge of settled material caused less microplastics overall to be captured by the MTD and significantly more high-density tirewear particles than low-density tirewear particles. The issues exhibited by the Whipple Road MTD show how proper maintenance and installation are a key factor in the effectiveness of these stormwater devices. If these concentrations are multiplied by the mass of sediment, Barbara estimates that over one billion particles are collected in an MTD over a six month period. High density tirewear particles are more likely to be trapped in baffle MTDs and in tidal creek outfall sediments. The study also observed the length of tirewear particles tended to decrease from roadways to outfalls (source to tidal creek), which has implications for toxicity, fate, and transport. The study observed variable source strengths in urban stormwater catchments. MTDs were found to be sinks for microplastics, but not 100% effective as capture by microplastic type was variable. Going forward, Barbara and the rest of her team will continue to sample storm events for microplastics and tirewear particles in stormwater and MTD treated discharge, improving tirewear volume and mass estimates from count data. They hope to better understand how environmental fate, ecosystem exposure, and toxicity affect risk.

To open discussion, Barbara clarified that the study only analyzed particles collected on 63 and 500 micron filters from the roadway sweeps. Other fractions (>500 µm and <63 µm) were archived and will be analyzed as improved methods are published and additional funding is obtained. SFEI noted that in the El Cerrito rain garden bioretention study, sampling methods that used 125 um and 355 sieves did not capture smaller tirewear particles smaller than the sieves size. Chris inquired whether these devices are designed to remove macro particles (>5 mm) similarly to the ones used in California. Removal of anything smaller was likely incidental. Industry studies show ratings for fine and coarse removal. Barbara clarified that only sediment samples were collected. Don inquired about the gradient of particle size going towards streams and how to differentiate transport of breakdown or age particles. Barbara noted that smaller and lower density particles are more easily transported through the MTDs but we don't yet understand the breakdown and aging process.

8. Information: Investigation Microplastics Sources

Chelsea Rochman of the University of Toronto gave two presentations, one on microplastics in various watersheds and another on construction site debris. The first study examined agricultural runoff, WWTP effluent, and urban stormwater runoff into four different watersheds: Sacramento – Bay Delta, the Mississippi River in the St Louis area, Lake Ontario in the Greater Toronto Area and the Chesapeake Bay near DC. She also sampled downstream of these pathways to compare the levels and composition of microplastics observed in receiving waters with what was observed in the pathways.

Bulk water samples were sampled, with microplastics and other anthropogenic microparticles found in nearly every sample. Particle levels were higher in the pathways (agriculture runoff, urban stormwater runoff, and wastewater effluent) compared to receiving waters. Different regions have different “more important” pathways. Urban stormwater runoff is the more important (higher levels of microplastics) pathway in Lake Ontario, whereas agriculture is the more important pathway in the Sacramento Delta. For Chesapeake Bay, they are all similar.

The different microplastics morphologies in samples fibers, rubber-like particles, fragments, spheres, etc… In general, different pathways have unique compositions. Fibers were abundant in WWTP effluent, while black rubbery fragments were most common in stormwater. Film was not as dominant in agriculture as expected. This suggests a different microplastic composition signature for different pathways.

Chelsea concluded that each region may have different priority pathways for the transport of microplastics to receiving waters, and therefore regional monitoring is important to inform which pathways and sources are the most important to inform mitigation strategies. Additionally, she said different pathways have different microplastic signatures that can be used to determine which pathways may be important drivers of contamination in a system.

Chelsea moved on to her next presentation that investigated the presence of polystyrene foam in construction site debris. Construction foams (EPS, XPS, PU) contain brominated flame retardants (BFRs). X-ray fluorescence (XRF) has been used to detect BFRs in foam litter. This foam litter is different from other foams that do not contain BFRs, such as takeout containers and packaging foam. The study started with developing a foam library and testing different foam materials to evaluate if bromine could be used as an identifier of source. Almost all tested foams from construction and marina materials contained bromines, while tested food contact materials and packaging for consumer goods almost exclusively had no bromines. The two foams under construction that did not contain bromines were both thin, PS attic vents, which are not used for insulating. The items that contained bromine used for packaging were packing peanuts and a foam cooler lid. One of the items classified as “other” was a crafting foam sculpture that was also brominated. Generally, best practice for XRF analysis is to ensure samples are infinite to allow for measurements to be comparable across samples. To do this, we measured four plastic foams with thicknesses ranging from <1mm to 75mm to create a relationship between thickness and bromine concentration. Then they determined a relationship between thickness and bromine concentration using a linear regression to normalize XRF readings to 30mm for macro-sized samples. Quantitative beach sampling of macro sized foam found 58% of sampled beach foam were brominated (suggestion construction material origin)These toxic foams have been found in the stomachs of marine birds and can leach into the environment. Chelsea concluded that these results could inform best management practices at construction sites to reduce release of construction material debris. Chelsea proposed practices that could reduce construction site debris, such as using handheld rasps with vacuum attachments, scaffolding with sheets/nets to create an enclosed space, periodic vacuuming within construction sites, and using baskets lined with mesh filters in catch basins. Currently, there are no best practices to prevent release cleanup at construction sites mentioned by EIFS Council of Canada and the Underwriter Laboratories of Canada installation standard. Organizations and construction/standards associations can have a role in developing/bringing attention to best management practices.

To open discussion, Chelsea pointed to South Korean studies that first reported the high levels of bromine in construction materials recycled into food packaging. Sutapa Ghosal noted it was unusual to see 51% of construction foam rather than other microplastics, and inquired if some foams with flame retardants could have been used in furniture based applications This may certainly be the case, with suggestions to compare results with cities with less construction. Shelly asked Chelsea for recommendations for differentiating between different types of foam that could be used in microplastics monitoring? Chelsea suggested this could be a good application for Py-GC/MS which can be tuned to detect chemical constituents in addition to base polymers.

9. Summary of Proposed MPWG Studies for 2024

For this agenda item, Diana presented the proposed microplastic workgroup studies for 2024. The first proposal was the microplastics in urban stormwater runoff pilot for special study funding. A major motivation for this study is that urban stormwater was identified as the major pathway for microplastics to be transported to the Bay.Another motivation for this study is the need for cost effective methods to measure urban stormwater runoff. Previously SFEI used an ISCO sampler and collected most samples by moving the intake tube up and down to collect a depth-integrated sample. This is really labor intensive, has significant staffing costs, and not logistically realistic at larger sites. The CEC-SPL team has been developing remote samplers that collect urban stormwater runoff samples using installed equipment that can be controlled remotely – which would significantly reduce cost and increase capacity to sample more locations. However, this would most likely be sampling at a single depth in the water column. To utilize these more cost effective options being explored by the RMP for CECs stormwater monitoring, there is a need to understand whether urban stormwater microplastic samples can be collected at a single depth and whether these results can be used to answer current management questions. This is an important question for informing the RMP monitoring approach. Additionally, this is important for statewide microplastics monitoring and the SCCWRP study to develop standardized field collection methods for microplastics. This proposed study would coordinate and leverage the state and SCCWRP efforts. Implementing this urban stormwater runoff pilot study will allow the RMP to evaluate future feasibility of using remote sampler devices for urban stormwater monitoring and measure smaller microplastics that were not sampled in previou studies.

Diana described the proposed pilot study design and sampling effort. At two sampling sites, depth-integrated samples would be compared to samples collected at a single depth using an ISCO pump. Samples would be collected at or near the deepest portion of the channel. And the single-depth samples would be collected at 3 different depths - surface, middle, and bottom of the channel. Duplicates would be collected at each depth as well as the depth-integrated samples. Diana acknowledged these will not be exact duplicates because it is not possible to collect samples at exactly the same time and location, but these will be as similar as possible. The water pumped will be passed through a stack of sieves, and this time, 53 and 20 um sieves will be added. The stormwater monitoring team has already been using this method for the ongoing Next Generation Urban Greening project. The particles collected will be rinsed into sample jars and extracted and analyzed for microplastics in the laboratory, leveraging method developments efforts currently underway with through the Next Generation Urban Greening project. Extraction procedures will be modified to capture tire wear particles and include mass and particle counts. Polymers will be identified using FTIR, Raman, pyrolysis GC-MS, or SEM-EDS (for tire wear particles) to inform composition. Microplastic levels and composition measured at each depth will be compared to provide recommendations for future stormwater monitoring. This effort will produce a draft and final technical report. Total funding for the two year project will be $117.2K with a request for $65.8K the first year and $51.4K the second year. Diana clarified for Lorien that this effort would leverage tDon has already deployed remote samplers as part of the ECWG/SPLWG special study. Tom expressed concern about conclusions that could be made from such a small sampling size and inquired why sampling during well-mixed conditions is recommended. Tan Zi explained that we do not know whether sites will be well-mixed beforehand. Shelly commented that the integrated vs single depth question seems like it would be well-suited to a long-term monitoring study so that particle characteristics could be examined in the context of storm-strength variability. Tom asked if this study could be completed in one year with Diana clarifying that the study would be completed in 2025 at the earliest. Tom noted the second year budget for the group to consider.

Ezra Miller presented a second proposal for analyzing the size distribution of microplastic particles in San Francisco Bay. This project could be scaled between $65k-105K, and the proposal was presented as a Supplementary Environmental Project (SEP). Current size distribution models used to rescale manta trawl data to assess microplastic risks may not accurately represent SF Bay microplastics. With the goal of answering the new MQ1 (What are levels of microplastics in the Bay? What are the risks of adverse impacts?), this study hopes to inform future monitoring study design, while correcting and aligning microplastics data. In a previous published manuscript, Coffin et al., 2022 used Bay microplastic data that used a 355 micron sieve, and applied corrections and alignments calculations to scale data down to 1 micron and compared re-scaled results with ecotoxicity thresholds. These smaller size portions are important for toxicity. Currently, there is significant uncertainty in the application of these models to extrapolate environmental monitoring data to much smaller sizes than what was collected, as these models are based on very limited data sets and there is limited to no QA/QC on the underlying data sets. This study will collect up to nine surface water samples and nine sediment samples. The water samples will be collected using a pump and filters to collect samples in triplicate from three sites from different subembayments (e.g., North, Central, and South Bay) and the sediment samples will be grab samples in triplicate from three sites (e.g., one ambient, two margins). Microplastics down to 10 μm in size will be analyzed. The study will produce a draft and final manuscript (to be submitted for peer-review publication). The estimated proposal budget is between $65K to $105K, although sediment analysis for tire particles may be more expensive per sample. Ezra clarified the extra $40k is for analysis of additional sediment sediment samples. Tom inquired if a non-manuscript option would be possible. Ezra explained the peer-review publication method is proposed so it can be more widely cited or referenced in future risk analysis. Jay suggested a technical report that could be submitted to a journal. Tom explained that manuscripts cannot be accepted as the SEP deliverable because publication may not be within the contract timeline. Diana suggested that the final deliverable could be a final report that is also a draft manuscript, that would be submitted for peer-review publication. Lorien noted that costs were not significantly lower for report as compared to manuscript

10. Discussion of Recommended Studies for 2024

For this agenda item, Diana opened discussion on the special studies proposed for 2024 funding. Although proposed for different pots of funding, Tom emphasized all proposals should be vetted at the same level. Jay reiterated to the group that special studies have a high probability of being funded with SEP proposals having lower probability of funding because they go on a list and are subject to the availability of penalty funds. Chelsea voiced support for both as they help inform current science and ongoing SCCWRP and OPC efforts. There is current tension regarding how to representatively sample stormwater and both these study address future monitoring strategies, answering MQ1 and MQ2. Risk assessment working groups have emphasized the importance of small particles.

Barbara inquired as to how SFEI would handle different results from the depth integrated and single depth sampling methods in a well-mixed storm. Most SSC will be less than 63 microns, with Kelly adding that SFEI is considering the addition of turbidity or SSC measurements. Field conditions will be recorded to inform analysis. Turbidity could be done in-field and SSC could be analyzed at SFEI. Leah voiced support for both studies, noting that SCCWRP would also be collecting sediment samples soon. Stormwater sampling could start this upcoming wet season if RMP approves early release of funds. Miriam also voiced support for both studies, noting that SFEI will need the particle size distributions to adequately address the MQ1 regarding risk (Q1). The work described in the particle size distribution study proposal is critical for risk evaluations given the high uncertainties associated with the theoretical particle size correction extrapolations. Tirewear particles are important to include for local samples since they will be a large proportion of the particle types.

11. Closed Session: Decision Recommendation for 2023 Special Study Funding

Eric Dunlavey led the closed session that provided recommendations for 2023 special study funding.

12. Report Out on Recommendations

Eric Dunlavey reported on the recommendations provided by the Microplastic workgroup during the closed session. Both proposals will move forward as written to the RMP Technical

Review Committing for vetting and then to the Steering Committee for final approval. The workgroup recommended including turbidity or SSC measurements in the special study and Diana clarified that there will be some size analysis built in. Eric recommended including a graphic of the sampling methods in the write-up.

Adjourn

About the RMP

RMP ORIGIN AND PURPOSE

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

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

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

RMP PLANNING

This collaboration and adaptation is achieved through the participation of stakeholders and scientists in frequent committee and workgroup meetings (see Organizational Chart, next page).

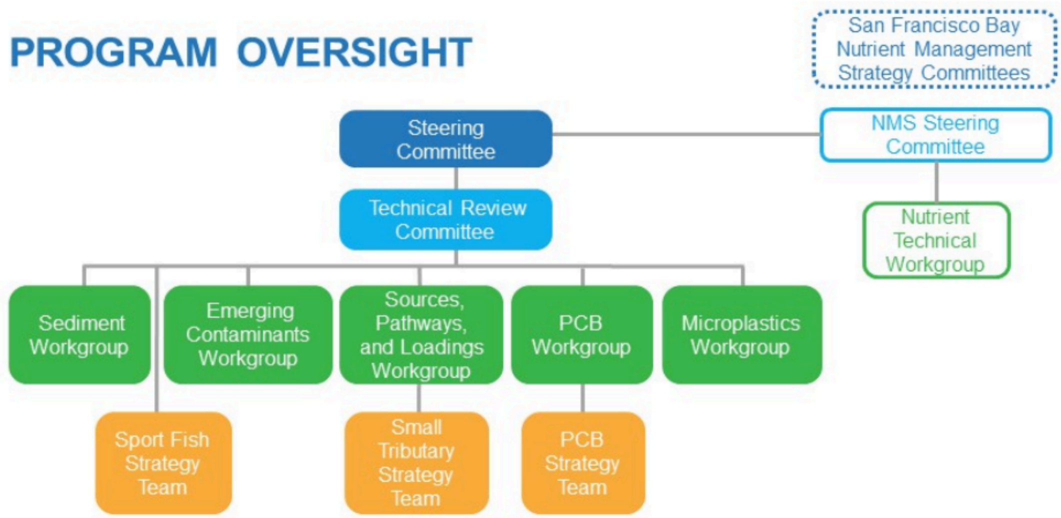
The annual planning cycle begins with a workshop in October in which the Steering Committee articulates general priorities among the information needs on water quality topics of concern. In the second quarter of the following year the workgroups and strategy teams forward recommendations for study plans to the 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. The Steering Committee then considers this recommendation and makes the final decision on the annual workplan.

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

PURPOSE OF THIS DOCUMENT

The purpose of this document is to summarize the key discussion points and outcomes of a workgroup meeting.

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—and 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.

MICROPLASTIC

Relevant Management Policies and Decisions

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

Plastic Pollution Prevention and Packaging Producer Responsibility Act (SB 54, Allen, 2022)

Local and state bans and other management actions on single-use plastics, including plastic bags, foam packaging materials, plastic straws

DTSC Safer Consumers Products Program decisions on regulation of chemicals in tires, food packaging, building materials

Federal policy on microplastics and microfiber pollution

State and Federal bans on microbeads

State-wide trash requirements

Municipal pollution prevention strategies including green stormwater infrastructure

Recent Noteworthy Findings

Plastics are among the most ubiquitous materials used in modern society. Microplastics, pieces of plastic under 5 mm in size, have been identified in virtually every environment on Earth. Microplastics are often derived from larger plastic items, such as tiny tire wear particles shed while driving, fibers shed from textiles during washing and drying, and fragments from litter. Tire particles may be the biggest global source of microplastics. Due to our car culture, scientists estimate that the US has the highest tire particle emissions in the world—7 to 12 pounds per person every year.

The San Francisco Bay Microplastics Project was completed in 2019, and found microplastics to be ubiquitous in Bay water, sediment, bivalves, and prey fish. This study quantified for the first time microplastics in urban stormwater runoff, and made the breakthrough discovery that concentrations in urban runoff were significantly higher than wastewater effluent. The vast majority of particles observed in urban stormwater runoff were suspected to be tire wear particles and fibers.

Additionally in 2020, a collaboration with University of Washington identified various tire ingredients present in Bay stormwater runoff, including 6PPD-quinone at concentrations that are lethal to a salmon species that was historically present in the Bay (coho). More recent data indicate that steelhead, a salmon species still migrating through the Bay to surrounding watersheds, are also sensitive to this chemical.

While fibers were the second most common class of microplastics observed in stormwater, there is minimal understanding of the major sources of fibers observed in urban stormwater.

Air transport of microplastics is a key data gap in our understanding of microplastic sources and pathways. Air transport is particularly important for tire wear particles and fibers because both types of particles have characteristics that make them easily suspended in the air and have the potential to be transported long distances. Other important remaining data gaps include exposure of Bay aquatic organisms and risk for adverse impacts, and the effects of current and future solutions implemented to reduce microplastic pollution.

Priority Questions for the Next Five Years

1. What are the levels of microplastics in the Bay? What are the risks of adverse impacts?
2. What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?
3. Are microplastic levels changing over time? What are the potential drivers contributing to changes?
4. What are the anticipated effects of management actions?

MULTI-YEAR PLAN FOR MICROPLASTICS

Microplastic studies and monitoring in the RMP from 2020 to 2026. 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 within other workgroups. Bold boxes indicate multi-year studies. Items shaded in yellow are considered high priority for 2025 funding and beyond.

Element	Study	Funder	Questions Addressed	2020	2021	2022	2023	2024	2025	2026
Strategy	Microplastic Strategy	RMP Patagonia/OPC	1,2,3,4	20 (30)	10	37	13 (50)	16 (100)	17 (50)	17
	Tires Strategy (ECWG)	RMP	1,2			25.5	10*	10*	10*	10*
Bay Monitoring	Bivalves	RMP	1,3							
	Fish	RMP	1,3							
	Sediment	RMP/OPC U. Rovira I Virgili	1,3		3.5		(15)			40
	Water	RMP/OPC	1,3						65	
Characteri-zing sources, pathways, loadings, processes	Wastewater	SCCWRP/OPC	1,2,3		(26)					
	Stormwater	RMP OPC	1,2,3					68	51	*(40)*
	Stormwater Conceptual Model	RMP OPC	1,2,4	30 (30)	30 (90)					
	Evaluating efficacy of rain gardens	SFEP/EPA	2,4			(62)	(62)	(62)		
	Investigating clothing dryers as a source	Sea Grant/OPC	2,4					(170)	(230)	
	Air monitoring	RMP OPC/Sea Grant/NOAA	1,2							(40)
	Assessing Information on Ecological Impacts	RMP NSF/CCCSD	1	(50)	18 (7.5+50)					
	Characterize microplastic additives	RMP ECWG	1,4						120*	
	Tire market synthesis to inform science (pro bono)	UC Berkeley	1,2,4			(20)				
RMP-funded Special Studies Subtotal – MPWG				**50**	**61.5**	**62.5**	**13**	**84**	**133**	**57**
High Priority Special Studies for Future RMP Funding									**116**	**40**
RMP-funded Special Studies Subtotal – Other Workgroups							**10**	**10**	**130**	**10**
MMP & Supplemental Environmental Projects Subtotal										
Pro-Bono & Externally-funded Special Studies Subtotal				**110**	**173.5**	**82**	**127**	**332**	**280**	**80**
OVERALL TOTAL				**160**	**235**	**144.5**	**140**	**416**	**413**	**137**

Special Study Proposal: Pilot Study for Field Collection Methods and Particle Distribution Analysis of Microplastics in Urban Stormwater to San Francisco Bay (Year 2)

Summary: In 2019, the San Francisco Bay Microplastics Project identified urban stormwater runoff as the major pathway for microplastics entering the Bay. More recent investigations on the sources and pathways of microplastics revealed that tire-wear particles and other smaller microplastics were under-counted in previous investigations due to collection and analytical methods. In addition, while depth-integrated sampling was prioritized for the 2019 study to better characterize microplastics in the full water column, this approach requires considerable labor resources relative to stormwater samples collected using unmanned, automated sample collection at a single depth, which is a more likely sampling scenario for any kind of automated sampling program.

This proposed pilot field study will take pilot steps to evaluate whether single-depth sampling within the water channel is adequately comparable to depth-integrated sampling during storm flow conditions in the channel. Specifically, we will take simultaneous single-depth samples at three different depths (surface, mid-depth, near-bottom) at two field sites at five times during one storm each and compare the microplastics content of these samples using advanced laboratory techniques that characterize tire wear and other fine particles.

Funding for this special study proposal was split over 2 years, and this proposal is for the remaining portion of funds needed to complete the project. The final deliverable will be a draft and final technical report.

Estimated Cost:	$100,500 for Year 2 (Year 1 funded: $78,100)
Oversight Group:	MPWG
Proposed by:	Diana Lin, Alicia Gilbreath, Lester McKee, Rebecca Sutton (SFEI)
Time Sensitive:	Yes, inform statewide plastics monitoring strategy, year two of a two-year study

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Develop study design and approach	June 2024
Task 2. Site selection and field reconnaissance	August 2024
Task 3. Sample collection	March 2025
Task 4. Laboratory analysis	September 2025
Task 5. Draft technical report	January 2026
Task 6. Final technical report	February 2026

Background

Through the San Francisco Bay Microplastics Project (Sutton et al., 2019), SFEI researchers identified urban stormwater runoff as the dominant pathway for microplastics entering the Bay. Average microplastic concentrations in urban stormwater runoff were over 100 times greater than average wastewater effluent concentrations. SFEI used a previously developed Regional Watershed Spreadsheet Model (RSWM) to extrapolate measured results and estimated that on the order of 7 trillion microplastic particles were entering the Bay per year from urban stormwater runoff. Tire-wear particles and fibers were the most abundant types of microplastics in urban stormwater runoff, and combined represented most of the microplastics observed in urban stormwater samples. More recent literature review, synthesis, and analysis (Moran et al., 2021; Moran et al., 2023) funded by the RMP and others has revealed that tire-wear particles and other smaller microplastics were under-counted in previous investigations due to the 125 µm sieve size used during field sampling, as well as the density separation methods used to extract microplastics from the samples.

In addition to sieve sizes and analytical density separation techniques, another important method consideration for field sampling is whether vertical depth integration is critical for measuring stormwater runoff concentrations, or whether water column concentrations are sufficiently well-mixed that sampling at a single depth in the water column is sufficient for answering RMP management questions. During the original Microplastics Project, depth-integrated sampling was conducted at most urban stormwater sites. However, the RMP studies at Guadalupe River at Hwy 101, Jan Jose, and Zone 4 Line A at Cabot Blvd, Hayward found that suspended sediment concentration profiles were sufficiently well-mixed during storm flow events to utilize single-depth sampling in the channel thalweg (deepest portion of channel) when vertically-integrated sampling is logistically not practical (personal communication with Lester McKee). Considering that microplastics are likely to have even slower settling velocities compared to suspended sediment (due to their lower density and larger surface area), we hypothesize that most microplastics may be sufficiently well-mixed in storm flows in many channels and that single-depth sampling may also be sufficient for microplastics. If single-depth sampling is found to be sufficient for microplastic stormwater sampling, this would open up more opportunities to leverage the RMP's developing urban stormwater monitoring program, including the development of automated remote samplers that would likely be sampling at a single depth.

Given the importance of the urban stormwater runoff pathway for microplastics, it is important to collect more urban stormwater data in the Bay area to inform and improve upon previous findings. **This study would evaluate microplastics concentration depth profiles during stormwater flows and provide recommendations for future urban stormwater monitoring needs. Additionally, this study would provide more comprehensive information about the distribution of microplastics in Bay stormwater runoff by capturing and analyzing microplastics that were under-represented in previous efforts.**

The California Ocean Protection Council (OPC) and State Water Board (SWB) have funded the Southern California Coastal Water Research Project (SCCWRP) to develop standardized field sampling methods for stormwater flows and other matrices that can be used to collect statewide microplastic monitoring data. This proposal provides an important opportunity to coordinate and collaborate to inform key data gaps about the characterization and distribution of microplastics in urban stormwater runoff, as well as their vertical distribution and transport, and to inform appropriate field sampling and analytical methods for monitoring. Coordinating RMP efforts with the OPC/SCCWRP effort will allow for greater context for interpreting urban stormwater runoff sampling results in the Bay Area and Southern California and piloting urban stormwater sampling methods that are appropriate for the smaller creeks and rivers in the Bay Area compared to the large concrete river channels in southern California. Recommendations from this study could also inform future statewide monitoring priorities and methods.

Study Objectives and Applicable RMP Management Questions

Table 1. Study objectives and questions relevant to the RMP ECWG management questions.

Management Question	Study Objective	Example Information Application
1) What are the levels of microplastics in the Bay? What are the risks of adverse impacts?	*Not applicable*	*Not applicable*
3) What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?	- Pilot sampling approaches for microplastics in urban stormwater that are suitable for the Bay Area's watersheds - Measure microplastic concentrations in urban stormwater	-What is the composition of microplastics in urban stormwater runoff ? - What uncertainties and biases are introduced from different sampling approaches? - How do results compare with previous urban stormwater runoff measurements?
4) Are microplastic levels changing over time? What are the potential drivers contributing to changes?	*Not applicable*	*Not applicable*
5) What are the anticipated impacts of management actions?	*Not applicable*.	*Not applicable*

Approach

Study design development

With the year one funding we have started coordinating with other researchers investigating microplastics in stormwater flows to refine the study design. We have refined our sampling and analysis approaches and identified analytical partners, which are further described below.

In this pilot study, we will collect an initial set of samples in the 2024/25 wet season to compare microplastic urban stormwater collection efforts at three different depths (surface, mid-depth, near-bottom) in creek flow in order to evaluate the importance of using vertically-integrated urban stormwater samples that are expected to be representative of water column concentrations. We will select two watershed sampling sites where well-mixed conditions (as known for suspended sediment) are likely during typical storm events based on previous stormwater team experience. It is important to start this pilot study at more ideal locations (for mixing) because results can be more easily interpreted to understand whether there are important differences between microplastics and suspended sediment hydrology (since suspended sediment is expected to be well-mixed). If results in this pilot study do indicate conditions are well-mixed for microplastics, then we can further explore less ideal conditions. Site accessibility for sample set up will also be critical. More urban watersheds are preferred, where higher microplastic loadings are expected.

Urban stormwater sample collection

During a storm, we will collect simultaneous sample sets at three different depths (surface, mid-depth, near-bottom) in the channel using three different ISCO pumps where the intake tubes are attached to a sampling pole that will be placed in the water column in or near the deepest portion of the channel (thalweg). Over the course of the storm and at varying flow rates, we will collect five separate sample sets for a total of 15 samples (five sets at three depths each) at each location. This approach will provide five data points for comparison of the three depths for pilot-level statistical evaluation of differences in microplastic concentration and composition.

At the onset of sample collection, we will also measure and record turbidity using a portable turbidimeter. These measurements would give us real-time information on how well-mixed the water column is for suspended sediment.

The urban stormwater for microplastics analysis will be pumped through a stack of sieves similar to previously deployed methods (Sutton et al., 2019) with a few important improvements. Stacked sieves will include 355 µm, 125 µm, 53 µm. The addition of the 53 µm allows capture of smaller microplastic size fractions that were not captured previously. These smaller sieves have recently been successfully deployed to collect urban stormwater runoff samples entering bioretention rain gardens in San Francisco. Sample volumes for microplastics are anticipated to be 10–30 L and will be determined based on anticipated levels of microplastics. Best practices will be used to avoid sample contamination, including collection of at least one field blank at each site.

We expect tire wear particles to be abundant in stormwater samples, and typical microplastic analytical methods using Raman or FTIR are not suitable for quantifying tire wear particles. Therefore, we will collect separate samples for tire wear particle analyses. Tire wear particles will be collected as 1 L bulk water samples. These 1 L samples will be filtered onto a 0.4 μm cellulose filter at SFEI, and shipped to NIVA for analysis of tire wear particles using pyrolysis GC-MS.

An additional 1-L bulk sample will be filtered onto a separate pre-weighed filter and measured for total suspended solids concentration at SFEI.

<u>Microplastic analysis</u>
Microplastic samples will be analyzed by Moore Institute of Plastic Pollution Research (MIPPR) in Long Beach, CA. MIPPR is currently undergoing evaluations, and anticipates being one of the first laboratories in the world to be accredited for microplastics analysis. They have already passed the first phase of accreditation and anticipate being accredited by summer of 2024. Samples will be extracted using a combination of density separation and digestion (depending on the contents in the samples). Blanks and spikes will be conducted to estimate particle losses and contamination rates. Samples will be quantified for microplastic counts down to 50 μm sized particles. Particle polymer type, counts, morphology, and size will be reported to understand the composition of microplastics. Particles between 50–500 μm will be automatically characterized using hyperspectral imaging FTIR. The Moore Institute has developed a novel data analysis pipeline and spectral reference library to automate the analysis of their hyperspectral maps. Particles larger than 500 μm will be characterized using visual microscopy and a subset of the particles (at least 100 per sample) will be assessed for polymer type.

Tire wear particle samples will be filtered onto 0.4 μm cellulose filter and sent to Elisabeth Rødland at Norwegian Institute for Water Research (NIVA) for tire wear particle analysis using pyrolysis GC-MS. NIVA researchers have developed state of the art methods for quantifying tire wear particles (composed of styrene butadiene rubber and butadiene rubber) using pyrolysis GC-MS to quantify the mass of 4 different marker combinations for comparison: M4 (benzene, methylstyrene, ethylstyrene, butadiene dimer), M3 (methylstyrene, ethylstyrene, butadiene dimer), 4-vinylcyclohexene (4-VCH) and butadienes (butadiene dimer, styrene butadiene dimer and styrene butadiene trimer).

<u>Data interpretation</u>
We will compare the levels of microplastics, tire wear particles, and suspended sediments solids at the three different depths. We will also compare the composition of microplastics at the three different depths. We will test our hypothesis that single-depth measurements are sufficiently representative of the water column during storm flow

conditions. Based on results, we will discuss implications and recommendations for future microplastics stormwater monitoring.

Based on this initial set of results, we will provide a recommendation on whether additional study is advised to answer the question: Can simplified single-depth sampling methods be used to representatively (appropriate for estimating loads) measure microplastics (or a subset of microplastics) samples in urban stormwater runoff during well-mixed flow conditions? We will also provide recommendations for future urban stormwater monitoring to address RMP microplastic data needs as outlined in the RMP Microplastics Strategy Revision (Paterson et al., 2024).

Communication

Results will be summarized in a technical report that will include recommendations for next steps in urban stormwater monitoring. Results will be shared with RMP, SCCWRP, OPC, and SWB to inform future monitoring efforts.

Budget

Table 2. Budget

Expense	Estimated Hours	Estimated Cost
Labor		
Study design	65	12,300
Sample Collection	150	35,500
Data management	48	8,300
Analysis and Reporting	190	30,800
Subcontracts		
Microplastics laboratory analysis via FTIR/Raman spectroscopy (Moore Institute of Plastic Pollution Research or equivalent laboratory)	N/A	70,400
Tire wear particle analysis via pyrolysis GC-MS		16,000
Direct Costs		
Supplies		10,000
Travel and shipping		2,000

Grand Total	**182,400**
Subtract Year 1 funded amount	**-78,100**
Year 2 Funding Request	**100,500**

Budget Justification

Study design
SFEI staff will coordinate with other researchers investigating microplastics in stormwater to refine the study design and data analysis. Hours are also included for internal and external meetings to finalize the study design.

Sample collection
SFEI hours are estimated to staff 2 storm sampling events with four staff members. This includes staff time needed for preparing for sampling events, event monitoring and sampling, post-event sample processing and filtering, and packaging for shipment.

Data management
Data management services include developing field sampling templates, compiling field data sheets, developing reporting template for analytical laboratories, communications with the laboratory, consultation with QA officer, and preliminary data analysis. Data will not be uploaded to a public database.

Analysis and Reporting
SFEI hours are estimated for data analysis and interpretation. Project updates will be shared during MPWG meetings. Results and findings will be summarized in a draft and final report.

Subcontracts/Laboratory Costs
Sample analytical costs are estimated to be up to $2,200/sample for microplastic analysis via FTIR spectroscopy for 32 samples (30 field samples + 2 field blanks). Tire wear particle analytical costs are estimated to be up to $250/sample via pyrolysis GC-MS for 64 samples ([30 field samples + 2 field blanks] x 2 duplicates).

Direct Costs
Direct costs will cover sampling supplies, including 15 sets of sieves, sample bottles, cleaned pump tubing, laboratory supplies and shipping costs.

Reporting

Deliverables will include a draft and final technical report.

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Special Study Proposal: Size Distribution of Microplastic Particles in San Francisco Bay Surface Waters

Summary: The majority of microplastic studies of surface waters have analyzed microplastics over 355 µm; however, only analyzing this size range significantly underestimates the amount of microplastics in surface waters. Because small microplastic sizes are associated with increased toxicity, understanding their levels in the environment can help with evaluating risks to aquatic ecosystems by comparing environmental levels with available thresholds. Extrapolations of smaller particle counts from total particle counts using existing surface water data have been done using proposed particle size distributions models; however, there is a large amount of uncertainty in the extrapolated data because of the lack of relevant environmental data to validate these particle size distribution models.

To better understand the levels and composition of microplastics in the Bay, this project proposes to leverage the 2025 S&T dry season water cruise to collect surface water samples for microplastic analysis. Microplastics between 10 µm–1 mm will be sampled and evaluated. This monitoring approach was identified as a high priority as part of the RMP MPWG Monitoring Strategy Revision to inform MPWG management questions. Additionally, this would be the first pilot study of this approach in California and would provide critical information and experience to inform RMP and statewide microplastic monitoring strategies.

Estimated Cost: $202,100
Oversight Group: Microplastic Workgroup
Proposed by: Diana Lin, Kayli Paterson, Ezra Miller (SFEI)
Time Sensitive: Yes, to pilot sampling prior to S&T Water Cruise (this proposal includes request for early release of funds)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Pilot sample collection	October 2024
Task 2. Laboratory analysis on pilot samples	February 2025
Task 2. Develop study design	May 2025
Task 3. Sample collection during S&T water cruise	September 2025
Task 4. Laboratory analysis	March 2026
Task 5. Draft Report	July 2026
Task 6. Final Report	September 2026

Background

Previous monitoring in San Francisco Bay provides a baseline understanding of microplastic levels and composition in water bodies in the region and state. Previous monitoring of surface water in the Bay relied on Manta trawls using a 355 µm net, which is the most widely used approach for monitoring microplastics in surface water. Since completion of the San Francisco Bay Microplastics study in 2019, there has been a growing scientific understanding of how manta trawls underestimate the abundance of microplastics smaller than the mesh size.

Addressing this data gap is important to addressing the updated MPWG Management Question 1, “What are the levels of microplastics in the Bay? What are the risks of adverse impacts?” Accurate assessment of levels of microplastics in the Bay, including understanding diverse microplastic characteristics to evaluate potential risks from microplastics, requires holistic exposure data to compare directly to ecotoxicological thresholds. While most microplastic surface water monitoring data are based on particle sizes greater than 355 µm, the microplastics known to be most toxic are smaller particle sizes.

Particle size distribution models to extrapolate environmental monitoring data to small sizes not captured in environmental sampling have been proposed by Koelmans et al. (2020) and Kooi and Koelmans (2019). These models were recently used by Coffin et al. (2022) to estimate San Francisco Bay particle counts, which, when compared to recently developed thresholds (Mehinto et al., 2022), indicated that more than three-quarters of samples exceeded the most conservative food dilution risk threshold. However, this risk characterization study had large amounts of uncertainty, as the size distribution models were based on very limited datasets in which data were selected in part to fit the model, had limited to no QA/QC, and were relatively limited in geographic scope (European water bodies). Most of the data were also limited to >100 µm particle sizes, yet were used to extrapolate to much smaller sizes. Therefore, the current size distribution models used to “rescale” manta trawl data to assess microplastic risk may not accurately represent San Francisco Bay microplastics.

There is an important need to supplement previous evaluations of microplastics in Bay surface water by addressing previous data gaps and quantifying microplastics smaller than 355 µm. The goal of this study is to collect and evaluate microplastics in surface water samples down to 10 µm. While evaluating even smaller microparticle sizes (< 10 µm) is important, smaller particle size remains a difficult barrier to overcome for microplastic analysis via microscopy. For example, an inter-laboratory comparison study found low microplastic recovery (average 32% recovery) for particles <20 µm among 22 participating laboratories from six countries (Kotar et al., 2022). The results from this study will provide more holistic data on microplastic characteristics and composition, including microplastic particle size distribution. These data will be used to inform more accurate estimates of microplastic levels in the Bay and will be used in future exposure assessments. In addition, this study will help evaluate field sampling methods to improve future monitoring efforts.

This study would also inform statewide monitoring design by being the first study in California to pilot and utilize standardized sampling guidance for surface water sampling led by Dr. Chelsea Rochman and a working group convened by the Southern California

Coastal Water Research Project (SCCWRP). The SOP development is part of a project funded by the California Ocean Protection Council to support the development of standardized field sampling procedures for environmental matrices. Monitoring in the Bay could be incorporated into a statewide microplastics monitoring network and inform future sampling at other locations in the state.

Study Objectives and Applicable RMP Management Questions

The purpose of this study is to characterize microplastics in SF Bay surface waters in order to gain a more accurate understanding of the levels, particle sizes, polymers, and morphologies of microplastics in surface waters.

Table 1. Study objectives and questions relevant to the RMP MPWG management questions.

Management Question	Study Objective	Example Information Application
1) What are the levels of microplastics in the Bay? What are the risks of adverse impacts?	Improve characterization of microplastics in Bay surface water by including smaller particle sizes not evaluated in previous methods.	What are the levels and composition of microplastics in Bay surface water? What is the particle size distribution of microplastics in the Bay?
2) What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?	Evaluate microplastic particle characteristics	What types of microplastics are observed in Bay waters? Can observed microplastics be linked to potential upstream sources?
3) Are microplastic levels changing over time? What are the potential drivers contributing to changes?	Collect measurements of microplastics in Bay surface waters using updated field and analytical methods.	How do levels and composition of microplastics compare with previous measurements?
4) What are the anticipated impacts of management actions?	N/A	N/A

Approach

Surface Water Sampling

Collection of Bay water samples will be coordinated with the RMP S&T dry season monitoring cruise in the summer of 2025. During the dry season water cruise, we will collect samples in duplicate at 10 sites for a total of 20 field samples. Additionally, we will collect at least two field blanks and two equipment rinse blanks for each sampling day, whichever is greater (estimated 3 days of sampling = 6 field blanks and 6 equipment rinse blanks). Sampling locations will include sites from different subembayments (e.g., Lower South Bay, South Bay, Central Bay).

The microplastic field sampling approach will utilize in-line filtration using a pump that samples bulk water from the top 0.5 m. Our sampling approach will be guided by recently developed surface water sampling guidance developed by Dr. Chelsea Rochman and the SCCWRP working group. Prior to sampling deployment, we will pilot test the sampling equipment and test for background contamination. SFEI staff will assemble a filtration device using a peristaltic pump fitted with silicon or Tygon tubing. Bulk water samples will be pumped onto a 50 μm and 10 μm filter in series. Pilot samples will be collected at one or more Bay locations. We will follow best practices for microplastic collection and analysis to minimize background contamination. Pilot and field blanks will be shipped to Ocean Diagnostics for microplastics analysis. Pilot test results will be used to guide evaluation of laboratory method detection limits and determine appropriate field sample volumes.

Microplastic Analysis

Filtered samples will be shipped to Ocean Diagnostics' specialized microplastic laboratory in Vancouver, Canada. Ocean Diagnostics is a small research organization that specializes in integrated water depth sampling for hard-to-sample materials such as microplastics and environmental DNA. Besides the novel portable depth samplers they developed, they also have microplastic laboratory services that provide Fourier Transformed Infrared Spectroscopy (FTIR) analysis. They have provided their microplastic analysis services to quantify the flow of microplastics to the Arctic Ocean (Ross et al., 2021), micro-textiles released during the washing machine wash cycle (Vassilenko et al., 2021), and the vertical distribution of microplastics in the ocean (DiBenedetto et al., 2023). They have recently been tapped to be the lead organization to coordinate microplastic sampling at up to five monitoring centers in Canada that will collect standardized microplastics samples that the National Research Council of Canada will use to validate microplastic modeling tools[1].

The microplastic laboratory is operated inside an ISO-5 cleanroom and utilizes cutting-edge FTIR equipment (Lumos II, Bruker Optics). Samples will be processed following stringent QA/QC practices modeled from ISO standards (ISO/DIS 160942, ISO 24187:2023) and previous microplastic studies (Brander et al., 2020; Cowger et al., 2020). This will involve the use of negative controls (*n*=6), recovery assessments (3 samples spiked with in-house reference materials), and polymer identification proficiency demonstration, using standards from the Hawaii Centre for Marine Debris Research (CDMR) and US National Institute of Standards and Technology (NIST). Volume-reduced samples will be digested for two days in Fenton reagent, following the

[1] https://canadabuys.canada.ca/sites/default/files/webform/tender_notice/8125/23-58029_rfp-_en_final.pdf

protocol of Ocean Diagnostics. Fenton digestion represents the most applied and tested preparation technique for water samples for microplastic analysis using spectroscopy, as highlighted by a recent systematic review of 580 studies (Primpke et al., 2023). Project pilot samples will be used to establish if a density separation step is needed following digestion which is recommended for samples with high silt/sand content, characteristic of locations near rivers or in high turbidity zones (Dr. Anna Posacka, Chief Scientist, Ocean Diagnostics personal communication). Subsequently, samples will be filtered onto aluminum oxide filters and processed using chemical imaging Focal Planar Array (10-300μm) and Attenuated Total Reflection FTIR (300μm - 1mm). Spectroscopy data will be processed using machine learning software and spectral libraries from Bruker Optics (Opus), Ocean Diagnostics (in-house), SiMPLe, and FloPPe (De Frond et al., 2021), to identify polymer types of microplastics detected. As part of Ocean Diagnostics' quality control and assurance measures, polymer analysis results will be verified by a spectroscopy expert. Polymer identification quality index will be provided alongside the sample results, and for particles that are heavily weathered, notes and recommendations on putative polymer sources will also be provided. The final results include data on the number, type (shape, material), and size of microplastics detected in each sample.

Samples will be extracted through digestion and density separation following accepted methods (ASTM D-8333-20; California State standard methods), and particles down to a size of 10 μm will be characterized using Fourier Transform Infrared Spectroscopy with ultrafast Focal Plane Array detection. The distributions of the number, type (shape, material), and size of microplastics for each sample will be reported.

<u>Data Analysis and Interpretation</u>

Microplastic levels and composition will be evaluated and compared to previous Bay monitoring results (Sutton et al., 2019).

The particle size distributions measured from this proposal will be compared with particle size distribution models proposed and utilized by others (Coffin et al., 2022; Koelmans et al., 2020; Kooi and Koelmans, 2019) to evaluate the uncertainty in the previously published risk characterization for the Bay (Coffin et al., 2022). We will make a recommendation on whether an updated risk characterization is advised for future studies based on results from this study and the availability of updated ecotoxicological thresholds and risk characterization approaches. **An updated risk characterization is not included in this proposal.**

The experience and results from this study will be used to inform future microplastic monitoring designs and approaches. Results will be shared with RMP, SCCWRP, OPC, and SWB to inform monitoring in the Bay and across California.

Budget

Table 2. Budget

Expense	Estimated Hours	Estimated Cost
Labor		
Study Design	150	25,300
Pilot and Sample Collection	190	28,500
Data Technical Services	85	15,000
Analysis and Reporting	500	67,100
Subcontracts		
Microplastics analysis via FTIR/Raman spectroscopy (Ocean Diagnostics or equivalent laboratory)	NA	57,200
Direct Costs		
Equipment and supplies (including filtration assembly)		9,000
Shipping		2,500
Open Access Publication		2,500
Grand Total		**202,100**

<u>Budget Justification</u>

Study Design
SFEI staff will develop study design in coordination with the RMP S&T dry season monitoring cruise in the summer of 2025. Hours are included to incorporate sampling instructions into the S&T Sampling and Analysis Plan, which will incorporate peer-reviewed best practices to reduce microplastic contamination as much as reasonably possible.

Sample Collection
SFEI hours are estimated to design, assemble, and pilot sampling equipment, and collect pilot field samples and blanks. Additionally, hours are included to send one additional staff on the S&T cruise for one week to collect the samples.

Data Management

Microplastic data will not go through standard RMP QA/QC procedures, which were developed for chemical analysis. Limited SFEI labor hours are included for the SFEI data management team to track and manage field sampling forms, laboratory data reporting, provide consultation on QA/QC considerations, and provide technical support for data analyses. Data will not be uploaded to a public database. Data upload could be incorporated through future study funding.

Analysis and Reporting
SFEI hours are estimated to synthesize and analyze microplastics data and compare results to previous Bay water monitoring data and other published comparable datasets. Additionally, we will fit particle distribution profile mathematical models to the data. SFEI staff will summarize findings and lessons learned in a draft manuscript. Hours are also included to present findings at the 2026 MPWG meeting. Recommendations will also be incorporated into other related RMP microplastic report deliverables, such as the RMP MPWG Strategy.

Subcontracts/Laboratory Costs
Sample analytical costs are estimated to be $1,200/sample for 52 samples (20 field samples x 2 filters + 6 field blanks + 6 samples for pilot testing).

Direct Costs
Direct costs will cover sampling equipment, field and laboratory supplies, and shipping costs.

Reporting

The deliverable for this project would be a draft manuscript that will be submitted for peer-review as an open access publication.

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Microplastics in San Francisco Bay Sport Fish

Summary: In summer 2024, as part of RMP Status and Trends monitoring, sport fish will be collected and analyzed for a suite of contaminants. This project would leverage this sample collection effort and analyze striped bass (*Morone saxatilis)* and shiner surfperch (*Cymatogaster aggregata*) to assess the level of exposure in the Bay food web to microplastics. Results will be compared to previously measured Bay prey fish and fish in other published studies. Striped bass and shiner surfperch are popular for human consumption and are important to analyze to assess potential human exposure routes to microplastics. The final deliverable will be a manuscript prepared by the University of Toronto with assistance from SFEI.

Striped bass are the most popular sport fish for consumption in the Bay, and a species that is higher in the food chain and provides an integrated signal for regions of the Bay because of its wide foraging behavior and opportunistic consumption of lower trophic level fish. Shiner surfperch are an abundant and popular sport fish species that feeds on invertebrates in the benthic zone and exhibits high site fidelity, making them useful for assessing spatial differences in contaminants. In total, up to 50 whole shiner surfperch are planned to be collected for microplastic analysis from sites within the Central Bay and South Bay and San Pablo Bay (Table 1). Additionally, up to 20 striped bass are planned for collection where the gut, liver, and muscle tissue from one side of the fish are allocated for microplastics analysis. Field blank samples will be collected as open wide-mouthed sample containers with a small amount of canola oil during sample dissection, and then closed and stored with the fish samples after processing.

Table 1. Sport fish samples available for microplastic analysis.

	Shiner Surfperch	Striped Bass
Central Bay		10
San Francisco	10	
Berkeley	10	
South Bay	10	10
San Leandro Bay	10	
San Pablo Bay	10	
Totals	**50**	**20**

Estimated Cost: $130,000
Oversight Group: Microplastic Workgroup
Proposed by: Diana Lin (SFEI) and Chelsea Rochman (University of Toronto)
Time Sensitive: Yes, to leverage S&T Sport Fish collection

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Laboratory analysis	September 2025
Task 2. Draft manuscript	January 2026

Tire Rubber Marker Analysis for Tire Wear Particle Quantification

Summary: Tire Wear Particles (TWPs) may be the biggest source of microplastics to San Francisco Bay, and are also a source of tire-related contaminants.
Norwegian Institute for Water Research (NIVA) scientists have developed state of the art methods for quantifying tire wear particles[1,2]. Reference materials of tire samples are used to estimate TWP using estimated relationships between emissions of tire materials from different types of vehicles and tires with different marker content. While NIVA has developed a tire database for tires used in Norway, no such reference database has been published for California tires. And while the U.S. Tire Manufacturers Association (USTMA) and the Tire Industry Project (TIP) have provided reference material (https://www.ustires.org/cmtt), they have not provided information as to types of tires used, and therefore it is not possible to ascertain whether the material is representative of what is in use in California. Because tire rubber composition varies due to brand, car type, area weather, and intended use, creating a representative regional tire database is important for improving the accuracy of estimated tire wear concentrations in environmental samples.
This proposal would analyze tire tread rubber from a representative set of new tires for the San Francisco Bay region (approximately 30 tires, each analyzed in triplicate[3,4]). Representative samples would include tires commonly used by passenger vehicles, and light trucks/SUVs, which represent a cumulative 76% of cars driven in California[5]. NIVA will analyze samples using pyrolysis GC-MS to quantify various tire markers to develop a reference database for tire material based on SF Bay Area regional tire trends. Results will be publicly shared through a peer-reviewed manuscript led by NIVA and supported by SFEI. Results will also be integrated into future RMP and SFEI reports to more accurately quantify TWPs analyzed via pyrolysis GC-MS. Overall, developing a robust database is critical for quantifying tire wear particles in the region and state. The data from this study could be used to update measurements of tire wear particles in Bay stormwater runoff.

Estimated Cost:	$105,000
Oversight Group:	ECWG and MPWG
Proposed by:	Diana Lin, Kayli Paterson, Kelly Moran, Rebecca Sutton (SFEI), and Elisabeth R⌀dland (NIVA)
Time Sensitive:	Yes, to inform other tire quantification studies in the Bay and state

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Develop study design	March 2025
Task 2. Collect tire rubber samples	September 2025
Task 3. Laboratory Analysis	February 2026
Task 4. Data analysis, interpretation, and reporting	June 2026

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[1] Composed of styrene butadiene rubber and butadiene rubber) using pyrolysis GC-MS to quantify the mass of 4 different marker combinations for comparison: M4 (benzene, methylstyrene, ethylstyrene, butadiene dimer), M3 (methylstyrene, ethylstyrene, butadiene dimer), 4-vinylcyclohexene (4-VCH) and butadienes (butadiene dimer, styrene butadiene dimer and styrene butadiene trimer.
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[4] Jefferson, A. 2023. *Tire Market: Top Brands & Retailers in 2023*. Traqline.com.
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Tire Wear Emissions and Washoff Estimates Journal Paper

Summary: Tire wear is one of the top sources of microplastic releases to the environment. Tire wear also disperses tire-related chemicals into the environment. SFEI studies supported by the RMP and others have found tire wear particles and tire-related chemicals in San Francisco Bay and its small tributaries, which drain the Bay watershed's local urban areas. In 2023, RMP published a report *Tire Wear: Emissions Estimates and Market Insights to Inform Monitoring Design* estimating the total emissions of tire wear particles in the San Francisco Bay region and the state of California. The report used extrapolations from the limited available monitoring data from SFEI's one-time microplastic monitoring effort (Sutton et al., 2019) to estimate the potential scale of tire particle and chemical transport into Bay Area surface waters at about 2-16% of overall emissions. While this washoff fraction estimate is lower than the 15–50% used in published tire particle modeling studies, it is in the range that would be expected based on road particle washoff data (9%, Pitt et al., 2005). To our knowledge, this is the first quantitative comparison between microplastic emissions and loads in urban runoff.

Presentations on this report have garnered international interest. Sharing the information in the form of a scientific journal paper would make it more widely used and could improve study design and data interpretation by others, thus improving the information available to the RMP.

This proposal requests funding to turn the relevant portions of the report into a scientific paper for publication in a peer-reviewed journal. We propose to collaborate on the publication with Professor Barbara Beckingham (College of Charleston), who helped us with tire particle volume estimates supporting the washoff estimates.

Estimated Cost: $15,000
Oversight Group: ECWG and MPWG
Proposed by: Kelly Moran and Rebecca Sutton (SFEI), Barbara Beckingham (College of Charleston)
Time Sensitive: Yes, report was published in 2023

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Draft journal paper	Spring 2025
Task 2. Final journal paper	Fall 2025

References

Moran, Kelly; Gilbreath, Alica; Méndez, Miguel; Lin, Diana; Sutton, Rebecca. 2023. Tire Wear: Emissions Estimates and Market Insights to Inform Monitoring Design. SFEI Contribution #1109. San Francisco Estuary Institute, Richmond, CA.

Pitt, R. E., Williamson, D., Voorhees, J., & Clark, S. (2005). Review of Historical Street Dust and Dirt Accumulation and Washoff Data. *Journal of Water Management Modeling*, *13*, 203–246.

Sutton, R., Lin, D., Sedlak, M., Box, C., Gilbreath, A., Holleman, R., Miller, L., Wong, A., Munno, K., Zhu, X., & Rochman, C. (2019). *Understanding Microplastic Levels, Pathways, and Transport in the San Francisco Bay Region.* (SFEI Contribution No.950.)