REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
sfei.org/rmp

RMP Microplastics Workgroup Meeting

April 10, 2023
9:00 AM – 3:00 PM

REMOTE ACCESS
https://us06web.zoom.us/j/89592183139

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AGENDA

1.	**Introductions and Goals for This Meeting** The goals for this meeting: ● Finalize RMP Microplastic Workgroup (MPWG) Management Questions ● Discuss ongoing MPWG Strategy Update and future direction of RMP microplastic work ● Provide update on ongoing State-funded activities ● Recommend which study proposals should be funded in 2024 and provide advice to enhance proposals Meeting materials: 2022 MPWG Meeting Summary pages 5 - 19	9:00 Amy Kleckner Rebecca Sutton
2.	**Information: Update on Microplastics in Bay Sediment** The workgroup will hear an update on a pro-bono study of microplastics in Bay sediment to evaluate spatial and temporal trends. Sample pre-treatment processes were modified to improve recovery of denser microplastics, such as tire-wear particles. Desired Outcome: Informed Workgroup	9:15 Lara Dronjack (U. Rovira i Virgili)

3.	**Information: Developing a Statewide Plastics Monitoring Strategy** The workgroup will hear an update from the California Ocean Protection Council on plans to implement a future Statewide Plastics Monitoring Network. Recently funded projects include support for SFEI to develop a report that outlines the priority management questions, monitoring strategy, and monitoring plan developed through a rigorous stakeholder input process. Additionally the Southern California Coastal Water Research Project is funded to develop standardized field sampling methods. OPC is also conducting a research call for studies that will inform microplastic contamination sources, ecological sensitivity, removal efficacy via low impact development. Desired Outcome: Informed Workgroup	9:30 Kaitlyn Kalua (OPC)
4.	**Discussion: MPWG Management Questions** The workgroup science lead will present recommended revisions to the MPWG Management Questions that will inform the RMP MPWG Strategy Revision and the MPWG Multi-year Plan. The workgroup will review and finalize revisions that will guide the future direction of the program. Meeting materials: MPWG Management Questions, page 20 Desired Outcome: Decision to finalize revisions to MPWG Management Questions that will be incorporated into the RMP MPWG Strategy Revision and Multi-year Plan	9:55 Diana Lin
	Short break	10:40
5.	**Discussion: MPWG Strategy Revision Process** The workgroup science lead will present a draft outline for the RMP MPWG Strategy Revision and process. The workgroup will provide feedback on key management drivers and microplastic information needs that will guide the MPWG Multi-Year Plan. Meeting materials: MPWG Multi-Year Plan, page 21-22 Desired Outcome: Feedback on management drivers, information needs, and the suggested report outline and process.	10:55 Diana Lin
6.	**Information: Microplastics Monitoring in Southern California Bight and Sample Collection Standardization** The workgroup will hear an update from the Southern California Coastal Water Research Project on microplastics monitoring in the Southern California Bight. Bight monitoring efforts will be leveraged to provide sample collection for the OPC and State Water Board-funded project to	11:25 Leah Hampton (SCCWRP)

	develop standardized field sampling methods for stormwater, sediment, ambient water, and biota. Desired Outcome: Informed Workgroup	
7.	**Information: Microplastics Transport in Stormwater** The new MPWG advisor will share work relating to monitoring microplastics and tire-wear particles in stormwater systems, including considerations about how shape and density affects transport and fate. Desired outcome: Informed Workgroup	11:55 Barbara Becking-ham (C. Charles-ton)
	Lunch	12:15
8.	**Information: Investigating Microplastics Sources** The workgroup will hear an update on investigations to identify microplastic sources. Desired Outcome: Informed Workgroup	1:15 Chelsea Rochman (U. Toronto)
9.	**Summary of Proposed MPWG Studies for 2023** SFEI staff will present microplastic proposals. 2023 Proposals include: ● Microplastics in urban stormwater runoff pilot (RMP special study proposal) ● Size distribution of microplastic particles in San Francisco Bay (SEP) Meeting materials: Proposals, pages 23 - 31	1:35 Diana Lin, Ezra Miller
10.	**Discussion of Recommended Studies for 2023** 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.	1:50 Rebecca Sutton
11.	**Closed Session - Decision Recommendation for 2023 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.	2:30 Eric Dunlavey

	For this agenda item, the MPWG is expected to decide (by consensus) on whether to recommend the special study study to the TRC. 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 whether special study proposal should be funded in 2023.	
12.	**Report Out on Recommendations**	3:00 Eric Dunlavey
	Adjourn	

RMP Microplastic Workgroup Meeting

April 20, 2022 (remotely held meeting)

Meeting Summary

Advisor

Name	Affiliation/Roles	Present
Chelsea Rochman	University of Toronto	Yes

Attendees:

Adam Wong (SFEI)
Alicia Gilbreath (SFEI)
Artem Dyachenko (EBMUD)
Bridgette DeShields (Integral)
Carlie Herring (NOAA)
Chris Sommers (EOA)
Diana Lin (SFEI)
DJ Alejandro (SFSU)
Don Yee (SFEI)
Eric Dunlavey (City of SJ)
Erica Senyk (Applied Marine Sciences)
Ezra Miller (SFEI)
Jay Davis (SFEI)
Jeremy Conkle (Texas A&M Corpus Christi)
June-Soo Park (DTSC)
Kaitlyn Kalua (OPC)
Kelly Moran (SFEI)
Kevin Lunde (SFBRWQCB)
Kevin Messner (Association of Home Appliance Manufacturers)
Kristen Isom (EPA Region 9)
Krystle Wood (Materevolve)
Lara Dronjak (DTSC),
Leah Hampton (SCCWRP)
Lisa Erdle (5 Gyres)
Liz Roswell (LACSD)
Lorien Fono (BACWA)
Luisa Valiela (EPA Region 9)
Maggie Monahan (SFBRWQCB)
Martin Trinh (SFEI)
Mary Lou Esparza (CCCSD)
Melissa Foley (SFEI)
Miguel Mendez (SFEI)
Miriam Diamond (University of Toronto)
Monica Arienzo (Desert Research Institute)
Rebecca Sutton (SFEI)
Sakereh Carter (SWRCB)
Sami Harper (SFBRWQCB)
Scott Coffin (SFBRWQCB)
Simona Balan (DTSC)
Simret Yigzaw (City of San Jose)
Sriram Gopal (Association of Home Appliance Manufacturers)
Steph Karba (Patagonia)
Steve Weisberg (SCCWRP)
Susan Brander (Oregon State University
Sutapa Ghosal (CDPH)
Tan Zi (SFEI)
Violet Renick (Orange County Sanitation)
Xin Xu (EBMUD

1. Introductions and Goals for This Meeting

Melissa Foley 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. She also introduced the guidelines for inclusive conversations. Melissa then introduced the Workgroup's advisor, Chelsea Rochman. After a brief roll call, Melissa reviewed the day's agenda and communicated the goals for the day, emphasizing the roles of advisors, experts, and stakeholders in providing input on the upcoming Microplastics in Dryers proposal and priority management questions that will guide future multi-year planning and special studies. Updates were given on relevant microplastic findings, particularly those involving the San Francisco Bay.

2. Information: Microplastic Workgroup Strategy

Diana Lin explained that the Microplastic Strategy update would be a review of key findings from previous microplastic studies and highlight a few relevant non-RMP microplastic activities that inform the RMP MPWG Strategy. Diana emphasized that all the non-project work described in this Strategy Update is supported by RMP Microplastic Strategy funds, which is even more important in the coming years where there are limited funded microplastic projects.

The most recent Bay microplastic monitoring was completed in 2017, and is still often cited as the most comprehensive microplastic study completed to date. Microplastics were monitored in Bay surface water in the wet and dry season, neighboring marine sanctuaries, sediment, preyfish guts, and bivalves. Key findings included that fibers made up a majority of the samples in all ambient Bay matrices and average microplastic concentrations in Bay stormwater runoff were two orders of magnitude greater than average wastewater effluent concentrations. This finding strongly supports the conclusion that more microplastics are transported through urban stormwater runoff compared to wastewater. Therefore, management actions that address sources and pathways of microplastics contributing to urban stormwater runoff would be more effective than management actions focused solely on those entering wastewater. The composition of the stormwater samples overall was 85% tire particles and fibers. Several other studies support our findings that tire wear particles are one of the dominant sources of microplastics to the environment. Chemical ingredients have been shown to leach out of these tire wear particles, causing acute toxicity in some fish species. There are many science investigations on this topic at the moment. Susanne Brander of Oregon State University and Kelly Moran of SFEI will present on tire toxicity and priority data needs during later agenda items today. There is less research being done on other sources and pathways of fibers to urban runoff. SFEI's literature review and conceptual models of microplastic sources and pathways to urban stormwater highlight that air deposition is likely a major transport pathway to stormwater. Unfortunately, prioritization of the major outdoor sources of fibers are still unclear.

Monica Arienzo will present studies suggesting clothes dryers as a possibly significant release pathway. Diana noted that the US and Canada rely much more heavily on tumble air dryers compared to the rest of the world where clothes are more commonly hung out to dry.

Diana highlighted last year's health effects workshop convened by the Southern California Coastal Water Research Project (SCCWRP), where several experts developed a framework and approach for identifying several risk thresholds for managing microplastics. Susanne Brander, Chelsea Rochman, and SFEI's Ezra Miller were part of the health effects workshop.

Diana outlined a few external RMP projects relevant to developing the RMP's MPWG Strategy. Through Senate Bill 1263, the Ocean Protection Council is taking a leadership position on understanding MP impact and developing a statewide strategy to mitigate risks. Senate Bill 1422 required the State Water Board to develop a definition of microplastics in drinking water, becoming the first US agency to do so. This definition has also been adopted in the Statewide Microplastics Strategy. SFEI provided data and comments during the development of this definition.

During last year's September MPWG meeting, Scott Coffin from the State Water Board presented an approach to microplastic risk characterization that is based on the thresholds from the SCCWRP workshop and the San Francisco Bay monitoring data. This analysis is summarized in a draft manuscript that was shared with the MPWG last week via email and final comments from the RMP were requested.

Other microplastic activities include the Pacific Northwest Consortium on Plastics, which has a subgroup developing a draft manuscript discussing tires as a complex contaminant. SFEI staff are co-authors on the tires manuscript, and a large portion of the manuscript is based on SFEI's Stormwater Conceptual Model report funded by OPC. The CA Ocean Litter Strategy (OLS) working group had many objectives supported by the SF Bay Microplastics Study. Additionally, SFEI staff have been attending and presenting at multiple SETAC conferences.

The Save Our Seas Act 2.0 requires a microfibers report to Congress, which is being led by Materevolve and the EPA Trash Free Waters Program; Diana Lin is a science advisor. On the monitoring side of things, SCCWRP and CASA are currently conducting wastewater studies to measure wastewater removal efficiencies and inform improved collection and analysis methods. Additionally, the CA Water Monitoring Council Trash Monitoring Workgroup Microplastics Subcommittee is developing a microplastics sampling playbook. Tan Zi of SFEI's Sources, Pathways, and Loadings Workgroup is leading a project to develop a strategy on how to use various models and pilot projects to better support multiple workgroup management questions about chemicals and particles in the Bay. Finally, Win Cowger of the Moore Institute for Plastic Pollution will be leading a project to develop the first open-source data analysis and data sharing portal for microplastics. SFEI is a collaborator on the project.This project is important for sharing and reporting microplastics data because current public databases are inadequate for reporting microplastics.

To wrap up the item, Diana reviewed the RMP priority management questions based on feedback from RMP stakeholders during the September MPWG meeting. The highest priority question identified by stakeholders is understanding the sources, pathways, loadings, and processes leading to microplastic pollution in the Bay. Past studies have demonstrated atmospheric deposition as a key data gap in understanding the most important microplastic sources and pathways and is crucial to informing management actions. This data gap is a key driver behind this year's special study proposal. Lower priority management questions include examining the extent of microplastic pollution in the Bay, the associated health risks, and corresponding management actions that could reduce pollution.

Finally, Diana emphasized the importance of RMP MPWG strategy funds to allow SFEI and the RMP to stay engaged in the rapidly developing field of microplastics. MPWG Strategy funds support SFEI staff to identify and communicate priority information needs to inform management about Bay priorities, identify data gaps, learn and apply most current methods, and
identify funding opportunities and collaborations to address RMP microplastic priorities.

To open the discussion, Sutapa Ghosal inquired about the possibility of replacing single use plastics with non-plastic alternatives. Diana commented that statewide policies to reduce single use plastics are working towards this goal. Chelsea Rochman recommended analyzing sportfish samples that have been previously archived to inform microplastic risks given the uncertainties on the effects of microplastics in wildlife and human health. She also suggested additional ambient monitoring to inform risk characterization. Jeremy Conkle inquired about whether wind was a variable investigated in SFEI's proposed study. Diana responded that while she agrees this is an important topic for investigation, this is currently not in the scope of the upcoming dryer proposal.

3. Information: California Microplastics Strategy

Kaitlyn Kalua from the Ocean Protection Council (OPC) gave an update on the ongoing Statewide Microplastics Strategy. Kaitlyn reviewed various efforts by the California OPC such as the California Ocean Litter Strategy (2008, updated in 2018), the Interagency Plastic Pollution Steering Committee (facilitated by OPC), Top 10 Recommendations to Address Plastic Pollution in California's Coastal and Marine Ecosystem (2021), and the Statewide Microplastics Strategy (2022). Senate Bill 1263 required OPC, in close coordination with agency partners, to adopt a Statewide Microplastics Strategy with the goal of increasing the State's understanding of the scale and risk of microplastics on the marine environment, and to identify early actions to address impacts of microplastics. OPC must develop and submit the Statewide Microplastics Strategy to the Legislature on or before December 31, 2021, and to report findings and additional policy recommendations to the Legislature by December 31, 2025.

Kaitlyn highlighted two SFEI reports, "Understanding Microplastic Levels, Pathways, and Transport" (2019) and "A Synthesis of Microplastic Sources and Pathways to Urban Runoff" (2021) that were important to informing the Statewide Microplastics Strategy. SFEI found stormwater to be a major contributor to microplastics, with estimates that stormwater is a pathway for trillions of microplastic particles into the Bay annually, dwarfing the estimated billions of microplastics contributed by wastewater annually. Agricultural soils and aerial deposition are major data gaps. The OPC Science Advisory Team has recommended a precautionary approach to assessing risk and managing microplastics, as well as using a particulate approach until chemical effects are better understood to support using a toxicant approach. The Statewide Microplastics Strategy is a two-track approach with Track 1 focusing on current early action solutions and Track 2 emphasizing promoting science to inform future action.

Track 1 addresses pollution prevention by eliminating plastic waste at the source, intervening at pathways and the mobilization of microplastics into California waters, and increasing outreach and education by informing the public and industries of microplastics sources, impacts, and solutions. The OPC recommends implementing comprehensive statewide plastic source reduction, reuse, and refill goals as well as the regulation of sale and use of expanded polystyrene, intentionally added microplastics for specific consumer products, and single-use plastic products. OPC also identified priority sectors that could advance product alternatives such as vehicle tires, textiles, agriculture, foodware, packaging, fisheries, and aquaculture. Kaitlyn outlined how OPC envisions intervening at different pathways. For stormwater, OPC recommends including low impact development (LID) requirements in relevant coastal development permits, intercepting trash and plastic debris in 'trash hot spots' (high use beaches, recreational areas, and encampments adjacent to waterways, and enforcing existing trash and 'nurdle' discharge prohibitions), finalizing a Statewide Trash Provisions compliance deadline of 2030. Kaitlyn stressed the need to identify which best management practices are most effective. For wastewater, OPC recommends focusing on supporting recycling wastewater, upgrading facilities, and preventing pollution. The final objective of Track 1 is focused on community outreach and education. The OPC has worked to increase engagement with California Native American Tribes and other disproportionately burdened communities. Public awareness campaigns and educational programs on microplastic sources, impacts, and solutions will be initiated. Finally, industry members must be engaged to advance sector-specific pollution prevention strategies.

For Track 2, Kaitlyn stressed that monitoring will inform risk thresholds, which will help with source and pathway prioritization leading to new solutions. To address monitoring needs, OPC recommends standardizing and accrediting microplastic monitoring sampling and analysis as well as piloting a model monitoring program and monitoring programs for agricultural soils, biosolids, and runoff. These efforts will inform future stormwater and wastewater monitoring requirements. To assess risk thresholds, OPC will work to update the existing risk assessment framework and implement risk assessments based on local microplastic monitoring data, while engaging with California Native American Tribes and communities disproportionately burdened by environmental injustice to conduct risk assessment of microplastic impacts. Microplastics water quality objectives will be developed and water body impairments will be identified in the California Integrated Report. In the process of prioritizing sources and pathways, microplastics will be quantified and characterized from urban stormwater, wastewater, agricultural runoff, and aerial deposition. A source emissions inventory will be created to quantify the most prevalent statewide sources. All of these findings will inform additional policy recommendations to the legislature by December 2025. Kaitlyn then provided a timeline of these proposed efforts.

OPC has identified key funding priorities, which involved completing both a wastewater microplastic removal efficacy study and low impact development efficacy study, standardizing monitoring methods, developing the model monitoring network, and compiling a source emission inventory. Key statewide information gaps are microplastics in agricultural soils and runoff, biosolids, and aerial transport. This Statewide Microplastics Strategy could be a model for national and international actions.

To open the discussion, Luisa wanted clarity on what would be completed by 2025. Kaitlyn explained that a model monitoring network will be in place by then. Initial data and analysis from this effort will inform the policy recommendations. Chelsea Rochman inquired about developing standard methods for measuring levels in drinking water and if these methods will be adopted in the field. Kaitlyn clarified the difference between standard methods for “dirty” water and drinking water. Steve Weisberg added that there is a legislative mandate to develop a clean water method. This was not the case for fish and other biota, but these methods were developed with this obligation in mind. EPA is working on developing sediment methods. Chelsea suggested that she thinks governments should prioritize providing funding to agencies and labs to implement long-term monitoring, over funding academics to conduct research, which seems to be where most of the funding is going. Kaitlyn agreed. Jay Davis requested more specificity about upcoming funding. Kaitlyn stated that OPC has committed a flat sum of $3 million to support monitoring, finding alternative materials, and other related efforts to implement the Statewide Microplastics Strategy.

4. Information: The Biological Impacts of tire micro/nanoparticles and microfibers on growth and swimming behavior in coastal species, and the implications

Dr. Susanne Brander from Oregon State University presented ongoing efforts related to risk and toxicological assessment of microplastics. She discussed the exponentially growing research on plastics, highlighting the importance of size and shape as well as the toxicity of certain microplastics. Susanne noted that most of the data is on commercially available particles rather than microplastics found in the environment. To address the need to test so many combinations of microplastic size, shape, associated additives, and concentrations, high throughput testing should be considered. Susanne gave a brief review on tire particles which are complex mixtures of synthetic polymers, natural rubbers, carbon black, polyester and nylon fibers, chemical additives, petroleum, and pigments released into the environment by mechanical abrasion. The Brander and Harper labs have created micro and nano particles to mimic the complexity of microplastics in the environment. They have been able to test fibers, tire wear, polylactic acid (PA), polypropylene (PP), and polyethylene terephthalate (PET) for toxicity and non-lethal effects.

Susanne presented her lab's study measuring the effects of microfiber particle exposure on two estuarine species' behavioral responses, growth, biochemical changes, observed distance moved, in zone duration, meander, and turn angle using a video tracking system. The study was conducted on inland silversides and mysids across three different particle concentrations and three salinities. Mysids were exposed over seven days and silversides over four days. There was a difference noted for ingestion rates between solutions of different salinities, perhaps affected by changes in how long particles stayed in suspension. Future studies will investigate the sinking rates of different polymers. Fish exposed to both size fractions of tire wear particles across salinities had increased time in central habitat (in zone). This may indicate stress response, increased exploration or indiscriminate feeding behavior. This changed behavior could lead to an increased risk of predation for larval fish as swimming behavior is critical for defense, food acquisition and social activity, e.g., schooling and shoaling behaviors. Leachate affected more behavior variables, but the actual size of the effect (distance from control) for most endpoints was relatively small compared to the size of the effects from particle exposure. The growth of mysids was affected by the agglomeration of tire particles in organisms. Overall, ingestion of tire wear particles reduced growth and altered behavior of the studied organisms in ways that may make them more prone to predation while simultaneously less able to find prey.

The fibers tested in the study consisted of cotton, polyester, and propylene. They confirmed the internalization of fibers by using reagents that show pigments in transparent organisms (fish more so than shrimp). Fibers were present in the gut and intestine, but appeared smaller than the original fibers, indicating the fish were breaking them down. There was more difficulty observing these fibers in the shrimp, indicating the mysids were better at masticating and breaking down the fibers. Susanne detailed the UV weathering process that allowed lab-made microfibers to imitate the weathered and worn microfibers found in real world conditions. Newer particles had a larger impact on growth than weathered particles, although the previous literature suggests otherwise. Mysid and silverside behavior were affected by all three fibers, with polyester and polypropylene having a larger observed impact on both taxa. Silverside behavior was affected by the microfibers more than mysid behavior. Silverside and myside growth were reduced following the ingestion of synthetic microfibers, particularly at a concentration of 15 parts per trillion. Susanne concluded the presentation with a Bayesian network model for tire particles effects onoutmigrating Chinook salmon smolt and northern anchovy, using data from SFEI, OSU, and CDFW. The model can run analyses to see which variables have the most affect over the output, such as matrix, region, and varying concentration.

To open the discussion, Chelsea noted some similarities and differences in observed behavioral effects to past studies. Don Yee recommended looking at synthetic cellulose as a potential fiber type. Luisa inquired about next steps. Susanne noted that the study found greater effects at smaller concentrations of fibers, so future studies will focus on these ranges. The link between anxiety and food ingestion will be further studied. Miriam Diamond observed a key challenge is the high variability of different fibers since there are not standard materials to use for toxicity testing. She noted a need for non-target chemistry analysis and funding.

5. Information: Tires Strategy Update

Kelly Moran of SFEI gave an update on the ongoing RMP Tires Strategy. She introduced the topic by highlighting recent RMP activity such as the OPC and RMP funded report “Synthesis of Microplastic Sources and Pathways to Urban Runoff” (2021). She emphasized that prevention is generally more effective and less costly to the whole society than remediation. For managing tire wear particles, this approach would emphasize the effectiveness of prevention by eliminating tire wear particles and removing toxic ingredients rather than focusing on remediation. Such efforts could be achieved by influencing tire manufacturer, vehicle manufacturer or fleet manager actions rather than waiting for the government and population to act. Kelly highlighted pro bono work by the UC Berkeley BEACN team, a diverse undergraduate sustainable business-oriented team who conducted background research to understand the tire market and help inform SFEI's interpretation of tire-related publications as well as the selection of a set of tires for scientific studies of tire tread materials. Kelly then noted the large volume of requests for microplastics presentations by the RMP at various conferences and agency briefings. Kelly highlighted occasions in which microplastic presentations were the most attended events in the conference, indicating the growing interest in the field, particularly for tire particles.

Kelly highlighted the quickly growing field of tire research. There have already been more papers on tires published in 2022 than all of 2021, with aquatic toxicology being the major focus of work. Kelly highlighted a recent study on the acute toxicity of tire rubber-derived chemical 6PPD-quinone to fishes of commercial, cultural, and ecological importance. Of note is the recent finding of 6PPD-quinone acute toxicity to rainbow trout which are genetically identical to the steelhead trout, which migrate through the Bay. Kelly highlighted three different wear debris collection system prototypes, each using different methods to capture tire particle release. Two of these companies are currently conducting on-track testing, with the Tyre Collective expressing interest in a Bay Area fleet on-road pilot. Please contact Kelly if you know of any organization/vehicle fleet that might want to participate in this pilot.

A key information gap for tire particles is the lack of sampling of nanoparticles. Current microplastic sampling methods typically detect a size range of 125 to 10,000 microns, thus generally missing most tire particles, which are primarily smaller 100 microns, with many in the nanoparticle size range. Any particle under two microns will pass through a filter, like the ones used in analytical labs to prepare "dissolved" samples for chemical measurements. Larger particles will fall closer to the road, while the smaller particles can disperse via the air throughout communities and have the potential to pass through cell membranes. While these tiny particles may not compose a large fraction of the total mass of tire particles, they could potentially contain a large fraction of the particle surface area, which raises the potential for chemical release at each step of their environmental journey.

Kelly reviewed the preliminary 2021 Bay and stormwater monitoring data. Sites were sampled in the open Bay and near-field Bay, as well as urban stormwater and reference sites. Lack of storm events has produced a small but intriguing batch of data. The full dataset has not been fully reviewed for QA/QC, and so interpretation of results are preliminary. Preliminary results indicate detection of 6PPD-quinone and N, N'-diphenylguanidine (DPG) in runoff samples and in Bay nearfield sites post storm. Further toxicity testing of these compounds to rainbow trout and other species is in progress, so it is not yet clear whether the concentrations detected in the Bay are in the range of sublethal toxicity conditions. There is a growing body of toxicity evidence suggesting that tire wear particles and associated chemicals have potential to harm a broad array of aquatic organisms based on exposures that researchers believe represent environmentally relevant concentrations. The relevance of these toxicity data to San Francisco Bay cannot be fully assessed, as we do not have local tire wear particle concentration data.

The RMP Tires strategy funded by the MPWG last year is more accurately described as a five-year plan that will serve as a short-term supplement to RMP's existing Multi-Year Plan for CECs (ECWG), microplastics (MPWG), and Sources, Pathways and Loadings (SPLWG). The strategy will answer priority questions for the next five years, while informing relevant management policies and decisions. A draft five-year plan is anticipated to be ready for review by mid-year. The timeline of the plan is constructed around anticipated upcoming management decisions, including DTSC Safer Consumer Products Program Workplan implementation (which includes tire chemicals and microplastics), the tires sector pollution prevention strategy envisioned in the Statewide Microplastics Strategy, and the US EPA Trash Free Waters Tires workplan. Kelly Moran asked for feedback on any additional relevant anticipated management decisions in the next 5 years. Kelly also asked for feedback on the draft management question for the Tires Multi-Year Plan: Do tire contaminants have the potential to adversely affect beneficial uses in San Francisco Bay? The feedback from RMP leadership last year was to focus on tire chemicals in the Bay (rather than tire particles and rather than upstream concentrations) but more recent feedback from the Emerging Contaminants workgroup seems to allow more flexibility on this. The tentative five-year special studies plan will continue monitoring known chemical groups in the wet season, while identifying new chemicals for monitoring in a few years. This data, along with tracking relevant literature, will help provide scientific information to management agencies. Kelly anticipates decreased science and management activity by 2028.

To open the discussion, Susanne inquired about the 6PPD-quinone testing on steelhead trout and whether it was done across different salinities or just freshwater. Different K_{ow}s could affect toxicity. Kelly clarified that the only studies done thus far have been conducted on rainbow trout in freshwater. Sutapa requested clarification about how the tire debris collection system companies reported collection data. Kelly answered that on road testers manually weighed and compared tires before and after trials and compared this data to the mass collected. The system from the Tyre collective can be retrofitted and installed while the Pureback Nexen is an entirely novel wheel design.

Chris Sommers acknowledged that tires are an area of high public interest, and he supported continued RMP work on this topic. He cautioned against a full pivot to focusing on chemicals at the expense of particle work, wanting to be a strong voice for a continued focus on both chemicals and particles. Until research shows it is not an important issue, Chris thinks that particle research should continue to be funded at a modest level. It is important to have a place to consolidate this information and the RMP should continue to be a leader here. Kaitlyn inquired about the extent of DTSC involvement in monitoring as their effort is not specific to the San Francisco Bay. Kelly clarified that DTSC does not have any budget for monitoring. Melissa clarified that the Tires Strategy/Multi-year Plan is not asking for any additional funding for the upcoming year, but will finish this draft strategy this summer and come back in future years for additional funding. Chelsea also agrees with Chris' feedback that particles should continue to be studied and prioritized in addition to tire derived chemicals.

6. Information: Are clothes dryers a source of microplastics in the environment?

Monica Arienza from the Desert Research Institute (DRI) gave a presentation on recent studies on microplastics from clothes and dryers. Synthetic fibers make up to 14% of global plastic production. Prior studies have shown that clothes washing results in the emission of microplastic fibers with some studies estimating that up to 5.6 megatons of synthetic micro-fibers were emitted from apparel washing between 1950 and 2016 (Gavigan et al., 2020). Many studies have focused on the contribution of clothes washing to microfiber but tumble dryers have been understudied as a potential source of microfibers to the atmosphere. Fibers have been identified in San Francisco Bay urban runoff with monitoring levels finding fibers to be the second most common particle type composing 39% of all particle counts (Sutton et al., 2019). At present, it is not possible to determine which sources are the predominant contributors of fibers to urban runoff. A handful of studies have started looking at fiber emissions from dryers, and these studies suggest that fibers emitted from dryers may be greater than from washing machines

Monica concluded the item by presenting on DRI's citizen science project. DRI recruited individuals through the League to Save Lake Tahoe and asked participants to install a "lint catcher" on their dryer exhaust. Citizen scientists recorded their two largest items they dried and what it was made of through a software application for one month, with the full study recording 115 dryer loads in total. Pants, sheets, and towels made up the bulk of the loads with cotton and polyester being the primary materials. Both synthetic and natural fibers were detected. Collectively these studies show that clothes dryers may be an underappreciated source of fibers to the environment.

7. Discussion: Proposed Microplastics Study

Diana Lin presented the proposed microplastics special study for 2023, studying fiber emissions from household dryers to estimate loads to urban stormwater and the Bay. The goal of this study is to assess whether dryer emissions are a significant source of fibers to urban stormwater and the San Francisco Bay. Understanding the relative importance of dryers as a source of microplastics is important to inform local, state, and national management actions that can significantly mitigate microplastic pollution. This effort will also inform the aforementioned Statewide Microplastic Strategy, and could support a state approach to promote condenser dryers, the development of a source emissions inventory, and understand the relative importance of aerial deposition as a microplastic pathway to the ocean. The proposed study has identified a unique opportunity to leverage ongoing studies and third-party funding to investigate this data gap. The 5 Gyres Institute will also be implementing a small-scale study to sample emissions from a few laundromats in the Bay region. Their study can inform sample collection methods and the number of sampling locations needed, while scoping potential sampling locations. Patagonia has committed to funding $25k for the first year of the project, with additional funding possible for future years.

This is proposed to be a multi-year study. Year 1 would characterize dryer use and develop an initial conceptual model for dryer emissions to urban runoff. Sample collection and analysis methods will be piloted before implementing the full study. Study partners and sampling locations (diverse residences and laundromats) will be identified and sampled. Sampling from residential locations is planned for Year 1. Sampling from laundromats is planned for Year 2, along with laboratory and data analysis of all samples. Year 3 includes the refinement of the conceptual model and conducting computational modeling to extrapolate measured results to estimate Bay loads to stormwater runoff. Results will be interpreted and reported in context of previously reported microplastic loads to the Bay.

The study seeks to identify diverse sampling locations and collect multiple loads from each location to capture a realistic range of dryer emission rates. The study would include single unit (residential and multi-family) homes and multiple unit (laundry room and laundromat) facilities. The exact number of sample locations may depend on study partners identified to sample multiple unit laundry facilities. Fiber counts and mass will be analyzed and polymers will be identified using FTIR. Particle counts will be compared to the mass of fibers collected, and measured mass and particle emission rates will be calculated from each "load." SFEI staff will extrapolate measured dryer emissions to Bay stormwater runoff, and include fiber wash off fraction and model sensitivity analysis. Washoff fraction will be a first-order estimate as no one has done fiber wash off studies to date. The Microplastic Workgroup would receive annual updates on the project for the next three years, culminating in a final report or manuscript in July 2025. The request for funding from the RMP for 2023 is for $71.5k, which will fund the first year of work supplemented by a $25k contribution from Patagonia that has already been received. Additional funding to complete the study is $182.6k, and the team is working to obtain external funding sources for the remaining budget.

To open the discussion Diana clarified that the study will use a mesh size of 100 microns which has worked well for stormwater measurement, but the minimum size could be modified. Kevin Messner of AHAM advised the study should use homes/facilities with proper ducting, rather than the accordion and consider how often lint traps are cleaned as well as the age of the dryers (as energy efficiency has dramatically increased). With real residents in their daily lives, standard deviation will be extremely high. Diana clarified that the study design is meant to a diverse array of realistic scenarios, rather than very controlled scenarios. Maggie Monahan agreed with the importance of considering clothes dryers relative to other sources in the Bay, but cautioned that controlling variables across homes will be difficult. Chelsea Rochman voiced support for the study, noting that it will greatly contribute to ongoing statewide and international efforts.

Maggie Monahan (speaking for the SFBRWQCB and having discussed with Tom Mumley and Kevin Lunde prior to the meeting) voiced some concern about the scope of the project being funded by RMP resources. The SFBRWQCB does not feel the RMP should be responsible for shouldering the load for these efforts, as it competes with other RMP funds. They proposed limiting the project to a first-year pilot study. Eric Dunlavey expressed that he liked the scope of the project as well as the focus on sources, pathways, and loading and agreed it would be great to get something started to generate useful information at a smaller cost. Steph Karba of Patagonia noted that Patagonia approves of funding on a fiscal year basis so she cannot guarantee future funding, but reiterated that she will advocate to continue funding the project at $25K annually. Diana responded that the study scope was carefully designed to be able to answer the study question and have some level of confidence about whether the dryer source is small or large. Scaling down the study would severely limit our ability to answer the study question and inform management. Kelly added that this is a consideration of past feedback from the Waterboard and other stakeholders that were concerned about the ability to answer the big or small question with confidence. Additionally, the audience will be larger than just the RMP and will inform other work and decision making.

Due to time limitations, Melissa Foley took a quick verbal vote whether there was support for the study to continue to the TRC. Stakeholders provided support given that the issues raised earlier on the scope (one year vs multiple years and additional funding sources) would be communicated to the TRC.

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.

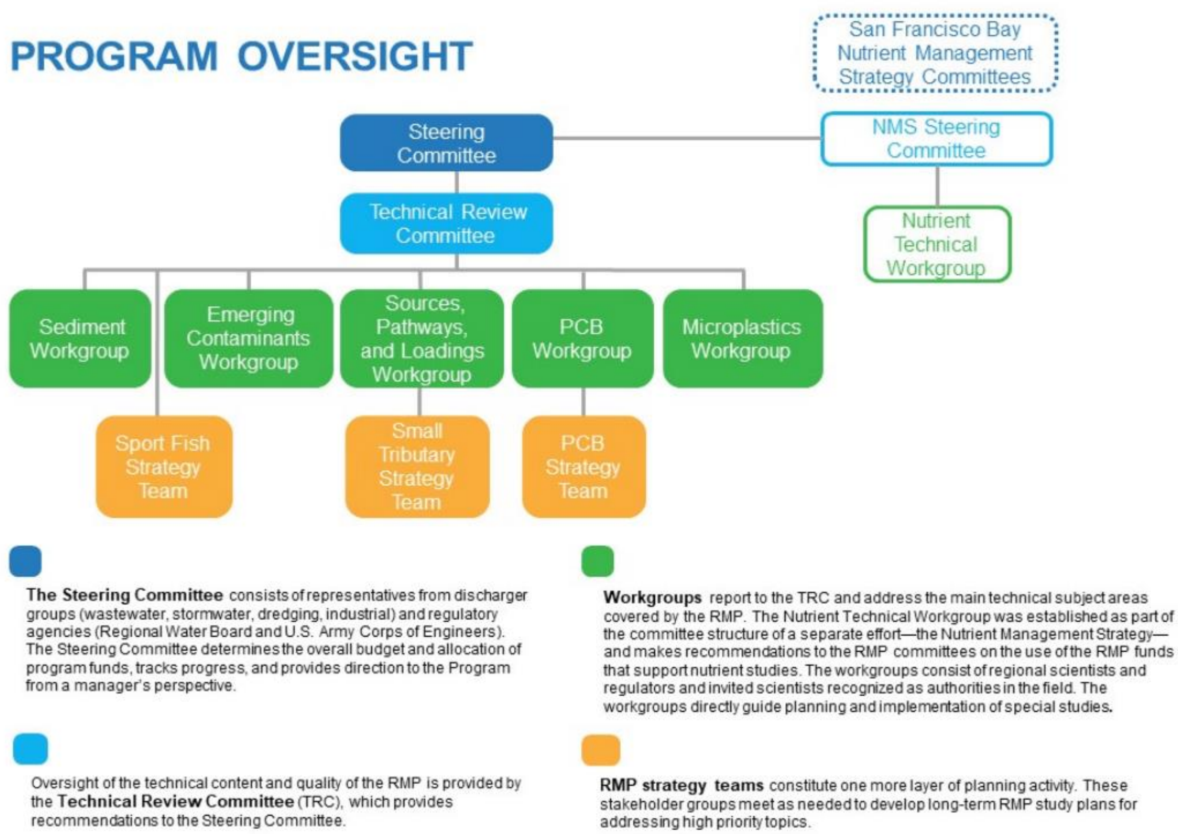
In order to fulfill the overarching goal of the RMP, the Program has to be forward-thinking and anticipate what decisions are on the horizon, so that when their time comes, the scientific knowledge needed to inform the decisions is at hand. Consequently, each of the workgroups and teams develops five-year 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.

Governance Structure for the
Regional Monitoring Program for Water Quality in San Francisco Bay

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



Current RMP MPWG Management Questions

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

Suggested revisions to MPWG Management Questions

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 microplastics levels changing over time? What are potential drivers contributing to changes?
4. What are the anticipated effects of management actions?

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)

State and regional 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.

And while fibers were the second most common class of microplastics observed in stormwater, there is minimal understanding of what are 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 both tire wear particles and fibers because both types of particles have characteristics that make them easily suspended in air and potential to be transported long distances. Other important data gaps remain including 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. How much microplastic pollution is in the Bay?
2. What are the health risks?
3. What are the sources, pathways, loadings, and processes leading to microplastic pollution in the Bay?
4. Have the concentrations of microplastic in the Bay increased or decreased?
5. What management actions could be effective in reducing microplastic pollution?

MULTI-YEAR PLAN FOR MICROPLASTICS: DRAFT March 2023

Microplastic studies and monitoring in the RMP from 2020 to 2025. 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.

Element	Study	Funder	Collaboration with other Workgroups	Questions Addressed	2020	2021	2022	2023	2024	2025
Strategy	Microplastic Strategy	RMP Patagonia/OPC		1,2,3,4,5	20 (30)	10	10	40 (200)	16 (200)	17
	Tires Strategy*	RMP	ECWG	1,2,3			25.5	10*	10*	10*
Monitoring biota	Bivalves	RMP		1,2						
	Fish	RMP								
	Assessing Information on Ecological Impacts	RMP NSF/CCCSD			(50)	18 (57.5)				
Monitoring water and sediment	Open Bay and Margins Sediment	RMP NOAA		1,2,3						25 *(50)*
	Surface Water: Bay and Sanctuaries									
	Limited particle size distribution analysis	SEP							(65)	
	Sediment core (archive, pro bono analysis)	RMP (U. Rovira I Virgili)				3.5		(20)		
Characterizing sources, pathways, loadings, processes	Wastewater	SCCWRP		1,3,5		(26)		(20)		
	Stormwater (method evaluation and monitoring)	RMP	SPLWG						65.8	51.4
	Stormwater Conceptual Model	RMP OPC			30 (30)	40 (90)				
	Air monitoring and air source investigations	RMP OPC/Sea Grant						(25)	(150)	(150)
	Tire market synthesis to inform science (pro bono)	UC Berkeley					(20)			
	Green stormwater infrastructure: Evaluating the efficacy of rain gardens	EPA/External					(62)	(62)	(62)	
RMP-funded Special Studies Subtotal – MPWG					**50**	**61.5**	**35.5**	**40**	**81.8**	**93.4**
High Priority Special Studies for Future RMP Funding									**65.8**	**51.4**
RMP-funded Special Studies Subtotal – Other Workgroups								**10**	**10**	**10**
Externally-funded Special Studies Subtotal					**110**	**173.5**	**82**	**327**	**477**	**200**
OVERALL TOTAL					**160**	**235**	**117.5**	**367**	**559**	**293.4**

‡ The RMP has submitted proposals for these projects. This MYP lists these potential funds, and will be updated to reflect the final funding decision relating to this proposal.

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

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 at a single depth, which is a more likely sampling scenario for any kind of automated sampling program. This proposed field study will take pilot steps to provide a better characterization of microplastics in urban stormwater runoff and inform estimates on the magnitude of loads to the Bay by taking simultaneous single-depth and depth-integrated samples at two field sites during one storm each and comparing the microplastics content of these samples using advanced laboratory techniques that characterize tire wear and other fine particles.

Estimated Cost:	$117,200 (Year 1: $65,800)
Oversight Group:	MPWG
Proposed by:	Diana Lin, Alicia Gilbreath, Kelly Moran, Tan Zi, Lester McKee, Rebecca Sutton (SFEI)
Time Sensitive:	Yes, inform statewide plastics monitoring strategy

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Develop conceptual model and refine study design	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	December 2025
Task 6. Final technical report	February 2025

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, primarily 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.

Another important 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, for suspended sediment stormwater sampling, the RMP has found that concentrations in many Bay Area channels are sufficiently well-mixed during storm flow events that it is a reasonable compromise to utilize single-depth sampling in the channel thalweg (deepest portion of channel) when vertical-integrated sampling is logistically not practical. Considering that microplastics are likely to have even slower settling velocities compared to suspended sediment (due to microplastics' 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 during storm events.

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 pilot different urban stormwater microplastic field sample collection approaches to 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 concentrations of microplastics in the Bay?	*Not applicable*	*Not applicable*
2) What are the health risks?	*Not applicable*	*Not applicable*
3) What are the sources, pathways, loadings, and processes leading to microplastic pollution 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) Have the concentrations of microplastics in the Bay increased or decreased?	*Not applicable*	*Not applicable*
5) Which management actions may be effective in reducing microplastic pollution?	*Not applicable*.	*Not applicable*

Approach

<u>Study design development</u>
First, we will briefly review and synthesize published literature and coordinate with other researchers investigating microplastics in stormwater flows to refine the study design. This includes making sure we are identifying the key gaps that have not been addressed by others and that will be most useful for informing RMP management questions. We will also make sure we are applying best practices and analytical methods for microplastic analysis.

In this pilot study, we will collect an initial set of samples to compare microplastic urban stormwater collection efforts at a single depth in the creek flow compared to vertically-integrated urban stormwater samples that are expected to be representative of water column concentrations. We will select two watershed sampling sites with the following considerations.

- High concentrations of microplastics in stormwater flows are expected based on previous monitoring or land use characteristics.
- Availability of information at the sampling location, including cross-sectional area, predicted depth ranges and flow velocities. Sites with channel size and shape that are representative of other watershed sampling sites in the region are preferred.
- Site analysis suggests well-mixed conditions are likely during typical storm events. This analysis will be informed by flow monitoring and hydraulic analysis, and published sediment transport tools and models adapted for microplastics. For example, Cowger et al., 2021, adapted Rouse profile (non-dimensional number in fluid dynamics used to define concentration profile of suspended sediment) analyses for microplastics by making assumptions of buoyancy and settling velocities, and sampling location characteristics. We can use such tools to derive theoretical mixing status of microplastic particles at different flow conditions for selected sampling sites.

<u>Urban stormwater sample collection</u>

The two selected sites will each be sampled once during a storm event. Microplastic urban stormwater samples will be collected using ISCO pumps, 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, and 20 µm sieves. The addition of the smaller sieves 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. Similar to previous approaches, samples will be collected by taking a series of “sips” during the rising and falling stages of a storm hydrograph to try to collect a representative urban stormwater sample. We will use the ISCO pump to collect samples at different depths as follows for each site (2 sites total) during one storm event.

- 2 depth-integrated samples collected in the channel thalweg
- 2 sets of 3 single-depth samples at varying depths (surface, mid-, near-bottom) in or near the channel thalweg, for a total of 6 single-depth samples

Best practices will be used to avoid sample contamination, including collection of field blanks.

<u>Microplastic analysis</u>

Samples will be processed in a clean lab by gently rinsing material collected on the sieves into a clean glass jar using Milli-Q water.

Microplastics, including tire-wear particles, will be extracted from sediment by density-separation. The mass of microplastics in each sieve, including tire-wear particles, will be weighed. A representative sub-sample from each sieve sample will be characterized for number of particles, morphology and polymer using FTIR and/or Raman spectroscopy. A subset of tire-wear particles will be confirmed using SEM-EDS or pyrolysis-GC/MS.

Since the science of microplastic and tire-wear particle analysis is rapidly evolving, literature review and coordination with other researchers will be essential to informing best practices and analytical methods.

Data interpretation

We will compare the measured concentration profiles with the derived theoretical profiles for the sample events to evaluate if conditions were expected to be well-mixed. We will also compare the levels and composition of microplastics in the samples collected at different depths with the vertically integrated sample. 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 to be outlined by the RMP Microplastics Strategy.

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	Year 1 Request
Labor			
Study design	164	28,100	28,100
Sample Collection	111	18,700	18,700
Data management	44	7,000	0
Analysis and Reporting	250	31,400	0
Subcontracts			
Laboratory analysis (Ocean Diagnostics or equivalent laboratory)	N/A	26,000	13,000

Direct Costs		
Honoraria - 1 science advisor	2,000	2,000
Equipment, supplies, shipping	4,000	4,000
Grand Total	**117,200**	**65,800**

Budget Justification

Study design
SFEI staff will conduct literature review and coordinate with other researchers investigating microplastics in stormwater to refine the study design and data analysis. Hours are also included for site reconnaissance and data analysis for selected sites to provide a rough estimate of mixing processes based on anticipated flow conditions.

Sample collection
SFEI hours are estimated to staff 2 storm sampling events with three staff members. This includes staff time needed for monitoring and preparing for sampling events.

Data management
Data management services include recording field collection information, communication with the laboratory, and QA review. Data will not be uploaded to a public database.

Analysis and Reporting
SFEI hours are estimated for microplastic data analysis, as well as post-event data analysis to derive microplastic concentration depth profiles for the sampled event and compare to measured concentrations. 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 $1,300/sample for 20 samples (16 field samples + 4 field blanks).

Direct Costs
Direct costs will cover equipment, supplies, and shipping costs.

Reporting

Deliverables will include a draft and final technical report.

References

Cowger, W., Gray, A. B., Guilinger, J. J., Fong, B., & Waldschläger, K. 2021. Concentration Depth Profiles of Microplastic Particles in River Flow and Implications for Surface Sampling. *Environmental Science & Technology*, 55(9), 6032–6041. https://doi.org/10.1021/acs.est.1c01768

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SEP Proposal
Size Distribution of Microplastic Particles in San Francisco Bay

Study Budget, Total: $65,000 - $105,000

SFEI Contacts: Ezra Miller (ezram@sfei.org) and Diana Lin (diana@sfei.org)

Analytical Laboratory Partner: Ocean Diagnostics or other suitable laboratory

Study Description

MPWG Management Question 2 asks, “What are the health risks of microplastics in San Francisco Bay?” Accurate assessment of potential risks from microplastics requires holistic exposure data to compare directly to ecotoxicological thresholds. Although our previous monitoring in San Francisco Bay (Sutton et al., 2019) remains one of the most comprehensive microplastics monitoring data sets, the more reliable surface water data were collected by manta trawl using 355 µm mesh nets, which underestimates the abundance of microplastics smaller than the mesh size.

Most microplastic surface water monitoring data are based on particle sizes greater than 355 µm, but what is known about microplastic toxicity is based on much 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 threshold. However, this risk characterization study has large amounts of uncertainty, as the size distribution models are based on very limited data sets in which data were partly picked to fit the model, had limited to no QA/QC, and were relatively limited in geographic scope. 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 a significant need to evaluate the particle size distribution of microplastics in San Francisco Bay to assess the validity and uncertainty of using these models to conduct risk characterization. Understanding the particle size distribution will also help inform future RMP monitoring and study design and science needs. The goal of this study is to collect and evaluate the size distribution of San Francisco Bay surface water microplastics to inform more accurate estimates of microplastic levels in the Bay and future exposure assessments. In addition, this study will help evaluate field sampling methods to better design future monitoring efforts.

The proposed approach is to collect up to nine surface water samples and nine sediment samples from within San Francisco Bay. Samples will be collected in triplicate from three water sites from different subembayments (North, Central, and South Bay) using a modified pump sampling method to collect sufficient water volume through a 10 µm filter to overcome blank contamination issues. If more funding is available, samples will also be collected in triplicate from three sediment sites (one ambient, two margins) using a modified Van Veen sediment grab. Samples will be extracted 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 at each site and across sites will be determined. 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 microplastic exposure and risks. The amount of variation among and between sites will also be used to inform future microplastic monitoring design.

The deliverable for this project would be a final draft short manuscript that will be submitted for peer-review publication.

Budget:

The SFEI labor budget is estimated to be between $55,000 - $80,500. This includes staff time required to develop study design, gather sampling equipment and materials, collect samples, ship samples, data management, data analysis, and reporting of data in a draft and final draft manuscript submitted for publication. A budget on the lower end includes sampling of the water matrix only, while a budget on the higher end includes water and sediment sampling and analysis.

The analytical budget is estimated to be between $7,000 - $17,500. This is based on an estimated cost of $700/sample and analysis of 10 - 25 samples (including QA/QC samples) for water and sediment.

Direct expense is estimated to be between $3,000 - $7,000. This includes equipment and supplies costs needed to collect samples, sample containers, and shipping costs to send samples to the analytical laboratory.

References

Coffin, S., Weisberg, S. B., Rochman, C., Kooi, M., & Koelmans, A. A. (2022). Risk characterization of microplastics in San Francisco Bay, California. *Microplastics and Nanoplastics*, *2*(1), 19. https://doi.org/10.1186/s43591-022-00037-z

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