# Special Study Proposal: Development of a Stormwater Conceptual Model for Microplastics

Summary: In the fall of 2019, SFEI will complete a three-year project to characterize microparticles and microplastics in San Francisco Bay, funded by the Gordon and Betty Moore Foundation and others. The project provides information to address many of the management questions articulated in the RMP Microplastic Strategy. A key element of this project was to characterize microplastics in stormwater. The findings suggest that the stormwater pathway contributes more than 200 times the number of microparticles than the wastewater pathway. Given this significant contribution, the Microplastics Workgroup recommends the development of a stormwater conceptual model for microplastics. This proposal is to fund that conceptual model development over a two-year time frame.

Estimated Cost: $60,000 over 2 years

Oversight Groups: Microplastic Workgroup (MPWG) and Sources Pathways and Loadings Workgroup (SPLWG)

Proposed by: Alicia Gilbreath, Meg Sedlak, and Rebecca Sutton (SFEI)

Time sensitive: No. However, this conceptual model will include a survey of data gaps and development of a framework that will inform future monitoring, which could begin as early as Water Year 2021 if this conceptual model were largely developed in 2019-2020.

### PROPOSED DELIVERABLES AND TIMELINE

| **Deliverable** | ***Due Date*** |
|---|---|
| Task 1. Literature review and discussion with experts | Winter 2020 |
| Task 2. Present update on findings at MPWG | Spring 2020 |
| Task 3. Draft Conceptual Model to MPWG | Spring 2021 |
| Task 4. Final Conceptual Model completion | Summer 2021 |

## Background

Plastic is ubiquitous in modern life. Global plastic production was estimated to be 299 million tons in 2013 (Gourmelon 2015); nearly a third of plastic production is used for plastic packaging, including single-use items (Andrady and Neal 2009) that are discarded after use. For the last two decades, society has focused on macroplastic in the ocean, such as the Pacific Ocean Garbage Patch, but recently attention has turned to the plastic particles < 5 mm in diameter, referred to as microplastics.

Based on a small screening study that identified microparticles in Bay surface water and effluent, the RMP developed a RMP Microplastic Strategy (Sutton and Sedlak 2017). Many elements of the first two years of the Strategy are currently being addressed through the San Francisco Bay Microplastics Project (primarily funded by the Gordon and Betty Moore Foundation), including monitoring of surface water, sediment, prey fish, and stormwater and

wastewater pathways to the Bay. A high priority for the Strategy is to assess the relative potential contribution of each pathway to the Bay.

As part of the San Francisco Bay Microplastics Project, 12 tributaries comprising 11% of the watershed drainage area to San Francisco Bay (i.e., 763 sq. km out of a total of 6,725 sq. km) and 6% of the total flow to the Bay via small tributaries were sampled during storms in WYs 2017-2019 to estimate concentration of microparticles. Geographically distributed throughout the Bay Area, these tributaries were selected based on watershed size, watershed characteristics (e.g., impervious surfaces), land use characteristics (e.g., commercial, industrial, rural, etc.) and whether the tributary was located near microplastics sediment and surface sampling sites.

Microparticles and microplastic were identified in stormwater from all 12 tributaries, discharging between 1.3 and 30 microparticles per liter, with a mean 9.2 particles per liter. A load of 10.9 trillion microparticles to the Bay per year from small tributaries was estimated using a previously developed Regional Watershed Spreadsheet Model (RWSM). Approximately two-thirds of those particles were estimated to be microplastic (not all microparticles are plastic based on chemical analyses conducted on a subset of microparticles). The microparticle estimate is 230 times greater than the estimated combined annual load from all wastewater treatment plants discharging to the Bay. The stormwater microplastics estimate is 330-470 times greater than the microplastics load estimated from wastewater.

The results of the loads modeling effort suggest that industrial areas may be linked to higher microparticle concentrations in stormwater (Figure 1). This hypothesis has not been reported previously in the literature. It is therefore recommended that additional investigation into sources of microplastics to stormwater be conducted, including the potential influence of a greater number of relevant landscape attributes (e.g., imperviousness, proximity to roadways), to more fully explore factors that are potentially related to higher levels of microparticles in stormwater.

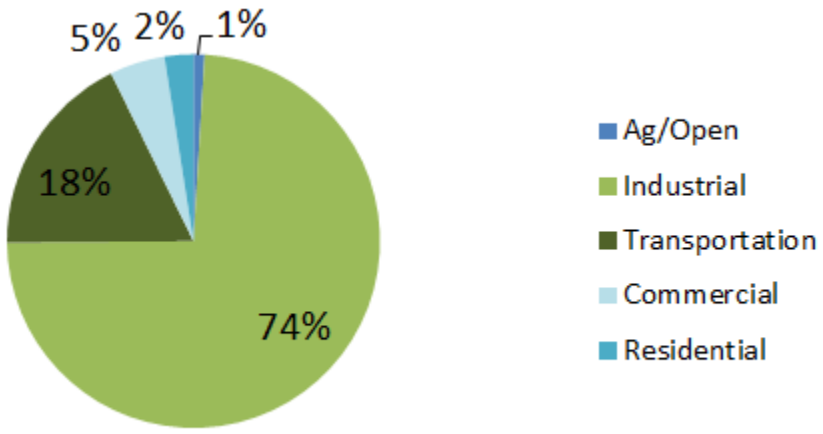


Figure 1. Regional land use distribution of microparticle contributions to small tributaries of the San Francisco Bay, which suggests industrial land uses may be associated with higher levels of microparticles (Gilbreath et al., in prep).

The urgency of developing a robust conceptual model has increased with the recent findings that suggest the microplastics to the Bay via the stormwater pathway is orders of magnitude greater than via the wastewater pathway, and the recent designation of microplastics as emerging contaminant of Moderate Concern to the Bay, based on the RMP's tiered risk framework (Sutton et al. 2017). It is important to understand the sources and sub-pathways for microplastics into stormwater that could help to determine potential management actions to reduce microplastics into the San Francisco Bay.

## Study Objectives and Applicable RMP Management Questions

The purpose of this study is to develop a conceptual model of sources and sub-pathways of microplastics into stormwater, and the patterns that may exist among different landscape factors (e.g., land use, imperviousness, etc.). The Microplastic Workgroup has identified stormwater as a priority for additional investigations based on recent findings (Gilbreath et al., in prep). The model will be used to identify priority sources and sub-pathways for potential management action, assess data gaps, and prioritize monitoring data needs. We will create this model based on an in-depth literature review and discussion with relevant experts. Limited numerical modeling may be used to test different hypotheses.

**Table 1.** Study objectives and questions relevant to RMP Microplastic Strategy management questions (Sutton and Sedlak 2017).

| Management Question | Study Objective | Example Information Application |
|---|---|---|
| 1) How much microplastic pollution is there in the Bay? | NA | NA |
| 2) What are the health risks? | NA | NA |

| | | |
|---|---|---|
| 3) What are the sources, pathways, loadings, & processes leading to microplastic pollution in the Bay? | Assess potential sources of microplastics to stormwater, and potential landscape attributes that may be related to higher levels of discharge. | Inform future monitoring efforts and gain insights into potential management actions. |
| 4) Have the concentrations of microplastic in the Bay increased or decreased? | NA | NA |
| 5) Which management actions may be effective in reducing microplastic pollution? | Assess potential sources of microplastics to stormwater, and potential landscape attributes that may be related to higher levels of discharge. | Understanding the high leverage areas of microplastic pollution and point source discharges will be important for prioritizing appropriate management actions. |

## Approach

We propose to develop a conceptual model that describes sources of microplastics to stormwater. The model will include a diagram depicting the sources and sub-pathways. An example of a conceptual model diagram is depicted in Figure 2. The conceptual model diagram will be accompanied by a report detailing the research behind each compartment of the model.

An important feature of this conceptual model will be linkages to land uses and/or landscape attributes that could be linked to higher levels of discharge. These linkages are important for the purposes of modeling to estimate total regional loads; water quality models are often based on attributing loading coefficients to specific land uses or other landscape attributes. They are also essential for developing effective management actions that target high leverage areas.

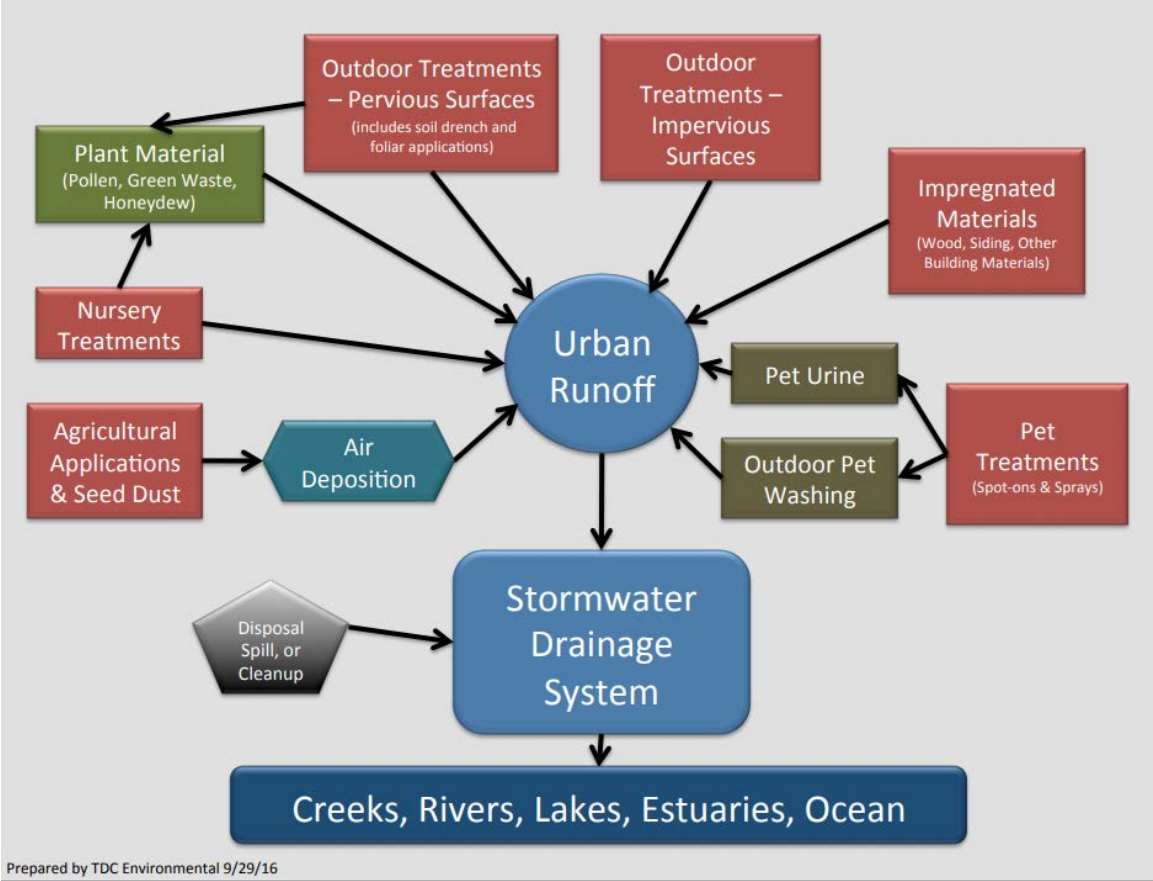


Figure 2. Conceptual model for imiacloprid in stormwater. Prepared by Kelly Moran, TDC Environmental (2016).

The model will be based on an indepth review of the scientific literature on potential sources and landscape attributes linked to microplastics. Given that microplastics are a relatively new pollutant of concern across the globe and, therefore, appropriate literature may be limited, additional efforts will be made to draw inferences from contaminants with similar sources and/or transport-related properties, as well as to interview experts in the relevant fields. The main sources of information are likely to come from:

- Scientific peer-reviewed journal articles
- Grey literature technical reports
- Internet searches and industry publications, and
- Interviews with experts in the relevant industry and scientific fields.

This project will benefit from additional oversight and technical expertise from a local consultant (Kelly Moran, TDC Environmental) who is well-versed in the development of conceptual models to explain sources and pathways of pollutants to the Bay. In addition, Dr. Moran has been involved in several studies of pollutants that result from tire wear.

The literature review and interviews may suggest specific landscape attributes such as industrial land use, impervious surfaces generally, or proximity to roadways as key factors that may explain higher levels of discharge. Identifying strong correlations with such

landscape attributes will aid in improving loads estimation through modeling. Limited numerical modeling may be used to test different hypotheses.

Evaluating possible factors influencing microparticle and microplastic loads is important; however, controlling microplastics in stormwater runoff is an expensive endeavor. Therefore, additional focus will be placed on identifying true sources and mechanisms of discharge into the environment. Such identification can serve to aid in development of effective management actions aimed at reducing microplastic discharge at the source.

A comprehensive stormwater conceptual model will help the MPWG identify key data gaps and areas of uncertainty that could be central to future monitoring efforts.

The final deliverable will be a detailed report accompanying a conceptual model diagram. A draft of the report will be provided for Microplastic and Sources Pathways and Loading workgroups and TRC review.

## Budget

The following budget represents estimated costs for this proposed special study (Table 2).

**Table 2.** Proposed Budget over two years.

| Expense | Estimated Hours | Estimated Budget |
|---|---|---|
| **Labor** | | |
| Literature review and conceptual model development | 300 | $42,000 |
| Senior review | 40 | $7,500 |
| MPWG update presentation | 20 | $3,000 |
| **Subcontract** Kelly Moran, TDC Environmental | | $7,500 |
| **Total** | | **$60,000** |

*Budget Justification*

Labor Costs
Labor will primarily be spent on reviewing the literature and talking with relevant experts in the field. Senior scientists will help guide the process and review interim products. Up-to-date drafts of the conceptual model will be presented at the MPWG and SPLWG meetings in the springs of 2020 and 2021.

Subcontract Costs
Dr. Kelly Moran (TDC Environmental) will help guide and supplement development of the conceptual model. Dr. Moran has been involved in developing numerous such conceptual models on emerging contaminants, copper, and pesticides in stormwater. In addition, she has considerable expertise with pollutants associated with tire wear.

## Reporting

The results of this project will be summarized in a detailed report accompanying a conceptual model diagram.

## References

Gilbreath, A., Sedlak, M., Sutton, R., Rochman, C. 2019. Microparticles and Microplastics in Bay Area Stormwater. Draft Report in preparation.

Sutton R, Sedlak M, Sun J, Lin D. 2017. Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations. 2017 Revision. SFEI Contribution 815. San Francisco Estuary Institute, Richmond, CA. https://www.sfei.org/documents/contaminants-emerging-concern-san-francisco-bay-strategy-future-investigations-2017