Microplastics in Stormwater Conceptual Models

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Microplastics in San Francisco Bay

**STORMWATER:** Vehicle tires, textiles, single-use plastic litter, cigarette filters, construction and roadway debris, spills, many others

**WASTEWATER:** Textiles (via washing machines), personal care and cleaning products with microbeads, single-use items such as wet wipes

**ATMOSPHERIC DEPOSITION:** Textiles (via clothes dryers), brake pads, auto shredders, abrasive blasting

**RIVERS:** Delta wastewater and stormwater discharges, agricultural sources including land applied biosolids

**AQUATIC AND SHORE ACTIVITIES:** Fishing lines, nets, marine and shipping spills, litter and debris
Microplastic Stormwater Conceptual Models

- Tires
- Fibers, except cellulose acetate
- Cigarette filters
- Single-use plastic foodware

Image Credit: M. Eliot


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Ocean Protection Council
Indoor Fibers

- Indoor fiber-containing goods
  (e.g., clothing and other textiles, fiberfill)
- Manufacturing

Outdoor Fibers

- Outdoor fiber-containing goods
  (e.g., carpet, weed wackers, artificial turf, tarps)
- Clothing
  (when worn outdoors)
- Outdoor industrial fibers
  (e.g., geotextiles, architectural fabric, cordage, packaging; wear from vehicle parts; cutting, decay and demolition of fiber-containing building materials)
- Litter
  (macroplastics, medical masks, losses in waste collection; encampments)
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**Indoor Fibers**

- Indoor fiber-containing goods (e.g., Clothing and other textiles, fiberfill)
- Manufacturing
- Air emissions (dryer and other exhausts)

**Air**

- Short-range and long-range transport

**Land**

- Runoff

**Water**
Are USA-type dryers a significant fiber release pathway?

Image Credit: Lorien Fono

USA

Most of the world

Image Credit: Whirlpool

Image Credit: SONGMICS

Image Credit: Lorien Fono
Are global and cumulative legacy pollution important local sources of microplastic pollution via long-range transport?
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**Indoor Fibers**

- Indoor fiber-containing goods (e.g., Clothing and other textiles, fiberfill)
- Manufacturing

**Waste Management**

- Air emissions (dryer and other exhausts)
- Air emissions and spills

**Urban Waterways**

- Storm Drains
- Urban Waterways

**Capture**

- Green Stormwater Infrastructure

**Land**

- Impervious Surfaces
- Pervious Surfaces

**Runoff**

**Air**

- Short-range and long-range transport

**Ocean**

- Long-range transport
Cigarette Filters and Single-Use Plastic Foodware


Image Credit: M. Eliot

www.scvurppp.org
Microplastics carry chemicals into the environment.

Image Credit: M. Eliot Wikipedia
Prevention

- Remove toxic/persistent ingredients or products

Remediation

- Reduce environmental release
- Collect and remove debris from roads and runoff
Prevention

Remove toxic/persistent ingredients or products

Reduce environmental release

Collect and remove debris from roads and runoff

Remediation

Key:
- Industry
- Government Action
- Population-wide Actions
**Prevention**

- **Remove toxic/persistent ingredients or products**
  - Cigarette redesign:
    - Remove filters
    - Re-formulate filters
    - Implement filter take-back programs
    - Change so can be extinguished without mechanical force

- **Reduce environmental release**
  - Additional labeling on cigarette packaging (voluntary or legislatively required)

- **Collect and remove debris from roads and runoff**
  - Legislative and local bans on sales of (filtered) cigarettes
  - Legislative and local smoking bans (e.g., on beaches or in public places)
  - Make cigarettes less affordable/economical
    - Taxes and/or fees
    - Set minimum prices
    - Prohibit redemption of coupons or discounts
    - Establish hazmat standards for sellers
    - Set businesses responsible for waste
    - Fines for violating bans
  - Implement deposit/return programs
  - Street sweeping
  - Trash capture devices
  - Improved runoff treatment (green infrastructure):
    - Porous pavement (without plastic fiber modifiers)
    - Bioretention runoff treatment
    - Runoff infiltration (if determined safe)
  - Increase proper butt disposal:
    - Educate smokers about butt toxicity/persistence
    - Make proper disposal easier by increasing availability of bins and providing smokers with portable ashtrays
    - Reduce other urban litter
  - Increase cleanup frequency and efficacy of trash collection campaigns

**Remediation**

- Decrease smoking incidence:
  - Decrease social acceptability
  - Provide addiction treatment and support

**Key:**

- Tobacco Manufacturer Action
- Government Action
- Population-wide Actions

- Already Widely Implemented
- Novel/Not Widely Implemented

**From:** Wikipedia

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Prevention

Remove toxic/persistent ingredients or products

Reduce environmental release

Collect and remove debris from roads and runoff

Remediation

Product redesign:
- Remove toxic ingredients in manufacturing and final products (e.g. DTSC safer consumer products regulations)
- Re-design products to reduce waste and litter

Key:
- Industry
- Government Action
- Population-wide Actions

Image Credit: M. Eliot, Wikipedia
Prevention

Remove toxic/persistent ingredients or products

Reduce environmental release

Collect and remove debris from roads and runoff

Labeling and public education about fiber pollution and how to minimize through proper material care

Provide economic incentives to switch to condenser dryers

Remove legal barriers to using outdoor clothes lines

Reduce use of traditional dryers vented outdoors
- Reduce overall washing frequency
- Switch to unvented condenser dryers
- Hang textiles to dry

Remediation

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Image Credit: Rebecca Sutton, Bosch, SONGMICS
Prevention

Remove toxic/persistent ingredients or products

Reduce environmental release

Collect and remove debris from roads and runoff

Remediation

Install wear debris collection systems on vehicles

Key:
- Industry
- Government Action
- Population-wide Actions
Prevention

Remove toxic/persistent ingredients or products

Reduce environmental release

Collect and remove debris from roads and runoff

Remediation

Improved runoff treatment (green infrastructure):
- Porous pavement (without plastic fiber modifiers)
- Bioretention runoff treatment
- Runoff infiltration (if determined safe)

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### Prevention

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### Remediation

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- Wikipedia
Final Report

● Available end of October at www.sfei.org/projects/microplastics
Final Report - Key Themes

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- Chemical ingredients in microplastics are important
Final Report - Key Themes

- Available end of October at www.sfei.org/projects/microplastics
- Air transport is a major data gap
- Chemical ingredients in microplastics are important
- Broad spectrum of potential mitigation options