California Water Boards
Perspective
Microplastics Health Effects Symposium
October 19, 2020

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State Water Resources Control Board
@DrSCoffin
Outline

• California’s Legislative Mandate
• How the Water Boards typically handles emerging contaminants
• What we need for Microplastics
PLASTIC FIBERS IN TAP WATER, 2017

PREVALENCE OF MICROSCOPIC PLASTIC FIBERS BY SAMPLE SOURCE LOCATION.

- WORLDWIDE: 83 PERCENT
- USA: 94 PERCENT
- EUROPE: 72 PERCENT
- INDONESIA, JAKARTA: 76 PERCENT
- INDIA, NEW DELHI: 82 PERCENT
- LEBANON, BEIRUT: 94 PERCENT
- UGANDA, KAMPALA: 81 PERCENT
- ECUADOR, QUITO: 75 PERCENT
California Senate Bill 1422 (2018)

July 1, 2020

- Define ‘microplastics’

July 1, 2021

- Standard method
- Four years of testing
- Health-based guidance level
- Accredit laboratories
California Senate Bill 1422 (2018)

- **Define ‘microplastics’**
- **July 1, 2020**
  - **Deadlines**
    - **July 1, 2021**
    - **Standard method**
    - **Four years of testing**
    - **Health-based guidance level**
    - **Accredit laboratories**
Official Adopted definition (June 6, 2020)
‘Microplastics in Drinking Water’

‘solid polymeric materials to which chemical additives or other substances may have been added, which are particles which have at least three dimensions that are greater than 1 nanometer and less than 5,000 micrometers.

Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded.’

Size-Based Classification

- Nanoplastics: 1-100 nm
- Sub-micron Plastics: 100-1000 nm
- Small Microplastics: 1-100 µm
- Large Microplastics: 100-5000 µm
- Mesoplastics: 5-25 mm
- Macroplastics: >2.5 cm
California Senate Bill 1422 (2018)

- Define ‘microplastics’
- Standard method
- Four years of testing
- Health-based guidance level
- Accredite laboratories

Deadlines:
- July 1, 2020
  - Define ‘microplastics’
- July 1, 2021
  - Standard method
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  - Accredit laboratories
“Although there is insufficient information to draw firm conclusions on the toxicity related to the physical hazard of plastic particles, particularly the nano size particles, no reliable information suggests it is a concern through drinking-water exposure.”

\begin{itemize}
  \item \textbf{Publications on "Microplastic" By Year}
  \item \textit{Scopus, Keyword: "Microplastic", 10-12-2020}
  \item \textbf{2.93 publications/day}
\end{itemize}
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Typical Path to Regulation for Drinking Water Contaminants

**Investigatory**
- Awareness of occurrence/toxicity
- Gather occurrence data

**Non-regulatory**
- Notification Level: HQ=1.0 OR or 1-in-1 million cancer
- Response Level: 10x NL (non-cancer) or 1-in 10,000 cancer

**Regulatory**
- Public Health Goal
- Detection Limit for Reporting
- Maximum Contaminant Level

US EPA, State Water Board, Other agencies/researchers

Division of Drinking Water Office of Environmental Health and Hazard Assessment

CAS REGISTRY

100 millionth substance
CAS Registry Number 1786400-23-4

June 2015

> 100 million organic & inorganic substances

Chemicals Registered

~3 million 10 years
~10 million 25 years
~25 million 40 years

Draft Water Boards CEC Program Conceptual Model

Information Gathering → Information Processing → Information Management → Program Delivery

- CEC Management Centers
- Regional Water Boards
- Drinking Water Programs
- Water Quality Programs
- CalEPA: Source Control & Management
Tiered Risk-based Strategy for Constituents of Emerging Concern

Maruya et. al 2013. Integrated Environmental Assessment and Management.
Example Microplastic Action Thresholds for Drinking Water

- **Highest Concern**
  - Operations halted
  - Threshold 4

- **Elevated Concern**
  - Mitigation strategies initiated
  - Threshold 3

- **Moderate Concern**
  - Investigate sources of contamination
  - Threshold 2

- **Low Concern**
  - Increase monitoring frequency
  - Threshold 1

- **No Concern**
  - No action required

Increasing Microplastic Concentrations
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Requirements for Risk Threshold Development

• Risk Assessment Framework
• Adverse Outcome Pathway(s)
• Measurable metric(s)
  • particle count/volume, mass/volume, volume/volume, etc.
• Factors of highest concern
  • Size, shape, sorbed contaminants, pathogens, etc.
Data May be Imperfect- Still Need A Threshold

Based on International Panel on Climate Change methodology (Mastrandea et al. 2010).

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Evidence (type, amount, quality, consistency)</th>
<th>Confidence Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>High agreement</td>
<td>Limited evidence</td>
<td></td>
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<tr>
<td>Medium agreement</td>
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</tr>
<tr>
<td>Low agreement</td>
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</tbody>
</table>
Needed: Microplastics Risk Assessment Framework

Hazard Identification
- Occupational/Epidemiology Studies
- Screening Studies
- Particle Characterization
- Associated Chemicals Characterization
- Associated Pathogen characterization?

Dose-Response Assessment
- Pharmacokinetics/
  Particokinetics
- Pharmacodynamics/
  Particodynamics
- Uncertainty
- Derivation of toxicity values

Risk Characterization
- Exposure Assessment
- Routes of Exposure
- Particle Characterization

Unique to Microplastics
Adverse Outcome Pathways Needed

OECD No. 260. (2016)
Adverse Outcome Pathways Needed

Putative adverse outcome pathway for microplastics (human health)

Jeong and Choi (2019). Chemosphere
“Microplastics” are Extremely Diverse

**Polymer**
- PP
- LDPE
- HDPE
- PVC
- PU
- PET
- PS
- ABS
- PMMA
- POM
- PBT
- PC
- PA
- SAN
- PEEK
- PSU
- PU
- ...

**Additives**
- Plasticizers
- Colorants
- Reinforcements
- Fillers
- Flame retardants
- Stabilizers
- ...

**Product types**

**Primary**
- Pre-production pellets
- Personal care products
- Industrial abrasives...

**Secondary**
- Agricultural materials
- Beverage bottles
- Carry bags
- Construction materials
- Containers
- Clothing
- Cutlery
- Electronics
- Food packaging
- Film
- Furniture
- Insulation
- Mattresses
- Medical
- Pillows
- Pipes
- Textiles
- Toys
- Tires
- ...

**Morphology**
- Fiber
- Fiber bundle
- Fragment
- Sphere
- Pellet
- Film
- Foam
- ...

**Size**
- <5mm
- Nano
- ...

**Colour**
- Red
- Orange
- Yellow
- Tan
- Brown
- Off white
- White
- Grey
- Blue
- Green
- ...

**Eco-toxins**
- PAHs
- PCBs
- DDT
- Heavy metals
- PBDEs
- ...

Method Should Be Tailored to Specific Particle Types

Photo: Mandy Barker
What are the (Combination of) Factors of Highest Concern?

Mockup of potential figure. Data not real.
 Routes of Exposure Must Be Considered

Cox, et al, Environmental Science & Technology, 2019
Choi et al. (2020). *Journal of Hazardous Materials*
Plastic is a Chemical Cocktail


Bergmann et al. (2015), *Marine Anthropogenic Litter.*
Food Packaging Contains Hazardous Additives

- Intentionally & unintentionally added
- 3,3777 substances possible associated with plastic
- 98 Hazardous additives
- 7 persistent, bioaccumulative, toxic
- 15 endocrine disrupting

Some Plastic Ingredients are **Endocrine Disruptors**

**Estrogen**
Endogenous Hormone

- 17-β-estradiol

**Common Plastic Additives**

- Bisphenol A
- 4-<sup>tert</sup>-octylphenol
- 4-n-nonylphenol

Figure: Coffin (2018)
Endocrine Disruptors Behave Strangely

Typical Toxicant/Drug

Endocrine Disruptor

Vandenberg et al Endocrine Reviews (2012).
<table>
<thead>
<tr>
<th>Considerations</th>
<th>Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Data is currently imperfect</td>
<td>• Drinking Water Health-Based Guidance Level</td>
</tr>
<tr>
<td>• Some data will never be perfect</td>
<td>• Hazard quotient = 1.0 (non-cancer)</td>
</tr>
<tr>
<td>• Multiple exposure routes</td>
<td>OR risk = $1 \times 10^{-6}$ (cancer)</td>
</tr>
<tr>
<td>• Uncertainties of many additives and endocrine disruptors?</td>
<td>• Human health risk assessment framework</td>
</tr>
<tr>
<td></td>
<td>• Adverse Outcome Pathways</td>
</tr>
<tr>
<td></td>
<td>• List of research and data gaps</td>
</tr>
</tbody>
</table>
Open Science and Collaboration Necessary

Datathons

Open-Access Journals

Open Data

Open Specy

View
Clean
Identify
Share
Thank you!

@DrS Coffin

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