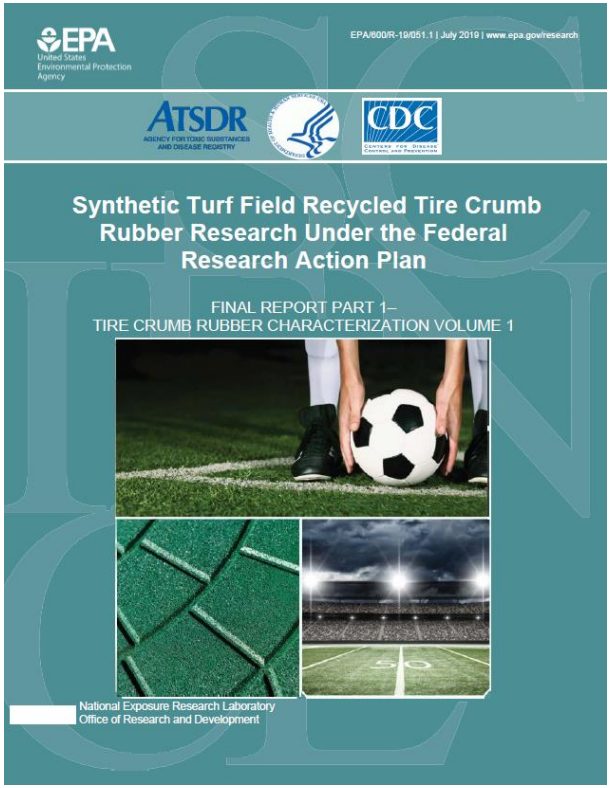
U.S. Federal Research Action Plan (FRAP) on Recycled Tire Crumb Rubber Used on Synthetic Turf Playing Fields and Playgrounds

Final Report Part 1 – Tire Crumb Characterization
EPA Tools and Resources Webinar

August 6, 2019

Agenda

- U.S. Federal Research Action Plan Overview and Status
- Tire Crumb Rubber Characterization Research – Report Key Findings and Messages
- Exposure Characterization Study Status
- Questions?



Research Context

- Currently there are 12,000-13,000 synthetic turf fields in the U.S., with 1,200 – 1,500 new installations each year.
- Most fields use tire crumb rubber as infill material, sometimes mixed with sand.
- Fields are at municipal and county parks; schools, colleges, and universities; professional sports stadiums and practice fields; and military installations.
- Parents, athletes, schools, and communities have raised concerns about potential negative health effects.
- Most studies to date (2016) examining potential risks had been considered limited.

In February 2016, EPA, the Centers for Disease Control and Prevention-Agency for Toxic Substances and Disease Registry (CDC/ATSDR), and the Consumer Product Safety Commission (CPSC) launched the *Federal Research Action Plan (FRAP) on Recycled Tire Crumb Used on Playing Fields and Playgrounds*.

More information available at: www.epa.gov/tirecrumb

Report Overview

- On July 25, EPA released the FRAP report.

- The FRAP report addresses exposure (what is in the tire crumb and how people come in contact with the material) to tire crumb rubber on synthetic turf fields.

- **This report is not a risk assessment**, nor can the information be used to identify a level above which health effects could occur.

- In general, the findings from the report support the premise that while chemicals are present as expected in the tire crumb rubber, human exposure appears to be limited based on what is released into air or simulated biological fluids.

Report Overview

- Only Part 1 was released. Part 2 is to be released at a later date. When combined, Part 1 and Part 2 will not constitute a risk assessment.

- Part 1 of this report presents results of the tire crumb rubber characterization research (i.e., what is in tire crumb rubber).

- The scope of this study was finalized, and the work initiated in 2016 at the request of the Obama Administration.

Status of Research Activities

Research Activity	Lead(s)	Status
Literature review and data gaps analysis	EPA ORD, CDC/ATSDR & CPSC	Completed; released with Status Report, December 2016*
Collect Tire Crumb Samples from manufacturing facilities (recycling plants) and synthetic turf fields Tire Crumb Characterization: Chemical constituents; Particle size; Microbes; Emissions; Bioaccessibility	EPA ORD and CDC/ATSDR	Completed; draft report peer reviewed; Part 1 report released to public
Exposure Characterization: How people are exposed based on activities on the fields	EPA ORD and CDC/ATSDR	Completed and draft report peer reviewed; Part 2 of report will be released at a later date along with the CDC/ATSDR biomonitoring study results
Biomonitoring Study	CDC/ATSDR	Institutional Review Board (IRB) approval received; awaiting final Office of Management and Budget (OMB) approval of the Information Collection Request (ICR)
Playground Study	CPSC	Telephone survey complete; results will be in a future separate report

*other items in Status Report include an industry overview and summary of stakeholder outreach

Tire Crumb Characterization Research Scope

- Using existing and novel scientific approaches, characterize U.S. tire crumb rubber collected from:
  - 9 Recycling Plants (ambient & cryogenic processes)
  - 40 Synthetic Turf Fields
    - From across the four U.S. census regions
    - Outdoor and indoor fields included
    - Fields across a range of ages
    - Not a representative U.S. sample
- Collect information from facilities around the U.S. to better understand how synthetic turf fields with tire crumb rubber infill are operated, maintained and used.

U.S. Census Region	Outdoor Fields	Indoor Fields	Total Sampled
Synthetic Turf Fields			
Northeast	5	4	9
South	11	2	13
Midwest	2	6	8
West	7	3	10
Total Number of Fields	25	15	40
Tire Recycling Facilities			
Ambient Recycling Process			6
Cryogenic Recycling Process			3
Total Number of Facilities			9

Year of Installation	2004 - 2008	2009 - 2012	2013 - 2016
Fields Sampled	11	19	10

Tire Crumb Characterization Research Scope

- Analyses (> 3000 sample analyses):
  - Chemical constituents (metals and organics)
  - Physical properties (e.g., particle size)
  - Microbes
  - Laboratory chamber emissions testing (organics)
  - Bioaccessibility (metals)

- Beyond the Scope of this Study
  - No analysis of synthetic blades, backing layer
  - No sampling of grass fields or other infill materials (e.g., coconut fibers, thermoplastic elastomers)
  - Not assessing potential for heat stress or personal injury from using fields, nor potential impacts to aquatic and terrestrial ecosystems

Sample Collection
Tire Recycling Plants

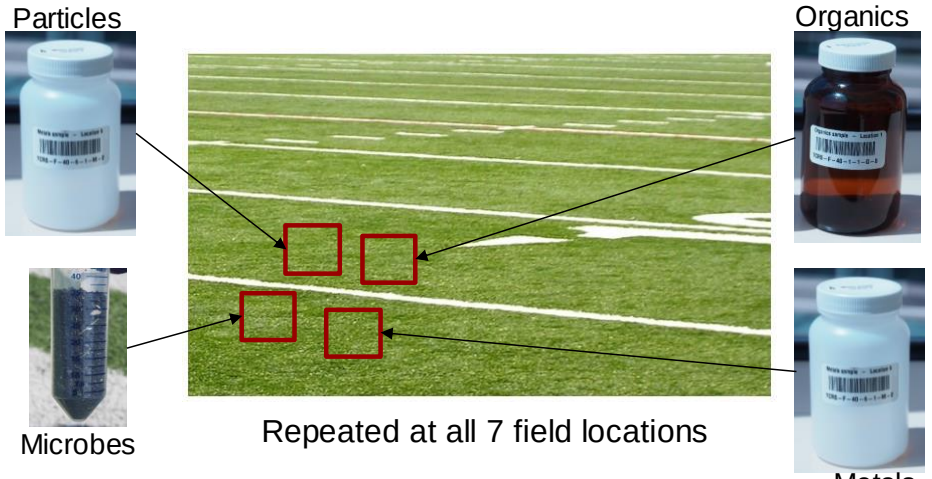
Recycling Plant

Storage Container 1	Storage Container 2	Storage Container 3	
			Organics
			Metals
			Particles

Sample Collection
Synthetic Turf Fields

Samples were collected from 7 locations on fields

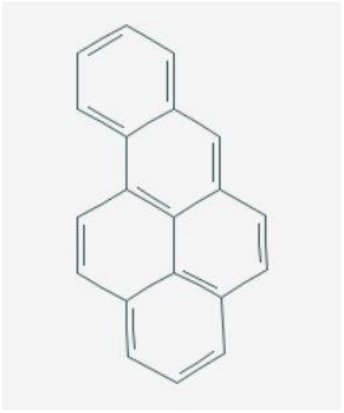
(locations modified for one baseball field)



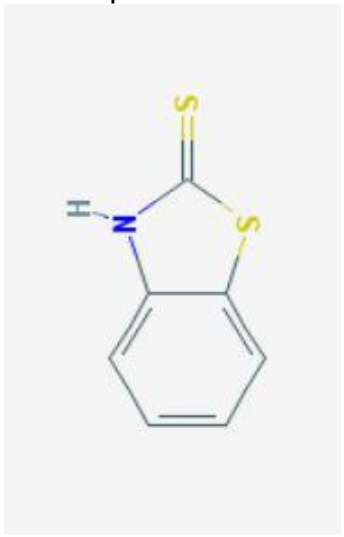
At each location, 4 different types of samples were collected

Sample Analysis
Particles, Chemicals, Bacteria

Benzo[a]pyrene

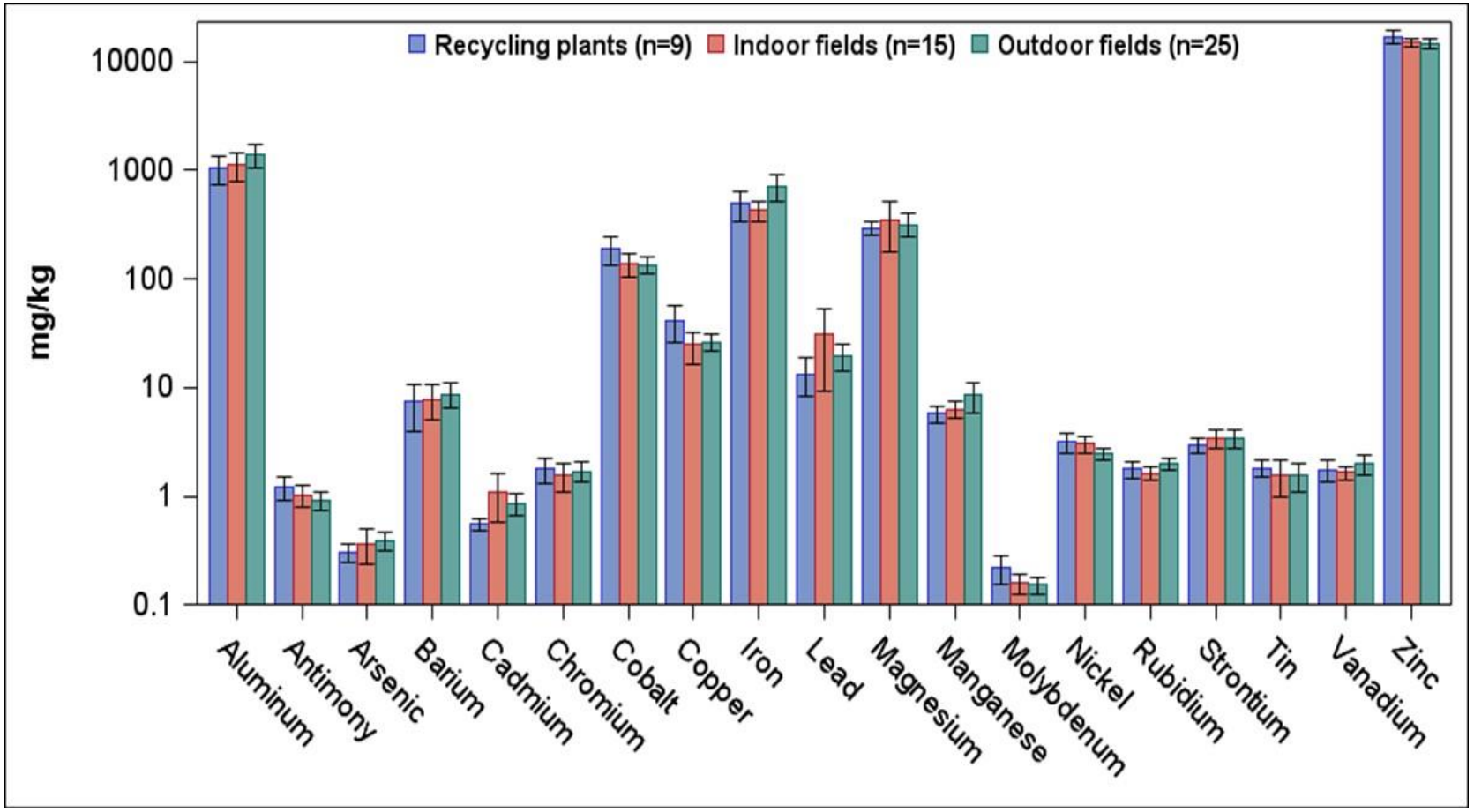


2-Mercaptobenzothiazole



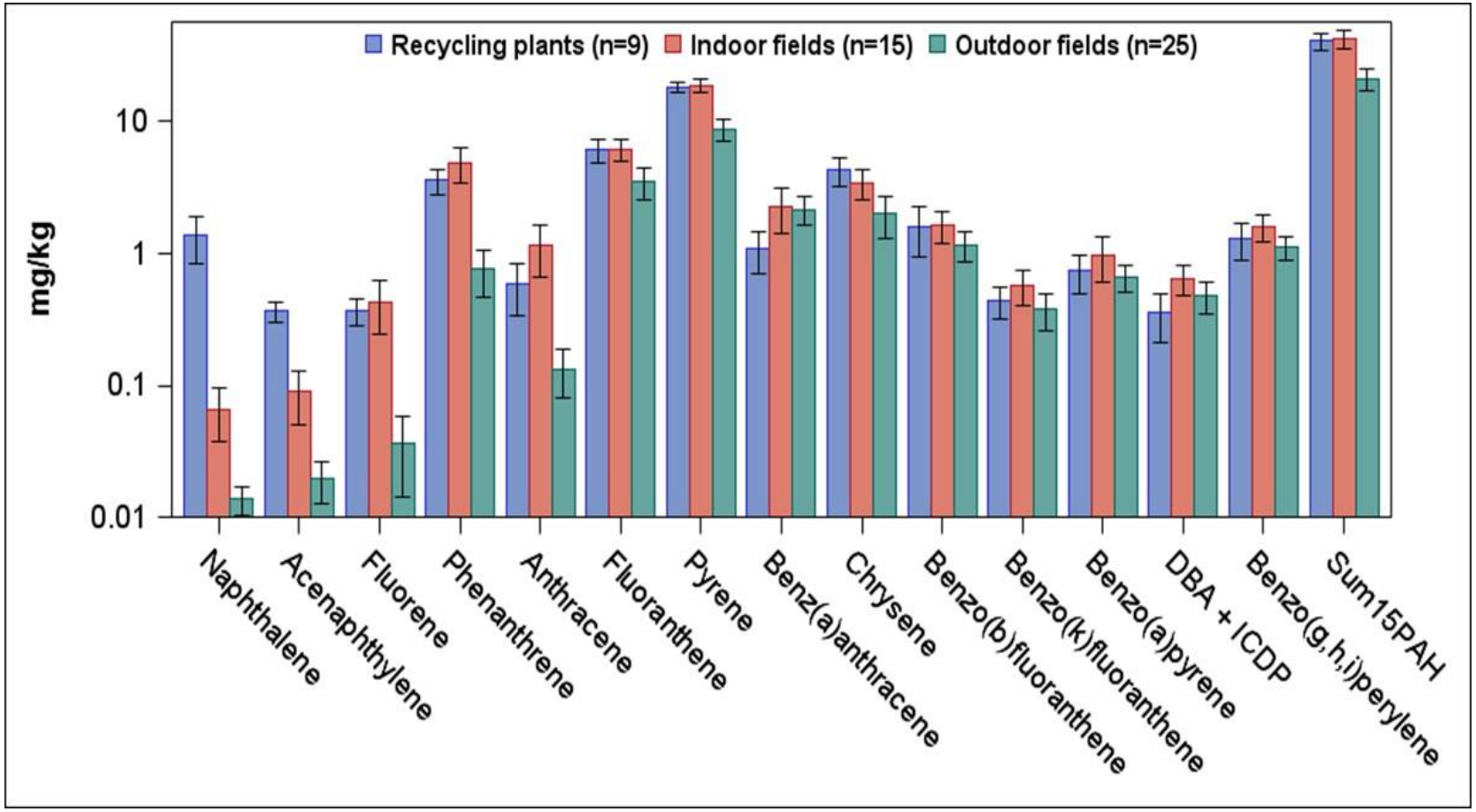
- **Particle characterization**
  - 7 particle size fractions
  - Moisture and sand content
- **Metals - 21 Targeted**
  - Examples: lead, zinc, chromium, cadmium, cobalt
- **Semi-Volatile Organic Chemicals (SVOCs) - 49**
  - Examples: PAHs, phthalates, thiazoles, amines
- **Volatile Organic Chemicals (VOCs) - 31 Targeted**
  - Examples: methyl isobutyl ketone, benzothiazole, styrene, 1,3-butadiene
- **Bacteria**
  - Three specific bacteria genes
  - Non-targeted survey

Example Results
Metals in Tire Crumb Rubber



Concentrations of different metals varied widely

Example Results
Polyaromatic hydrocarbons (PAHs) in Tire Crumb Rubber



PAH concentrations vary. Some differences were observed for recycling plants, indoor fields, and outdoor fields.

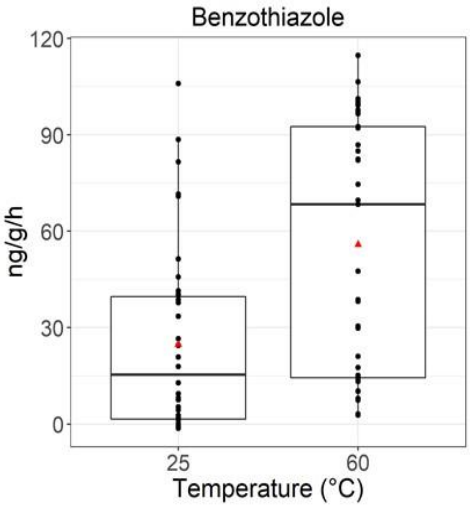
Key Findings:
Metals & SVOCs in Tire Crumb Rubber

- Most of the target analytes among the 21 metals and 49 SVOCs, and several of the 31 target VOCs, were found in tire crumb rubber collected at fields across the U.S.

- Average concentrations ranged from <1 mg/kg for several metals and extractable SVOCs to up to 15,000 mg/kg for zinc.

- In general, where information is available, concentrations measured in this study were consistent with, and within the range of, concentrations found in previous studies for most chemicals.

Key Findings:
Organic Chemical Emissions



- Air emissions tests were performed at both 25 °C (77 °F) and 60 °C (140 °F), temperatures chosen to represent moderate and high-end field temperature conditions, respectively.
- For most VOC and SVOC chemicals, air emissions were low at 25 °C and in many cases, not measurable above the detection limit or above background levels.
- At 60 °C, higher emissions were measured for some, but not all, VOCs and SVOCs.
- Overall, methyl isobutyl ketone and benzothiazole had the highest emission factors in this study.

Measuring Bioaccessibility of Metals From Tire Crumb Rubber

Preparation of artificial biofluids

- Saliva, sweat plus sebum, and gastric fluid

Dissolution of tire crumb rubber in artificial biofluids

- Extraction of 19 metals in each fluid at body temperature (37°C or 98°F)

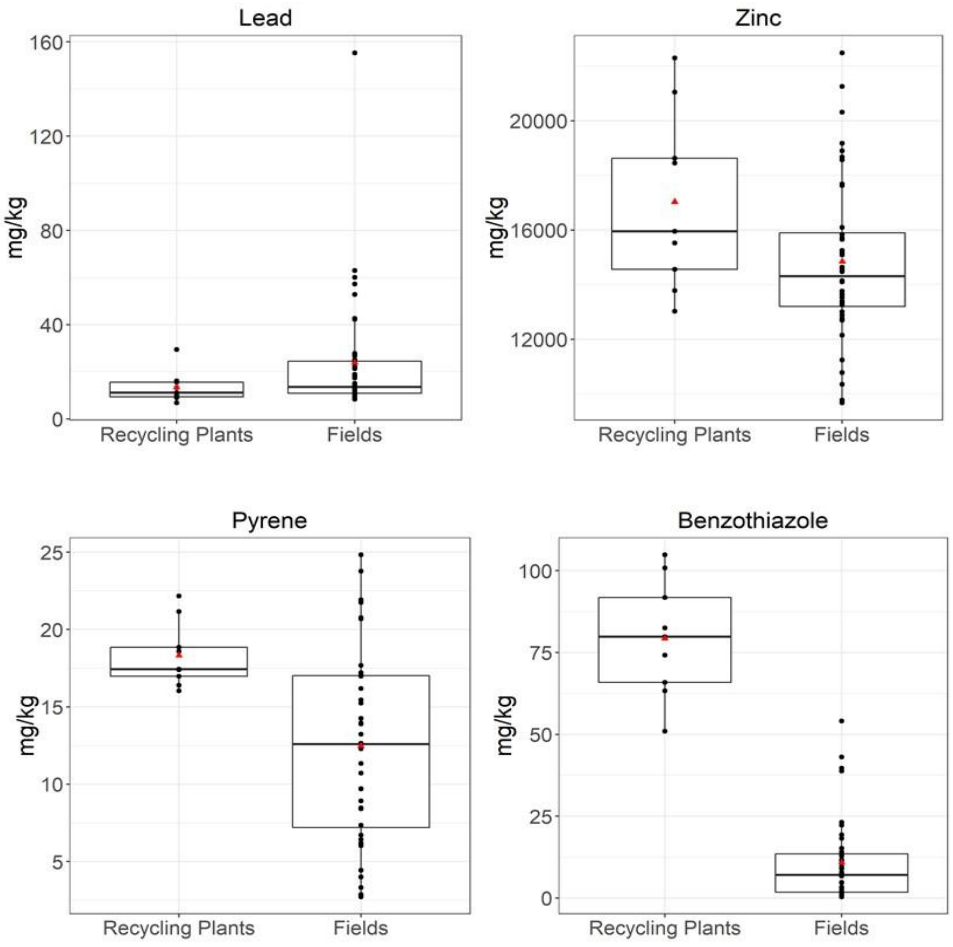
Calculation of the in vitro percent bioaccessibility

- Calculate the bioaccessible amount of each analyte in each biofluid
- Divide the bioaccessible amount by the concentration of the corresponding analyte in the tire crumb rubber sample and multiply by 100

Key Findings:
Bioaccessibility of Metals

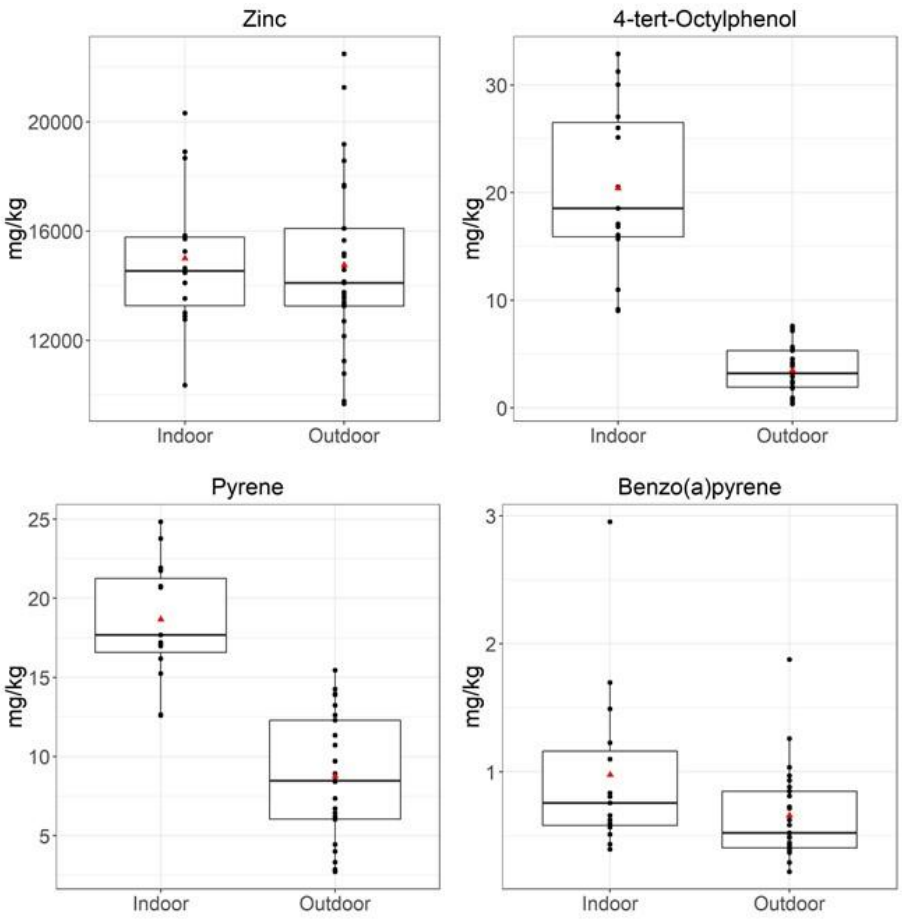
- Only small fractions of metals were released into simulated biological fluids.
- For all metals, the mean bioaccessibility values averaged about 3% in gastric fluid and less than 1% in saliva and sweat plus sebum.
- These results fill important knowledge gaps about potential bioavailability of chemicals associated with tire crumb rubber and would indicate that a default to 100% bioaccessibility for most metals should not be used when assessing potential exposures.

Example Results and Findings
Differences Between
Recycling Plants and Fields



- The same target analytes were measured in tire crumb rubber collected at tire recycling plants and synthetic turf fields.
- The concentrations of most metals in both materials were comparable.
- Many organic chemicals had higher concentrations in, and emissions from, tire crumb rubber collected at recycling plants.
- A few chemicals [e.g., lead and bis(2-ethylhexyl) phthalate] had higher average concentrations in samples from synthetic turf fields.

Example Results and Findings
Differences Between Indoor and Outdoor Fields



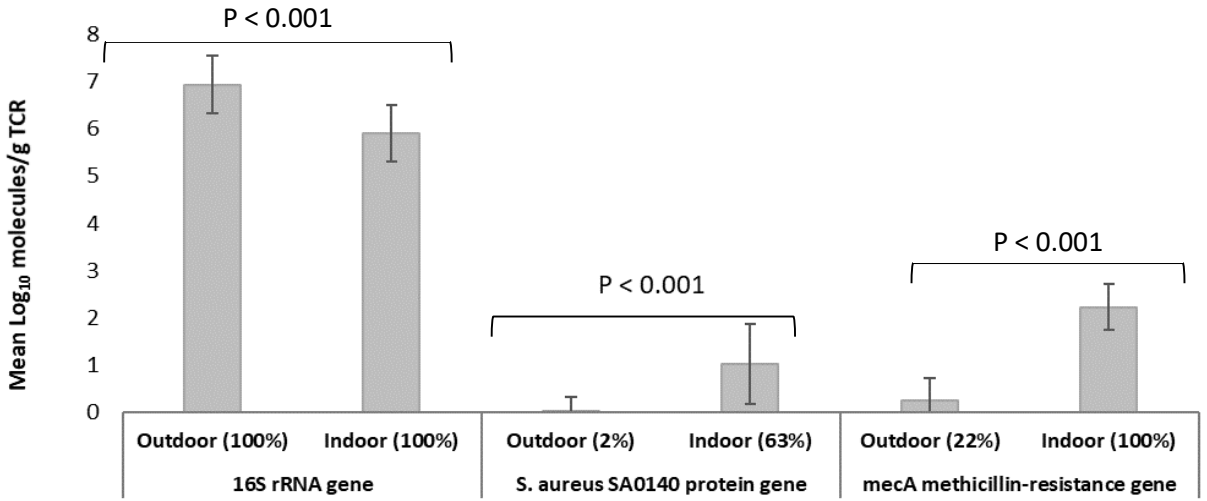
- Levels of most metals were similar at indoor and outdoor fields.
- Levels of many organic chemicals tended to be higher for indoor fields compared to outdoor fields.
- Additional research is needed to determine whether indoor field users experience higher exposures than those using outdoor fields as a result of these differences.

Bacterial Measurements for Tire Crumb Rubber Collected at Synthetic Turf Fields

Targeted analysis was performed for three indicators of bacteria

- An indicator of total bacteria
- An indicator gene for Staphylococcus aureus bacteria
- An indicator for methicillin resistance in bacteria

- ➢ Every sample from the 40 fields was positive for total bacteria.
- ➢ 42% had at least one sample with Staphylococcus aureus.
- ➢ 70% had a least one positive sample for methicillin resistance.



Exposure Characterization Status

Completed research activities:

- Field user activity questionnaires (n=32)
- Pilot study of exposure measurements during and around play/practice on fields (n=25)
- Athlete micro-activity data gathering from publicly available video and study participant video (n=60 and n=17, respectively)
- Exposure pathway modeling

Next steps:

- CDC/ATSDR is planning to conduct a biomonitoring study to assess exposure among synthetic turf field users players.
- The exposure characterization results will be reported along with results from CDC/ATSDR's biomonitoring study.

Tire Crumb Characterization – Summary of Key Findings

A range of metals, semivolatile and volatile organic compounds (SVOCs/VOCs), and bacteria were found.

- 21 metals, 49 SVOCs, 31 VOCs on targeted list – most metals and SVOCs detected; many VOCs detected; not unexpected
- All fields tested positive for bacteria; not surprising given reports of similar concentrations on common household items

Results for most metals and extractable SVOCs are generally comparable to other studies characterizing tire crumb, where available.

Tire Crumb Characterization – Summary of Key Findings (cont.)

Some statistically significant differences were found between recycling plants and fields and among fields.

- Recycling plants vs. fields – most metals comparable; most organics lower at fields; a few chemicals higher at fields vs. plants
- Indoor vs. outdoor fields – most metals comparable; many organics higher at indoor fields
- Older vs. newer fields – most metals comparable; at outdoor fields, many organics lower with older field age

Levels of many organic chemicals remain higher in indoor field infill than outdoor field infill.

- SVOCs in tire crumb from indoor fields were 1.5 to 10 times higher than outdoor fields; similar differences were seen for VOC and SVOC emissions
- Potential impact on exposures would need to be evaluated through additional research

Tire Crumb Characterization – Summary of Key Findings (cont.)

Only small amounts of most organic chemicals are released into the air through emissions.

- Organic chemical emission from tire crumb measured at two temperatures (25°C and 60°C)
- Generally low emissions for most target chemicals, often below level of detection (LOD) @ 25°C; some but not all chemicals showed higher rates @ 60°C; highest emissions measured for methyl isobutyl ketone and benzothiazole

For metals, only small fractions are released into artificial biological fluids compared to a default assumption of 100% bioaccessibility.

- Values for lead: 3 % for gastric fluid, < 0.1% for saliva and sweat plus sebum
- Across all metals, average of mean % bioaccessibility was about 3% for gastric fluid and <1% for saliva and sweat plus sebum

Take Home Messages

The exposure-focused research under the FRAP is being released in 2 parts: the first on Tire Crumb Characterization, and the second on Exposure Characterization.

Key Findings – Part 1:

- ❑ In general, and not unexpected, the study found a range of chemicals (metals and organic compounds) and all fields tested positive for bacteria.
- ❑ Chemical concentrations are generally similar to those found in other studies where these exist.
- ❑ Bacteria were found at levels similar to those previously reported on common household products.
- ❑ While a range of chemicals are present, air emissions of most organic chemicals, and bioaccessibility of metals are low.

This study is not a risk assessment; however, the results are expected to inform a risk assessment process.

Take Home Messages (cont.)

Part 2 of the FRAP, the Exposure Characterization Study, will be released at a later date, along with a CDC/ATSDR biomonitoring study that is currently being planned.

Overall, we anticipate that the results from this multi-agency research effort will be useful to the public and interested stakeholders for understanding the potential for human exposure to chemicals of potential interest and concern found in tire crumb rubber used on synthetic turf fields.

Acknowledgements – Team Effort!

Collaborating Federal Organizations
U.S. Consumer Product Safety Commission
U.S. Army Medical Command, Army Public Health Center

Other Collaborators
National Toxicology Program of the National Institutes of Environmental Health Sciences

California Environmental Protection Agency's Office of Environmental Health Hazard Assessment

Questions?

STUDY CONTACT:

Kelly Widener
U.S. EPA Office of Research and Development
202-564-6737

Feedback can be emailed to:
RecycledTireCrumb@epa.gov

***Disclaimer**: The views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA and the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry.*