RISKS TO PUBLIC HEALTH FROM CHEMICALS FOUND IN BROCK INFILL AND IN SOIL AT PLAYING FIELDS

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RISKS TO PUBLIC HEALTH FROM PLAYING FIELDS

- All sports-fields contain various chemicals, including traces of various metals, and, potentially, perfluorinated alkyl substances (PFAS).

- This is true of both synthetic turf-fields and of ordinary grass & soil fields.

- Are the chemicals in synthetic turf fields, and/or in grass & soil fields, present at unhealthful concentrations?

- Let's look first at PFAS … in soil and Brock infill

How much PFAS is in uncontaminated soil?

- Wenyu Zhu *et al.* (2019) evaluated uncontaminated soils in Vermont
- Shallow soil samples obtained from 66 sites
  - State forests, parks, school-yards, and other green areas
- Wide range of various PFAS detected
- Let's look at their results …

PFAS concentrations in uncontaminated soil (Zhu *et al.*, 2019)		
PFAS	**10th percentile**	**95th percentile**
PFPeA	less than 70 ng/kg	360 ng/kg
PFHxA	less than 7.6 ng/kg	920 ng/kg
PFHpA	less than 4.4 ng/kg	650 ng/kg
PFOA	59 ng/kg	1,000 ng/kg
PFNA	62 ng/kg	390 ng/kg
PFDA	40 ng/kg	390 ng/kg
PFUdA	35 ng/kg	180 ng/kg
PFBS	less than 6 ng/kg	500 ng/kg
PFHxS	less than 14 ng/kg	380 ng/kg
PFOS	310 ng/kg	3,000 ng/kg
PFDS	less than 5.3 ng/kg	170 ng/kg

How much PFAS is in brockfill?

- One "non-regulated" PFAS (perfluoropentanoic acid, PFPeA) detected in the infill (J-qualified, estimated value)

- Two other PFAS (but not PFPeA) detected in "synthetic leachate" generated from infill (tests of leachate were more sensitive than tests of infill)

- These results suggest that infill contains about
  - 455 ng/kg of perfluoropentanoic acid (PFPeA)
  - 58 ng/kg of perfluorohexanoic acid (PFHxA)
  - 100 ng/kg of perfluoroheptanoic acid (PFHpA)

- Recall that uncontaminated soil (per Zhu *et al.*, 2019) contains up to (at the 95th percentile)
  - 360 ng/kg of PFPeA
  - 920 ng/kg of PFHxA
  - 650 ng/kg of PFHpA
  - Many other PFAS, at concentrations up to 3,000 ng/kg

Are PFAS in soil, or in infill, harmful to health?

- Per MA DEP, acceptable daily intake of regulated PFAS (from all sources, including food, drinking water, and incidental ingestion of dust and soil) = 5 nanograms PFAS per kilogram body weight per day (5 ng/kg-day)

- How much incidental ingestion of soil and/or infill would an athlete receive playing on a sports field?

  - And would such ingestion be unhealthful?

- Here's how we addressed this question …

EXPOSURE-SCENARIOS CONSIDERED

- Consider an athletic girl, aged 5 - 18

- Make conservative assumptions:
  - Plays daily on sports fields, 9 months per year
  - Incidentally ingests 100 mg/day of either infill or soil
  - Absorbs 100% of ingested PFAS, and 50% of ingested metals
  - Acceptable daily intake-values derived by applying ample margins of safety (MA DEP ”reference dose”)

- Assume parallel exposures for
  - Synthetic field with Brockfill infill
  - Natural grass field with ordinary soil

Daily doses of PFAS from incidental ingestion of infill and of soil (based on Zhu *et al.*, 2019), compared with acceptable daily intake of PFAS			
PFAS	**Dose from Brockfill** (picograms/kg-day)	**Dose from Soil** (picograms/kg-day)	**Acceptable Daily Intake** (picograms/kg-day)
PFPeA	0.83	<0.13 – 0.7	**Assume > 5,000**
PFHxA	0.11	<0.01 - 1.7	**5,000**
PFHpA	0.18	<0.01 - 1.2	**5,000**
Five additional, MA DEP-regulated, PFAS	<0.01	<0.03 – 5.5	**5,000**

Other potentially toxic chemicals in soil and in brockfill

- Various metals, present naturally and/or because of contamination
- Three potentially important metals, toxicologically:
  - Arsenic & Cadmium
    - Poses risk of cancer
  - Lead
    - Poses risk of harm to developing brains

Concentrations of two metals in infill and in soil, from Oak Bluffs Elementary School and MVRHS			
Metal	**Brockfill** (mg/kg)	**Elementary school soil** (mg/kg)	**MVRHS soil** (mg/kg)
Arsenic	None detected <0.079	1.6	1.9
Cadmium	0.042	None detected (< 0.1)	None detected (< 0.1)
Lead	None detected <0.102	24.2	16.2

Daily doses of three metals from incidental ingestion of infill and of soil, compared with acceptable daily intakes			
Metal	**Dose from Brockfill** (ng/kg-day)	**Dose from Soil** (ng/kg-day)	**Acceptable Daily Intake** (ng/kg-day)
Arsenic	<0.07	2.0	**300**
Cadmium	0.04	<0.4	**500**
Lead	<0.09	97	**750**

Other field components:
Greenfield synthetic turf, shock pad, glues

- Trace, estimated amounts of a few PFAS detected in these other components, all at concentrations smaller than the trace concentrations of PFAS detected in the Brock infill and/or Brockfill “leachate”

- Potentially toxic metals detected either at trace, estimated concentrations or not at all

- No adverse impact expected on either the environment or the public health

Would tests for total organic fluorine (TOF) be informative?

- No.
- Soil would be expected to contain much more organic fluorine than Brockfill or other synthetic field-components.
- Soil can contain bacteria, *Streptomyces cattleya*, that naturally biosynthesize various organofluorine chemicals.
- Several plant-species biosynthesize organofluorine chemicals.
- Countless, non-PFAS, organofluorine compounds will have deposited onto soils from ambient air.
- **The best way to find PFAS is to analyze for PFAS.**

Would tests for total oxidizable precursors to PFAS (TOP) be informative?

- No.
- This test is appropriate only for materials that are
  - known to contain organofluorine chemicals that
  - might, *under strongly oxidizing conditions*, degrade into one or more PFAS of toxicologic significance.
- Neither Brockfill nor other synthetic field-components are such materials;
- and nothing about a sports field, whether synthetic or natural, represents strong oxidizing conditions.

Are microplastics at issue here?

- No.
- Brockfill consists only of wood granules.
- Small amounts of microplastic may form, however, from wear-and-tear of synthetic grass surface.
- This “secondary” microplastic would be negligible compared with microplastics ubiquitous in fresh water, seawater, drinking water, food, ambient air, and soil.
- No reliable evidence that exposures to microplastics harm health (see, for example, WHO, 2019, *Microplastics in Drinking Water*).