

RISKS TO PUBLIC HEALTH AND THE ENVIRONMENT
FROM CHEMICALS FOUND IN
BROCK INFILL/GREENFIELDS SYNTHETIC TURF-SYSTEM
AND IN SOIL
AT PLAYING FIELDS



Green Toxicology LLC

Laura C. Green, Ph.D., D.A.B.T
&
Edmund A.C. Crouch, Ph.D.

<http://www.greentoxicology.com>

March 3, 2021

- ❖ 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.**
- ❖ So, are the chemicals in synthetic turf fields, and/or in grass & soil fields, present at unhealthful concentrations?
- ❖ Let's **look first at metals** ... in soil and in Brock infill (pine wood chips/granules)

Metals detected in MVRHS soil and in Brock infill; parts per million

Metal	MVRHS soil	Brock infill
Antimony	not analyzed (n.a.)	not detected (n.d.)
Arsenic	1.9	n.d.
Barium	n.a.	5.6
Beryllium	n.a.	n.d.
Cadmium	n.d.	0.04 J
Chromium	6.0	n.d.
Lead	16.2	n.d.
Mercury	n.a.	n.d.
Nickel	2.5	n.d.
Selenium	10.4	0.66 J
Silver	n.a.	n.d.
Thallium	n.a.	n.d.
Vanadium	n.a.	n.d.
Zinc	17.5	5.7

PERFLUORINATED ALKYL SUBSTANCES (PFAS)

- ❖ How much is in uncontaminated soil?
- ❖ How much is in Brock infill?

PFAS IN UNCONTAMINATED SOIL (ZHU *ET AL.*, 2019)

- ❖ PFAS measured in uncontaminated soils in Vermont
- ❖ Shallow soil samples obtained from 66 sites
 - ❖ State forests, parks, school-yards, and other green areas
- ❖ **As expected, many PFAS were detected in soil samples**
- ❖ Let's look at their results ...

PFAS concentrations in uncontaminated soil (Zhu *et al.*, 2019)

PFAS	10 th percentile	95 th percentile
PFPeA	< 70 ng/kg	360 ng/kg
PFHxA	< 7.6 ng/kg	920 ng/kg
PFHpA	< 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	< 6 ng/kg	500 ng/kg
PFHxS	< 14 ng/kg	380 ng/kg
PFOS	310 ng/kg	3,000 ng/kg
PFDS	< 5.3 ng/kg	170 ng/kg

HOW MUCH PFAS IN BROCK INFILL?

- ❖ Only one, “non-regulated” PFAS (perfluoropentanoic acid, PFPeA) detected in the pine wood infill (J-qualified, estimated value)
- ❖ One would **expect** pine wood to be cleaner than soil
- ❖ Compared with ordinary soil ...

PFAS in uncontaminated soil (Zhu *et al.*, 2019) and in Brock infill

PFAS	10 th percentile	95 th percentile	Brock infill
PFPeA	< 70 ng/kg	360 ng/kg	455 ng/kg -- J-qualified
PFHxA	< 7.6 ng/kg	920 ng/kg	none detected
PFHpA	< 4.4 ng/kg	650 ng/kg	none detected
PFOA	59 ng/kg	1,000 ng/kg	none detected
PFNA	62 ng/kg	390 ng/kg	none detected
PFDA	40 ng/kg	390 ng/kg	none detected
PFUdA	35 ng/kg	180 ng/kg	none detected
PFBS	< 6 ng/kg	500 ng/kg	none detected
PFHxS	< 14 ng/kg	380 ng/kg	none detected
PFOS	310 ng/kg	3,000 ng/kg	none detected
PFDS	< 5.3 ng/kg	170 ng/kg	none detected

HOW MUCH PFAS APPEARED TO LEACH FROM BROCKFILL?

- ❖ Two other PFAS detected in “synthetic leachate” generated from infill
 - ❖ tests of leachate were more sensitive than tests of infill *per se*
- ❖ Synthetic leachate contained, **at most, an estimated:**
 - ❖ 2.9 ng/liter of perfluorohexanoic acid (PFHxA)
 - ❖ 5.0 ng/liter of perfluoroheptanoic acid (PFHpA)

ARE PFAS IN SOIL, OR IN BROCK INFILL, HARMFUL TO HEALTH?

- ❖ *Per MA DEP, acceptable daily intake of regulated PFAS = 5 nanograms PFAS per kilogram body-weight per 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 ...

- ❖ Considered two athletic girls, from 5 – 18 years of age
- ❖ Assumed:
 - ❖ Each 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
- ❖ One girl plays only on the proposed synthetic field with Brock infill
- ❖ Another girl plays only on natural grass fields with ordinary soils

**Each girl's daily doses of PFAS
from incidental ingestion of infill and of soil,
compared with acceptable daily intake of PFAS**

PFAS	Girl's dose from Brockfill (pg/kg-day)	Girl's dose from Soil (pg/kg-day)	Acceptable Daily Intake (pg/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 - 0.01	< 0.03 – 5.5	5,000

**WHAT ABOUT THE METALS IN SOIL, OR IN BROCK INFILL --
WOULD EXPOSURE TO THESE METALS
BE HARMFUL TO HEALTH?**

- ❖ Using the same assumptions about our two athletic girls, here's what we found ...

Each girl's daily doses of metals from incidental ingestion of infill and of **soil**, compared with acceptable daily intakes

Metal	Girl's dose from Brockfill (ng/kg-day)	Girl's dose from Soil (ng/kg-day)	Acceptable Daily Intake (ng/kg-day)
Arsenic	0 - 0.07	2.0	300
Cadmium	0.04	0 - 0.4	500
Lead	0 - 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 total concentrations of PFAS detected in the Brock infill and/or Brock infill “leachate”
- ❖ Potentially toxic metals detected either at trace, estimated concentrations, or not at all
- ❖ No threat to the health of the athletes or other people using, or living near, these fields

ANTIMONY

- ❖ Trace element present naturally in ores, soil, sea water & food (vegetables & fish)
- ❖ Antimony is emitted into air *via*:
 - ❖ windblown soils/dusts; sea spray; combustion of gasoline, oil, wood, municipal solid waste, etc.
 - ❖ Mining & industrial processes
- ❖ Used as a catalyst in making polymers
- ❖ Our exposures to antimony are dominated by our diets, inhalation of antimony containing-aerosols/smoke particles, and drinking water

IS ANTIMONY AN ISSUE HERE?

- ❖ Antimony in **uncontaminated soils** in Massachusetts:
 - ❖ 50th %ile = 0.34 parts per million (ppm)
 - ❖ 90th %ile = 1.4 ppm
 - ❖ 95th %ile = 4.8 ppm
- ❖ Antimony in synthetic turf-products:
 - ❖ Brock infill not detected
 - ❖ Turf carpet not detected
 - ❖ Glues not detected
 - ❖ Pad 0.38 ppm, J-qualified, estimated value ...

WHENCE THE “TOTAL ORGANIC FLUORINE” IN TURF-PRODUCTS?

- ❖ An inert, fluorinated copolymer
- ❖ This polymer is similar to what is used in medical-grade, biocompatible materials
 - ❖ Sutures
 - ❖ Skin-wearable sensors
- ❖ This polymer could not leach *via* rainwater
 - ❖ would not otherwise threaten the environment or players' health.

TOTAL PRECURSORS [TO PFAS] ASSAY – RELEVANCE?

- ❖ This is a laboratory test run under
 - ❖ **extremely caustic** conditions
 - ❖ similar to Drano, pH > 12
 - ❖ At **185 degrees F** for six hours
- ❖ These conditions are not indicative of Martha's Vineyard weather conditions

SOME PERSPECTIVES

- ❖ Thousands of synthetic turf sports field-systems worldwide
- ❖ > 12,000 such fields-systems in U.S. & Canada
- ❖ > 50,000 such field-systems in Europe
- ❖ Thousands more in Taiwan, Japan, Australia...

- ❖ No evidence of harm to athletes' health

- ❖ No evidence of contamination of groundwater (except possibly from zinc, etc. from **tire debris** ... not pine infill)

SOME PERSPECTIVES

- ❖ Pine infill is cleaner than dirt (& cleaner than recycled tire-infill).
- ❖ Plastic grass is not natural
 - ❖ **But nature is not inherently safe**
 - ❖ radon, aflatoxins, glycoalkaloids, tetrodotoxin, death cap mushrooms, viruses, bacteria ...
- ❖ The only reliable way to distinguish safe from unsafe is to rely on scientific & clinical evidence and judgment ...