qldwater Emerging Contaminants Workshop 2024

November 2024

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School of Civil and Environmental Engineering

UNSW
Water Research
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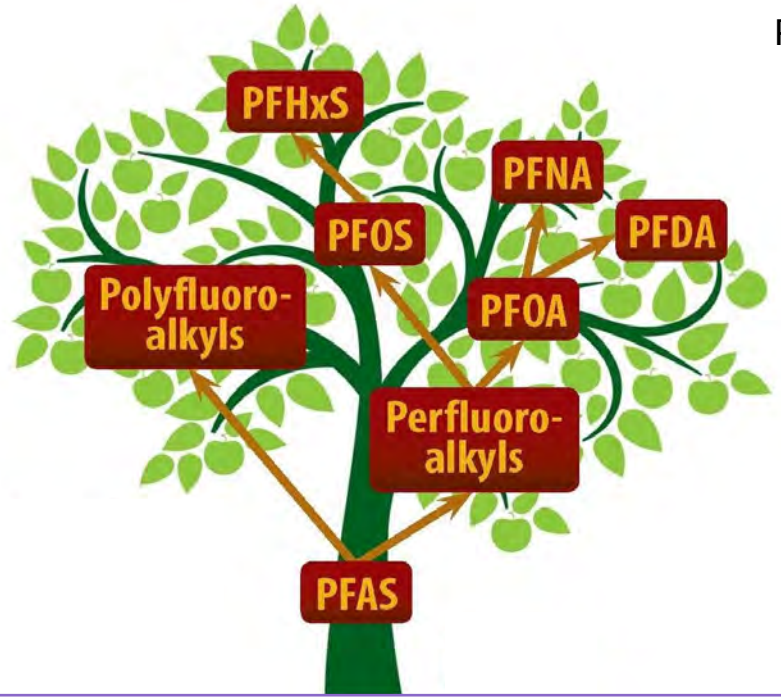
What are PFAS?

PFOA: perfluorooctanoic acid
PFOS: perfluorooctane sulfonate
PFHxS: perfluorohexane sulfonate
PFNA: perfluorononanoic acid
PFDA: perfluorodecanoic acid



Per- and polyfluoroalkyl substances

Over 14,000 PFAS

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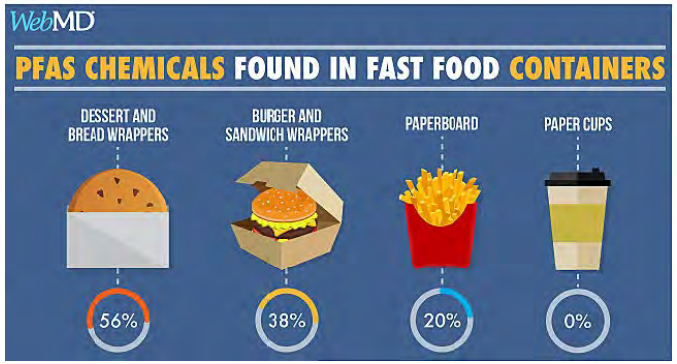
PFAS in daily life

Fire-fighting foams



Surface coatings

Source: Department of Defence, Australia
https://www.defence.gov.au/Environment/pfas/pfas.asp

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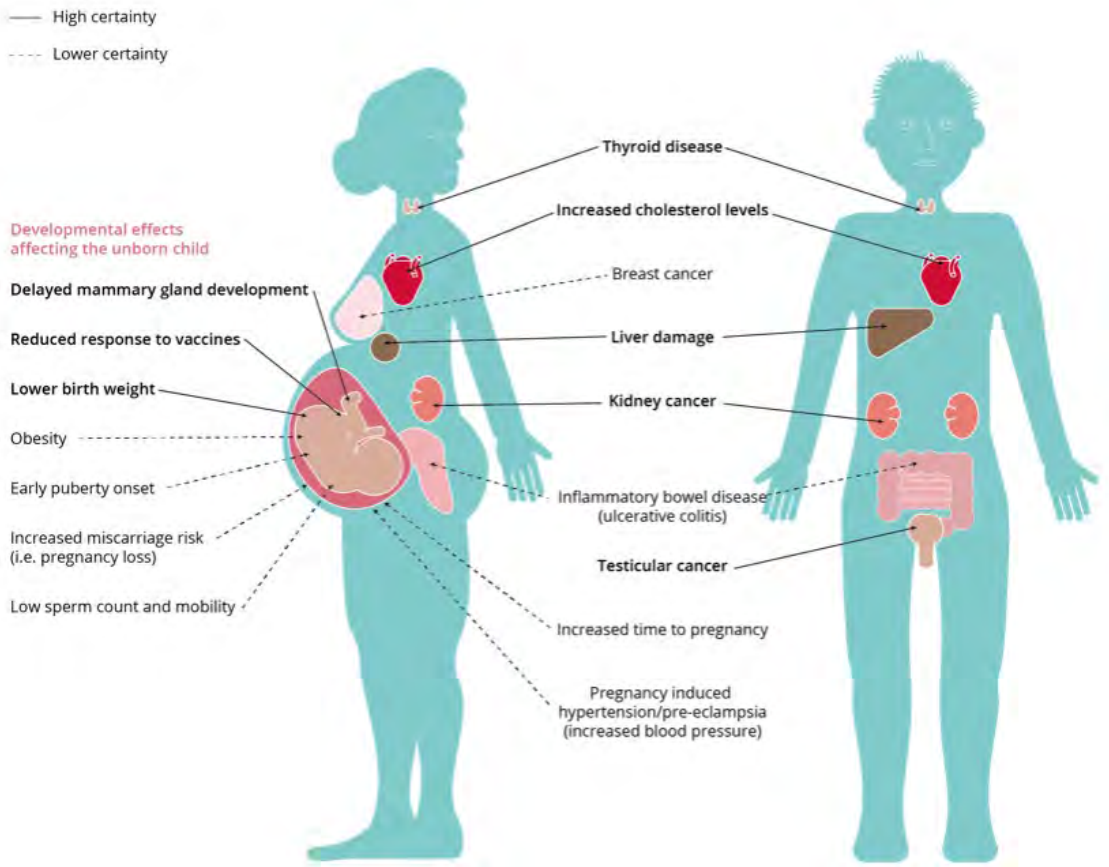
Potential Health Impacts of PFAS



Source: European Environment Agency
https://www.eea.europa.eu/publications/emerging-chemical-risks-in-europe

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Current Understanding of potential health effects

- Increased cholesterol levels
- Changes in liver enzymes
- Small decreases in infant birth weights
- Decreased vaccine response in children
- Increased risk of high blood pressure or pre-eclampsia in pregnant women
- Increased risk of kidney or testicular cancer

https://www.atsdr.cdc.gov/pfas/health-effects/index.html

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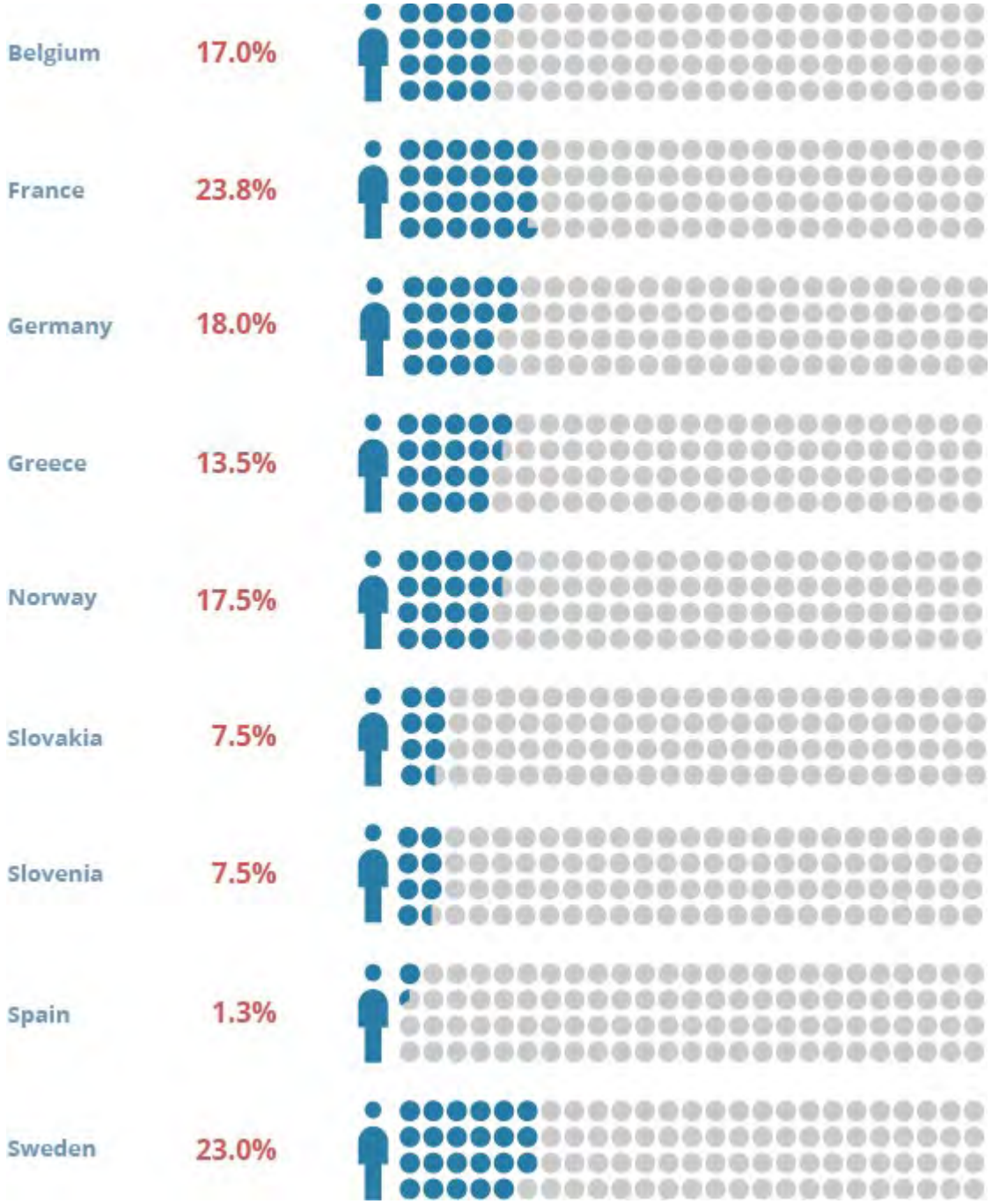
Share of European teenagers in nine European countries with combined blood levels of PFAS above the health-based guidance value (2014 - 2021)



> 97% of US population have measurable PFAS in blood

https://www.eea.europa.eu/publications/zero-pollution/cross-cutting-stories/pfas

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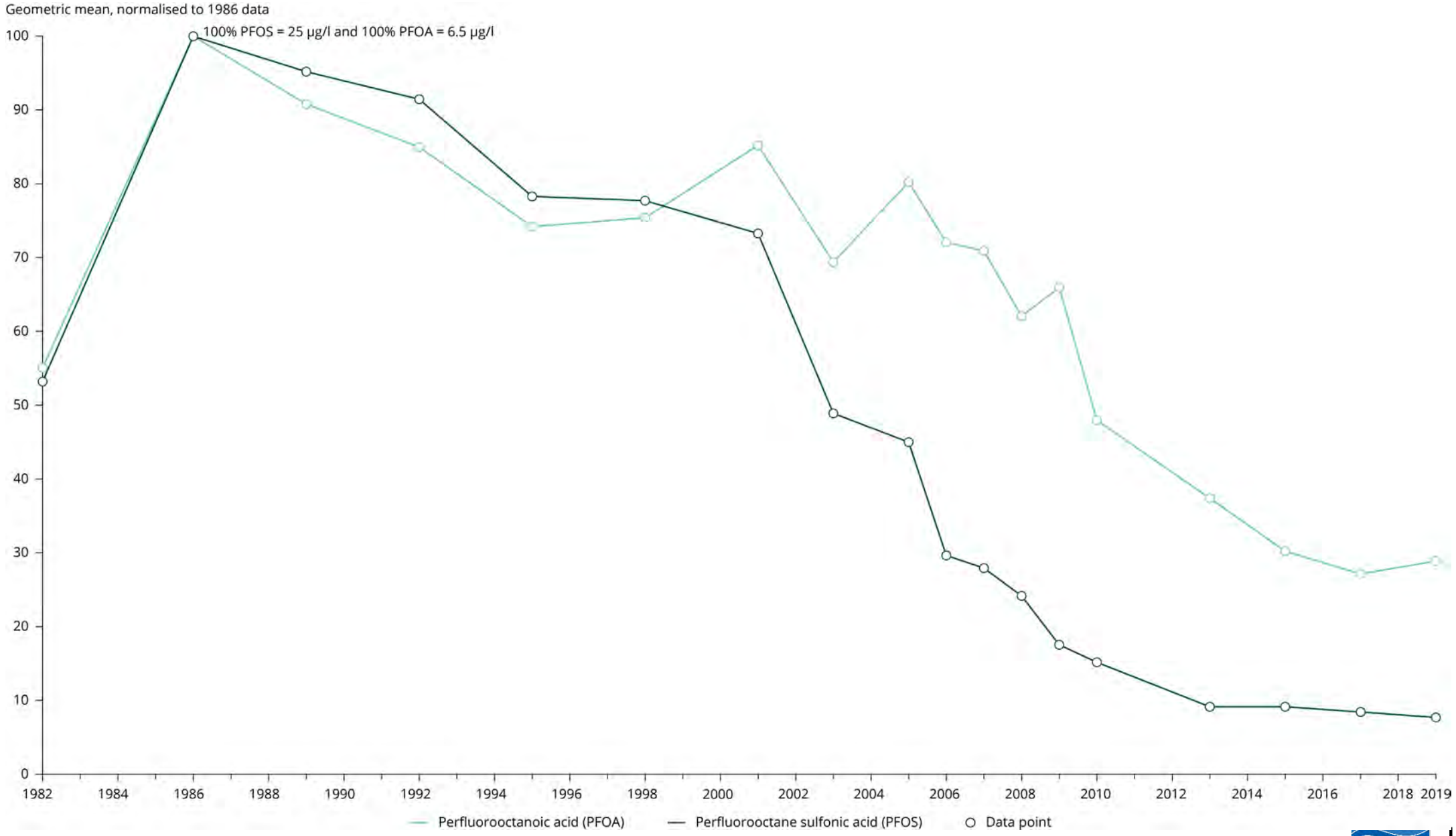
Blood levels of PFOS and PFOA in young adults in Germany from 1982 to 2019



Note: This presents the geometric mean value, normalised to the value measured in 1986. Hence the value for 1986 = 100%.

https://www.eea.europa.eu/publications/zero-pollution/cross-cutting-stories/pfas

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Hollywood and Water Contamination

Dark Waters (2019)

- starring Anne Hathaway & Mark Ruffalo
- PFAS - contamination in Parkersburg, West Virginia
- DuPont's stock price dropped ~ 10% on day of movie release
- DuPont financial settlement ($671 million) for over 3,500 lawsuits

Trailer:
https://www.youtube.com/watch?v=quZEHjkVjTA

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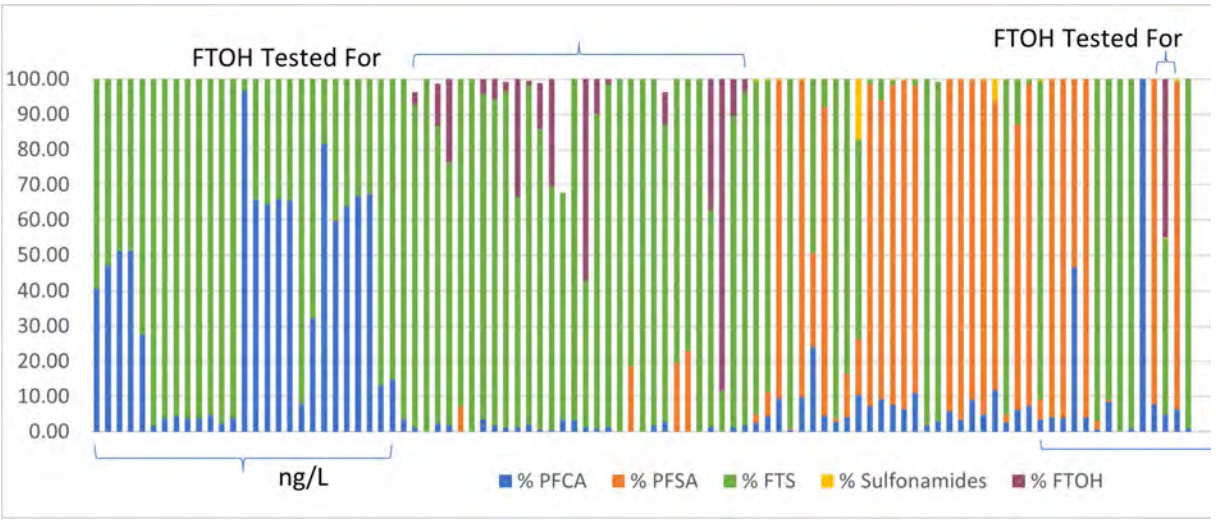
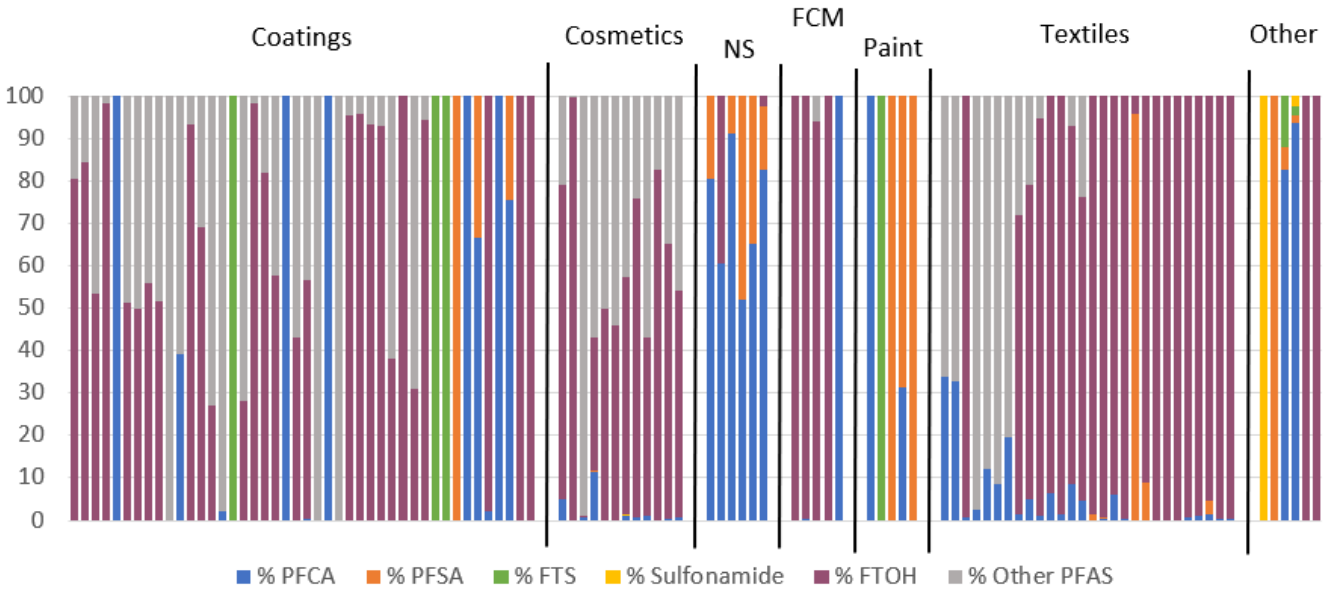
PFAS in daily life

AFFF





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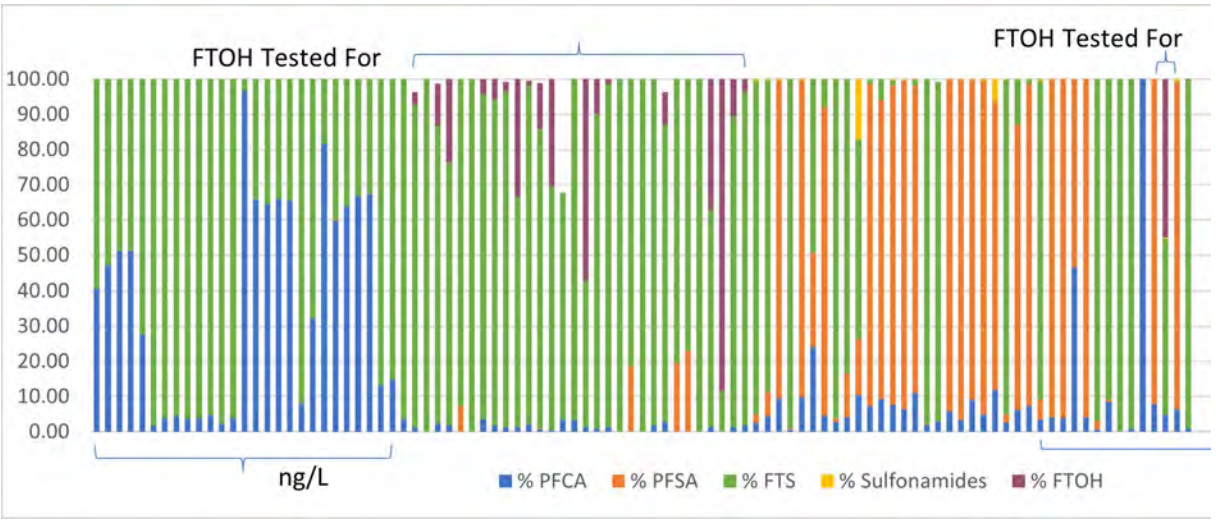
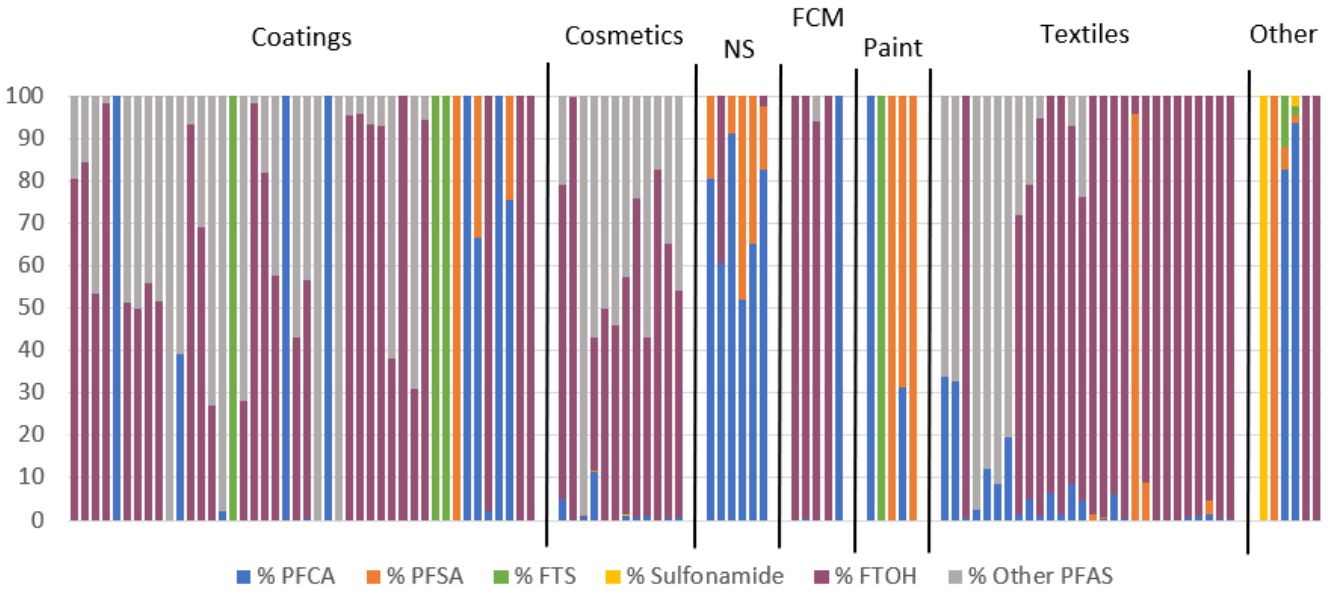
PFAS in daily life

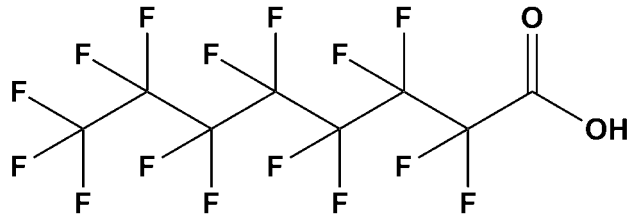
AFFF





For Example:

PFOA



PFBA PFHpA PFHxA PFNA PFDA ….

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PFAS in daily life

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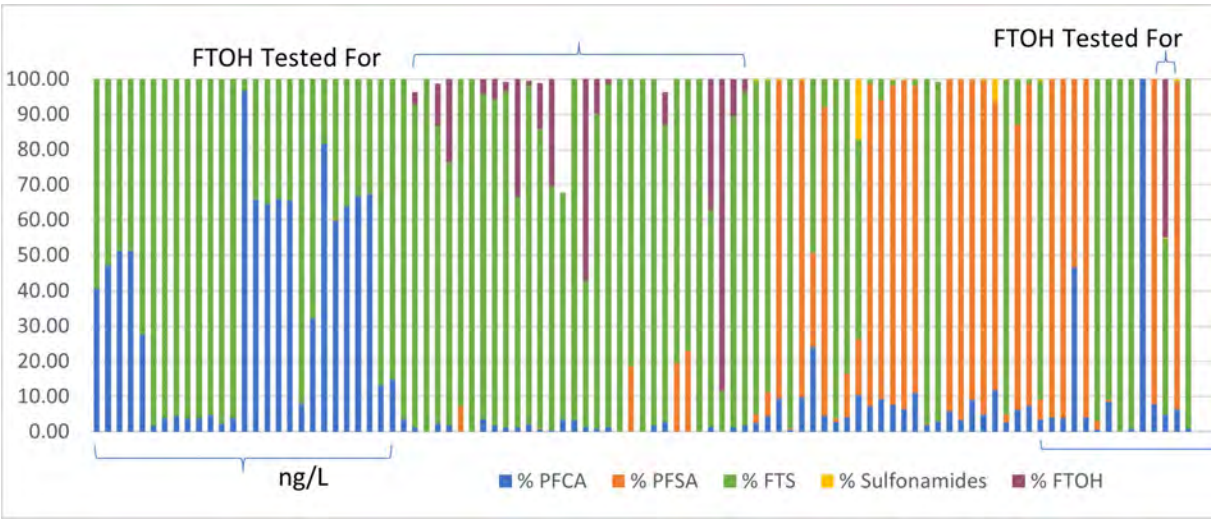
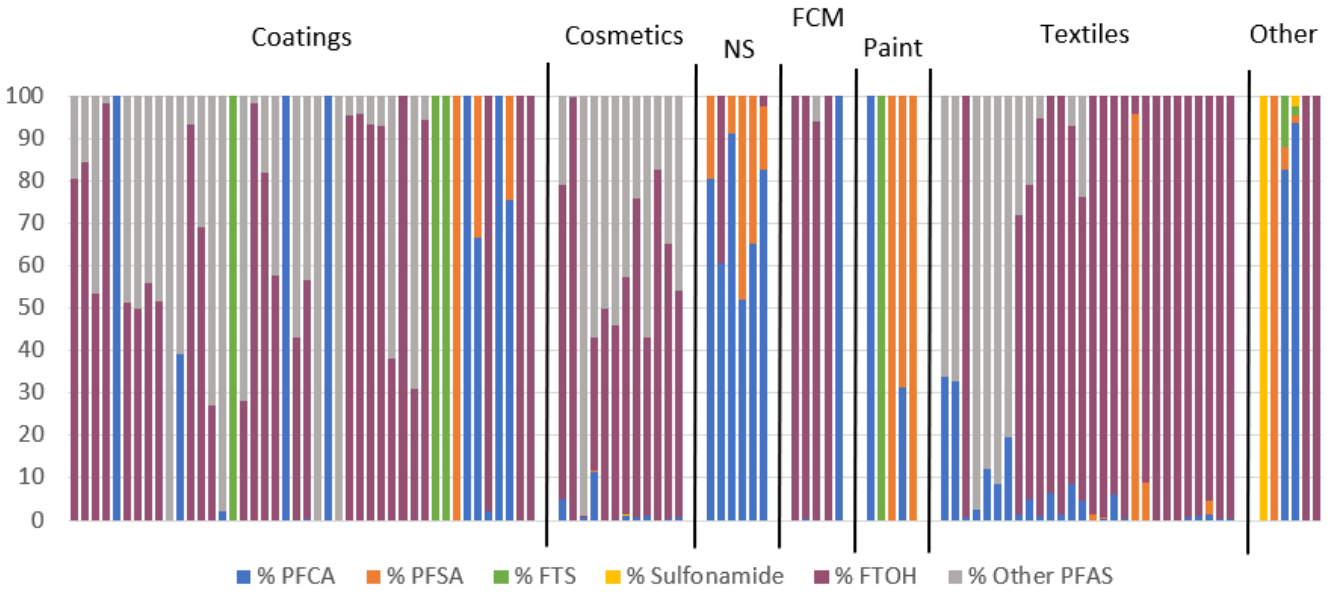
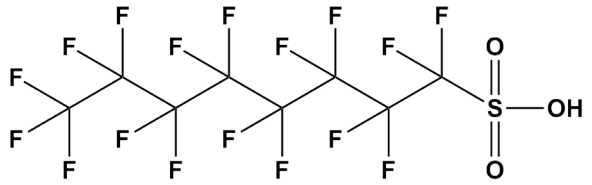




For Example:

PFOS



PFBS PFHxS …

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PFAS in daily life

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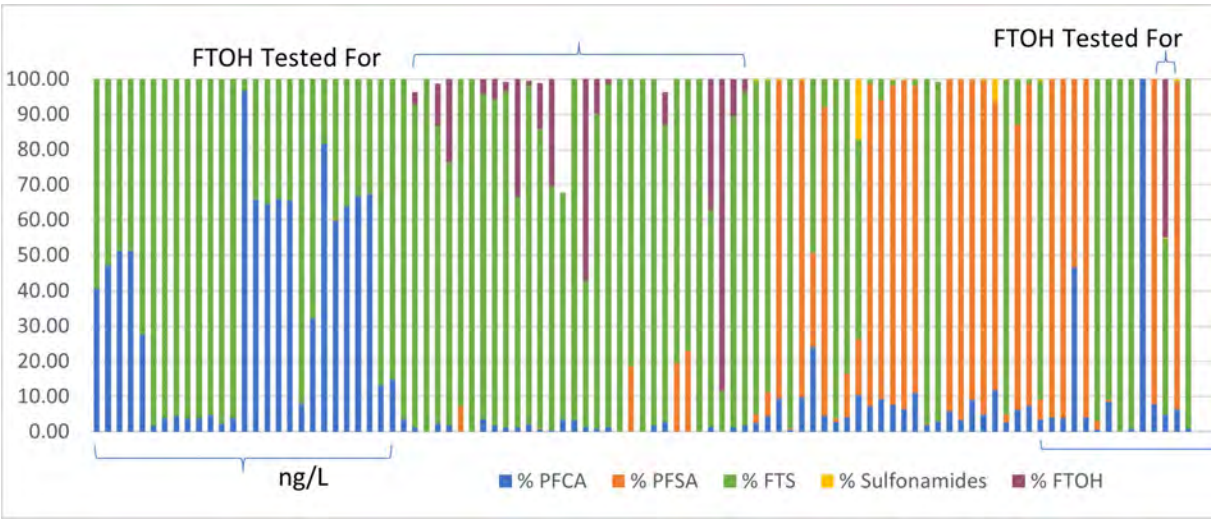
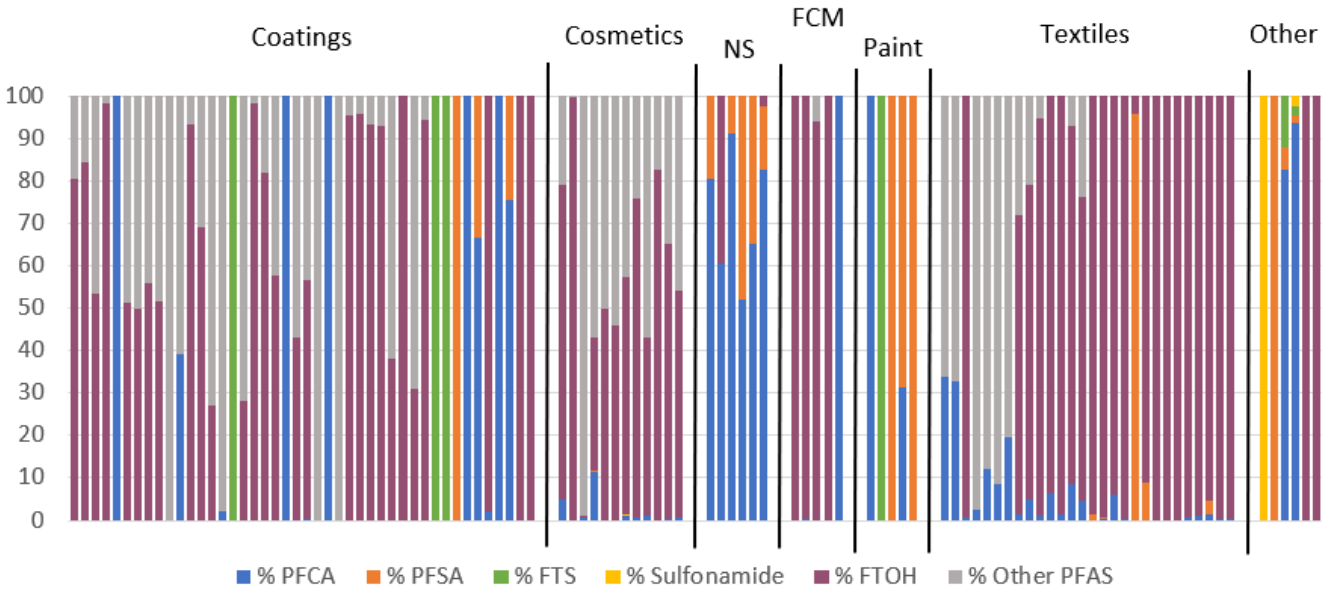
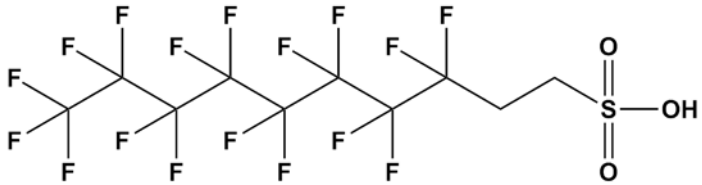




For Example:

8:2 FTS



4:2 FTS 6:2 FTS …

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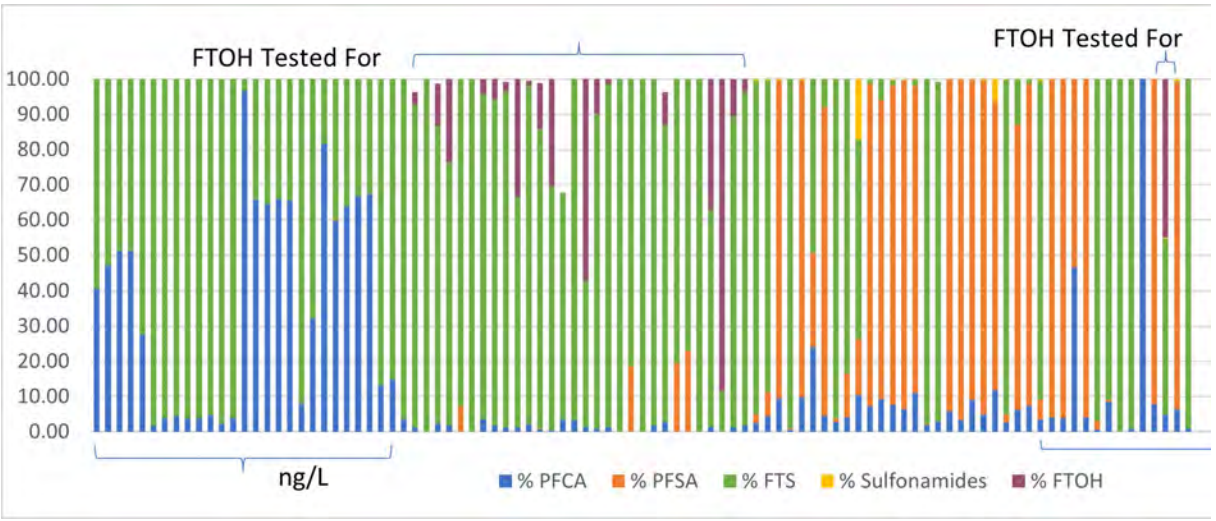
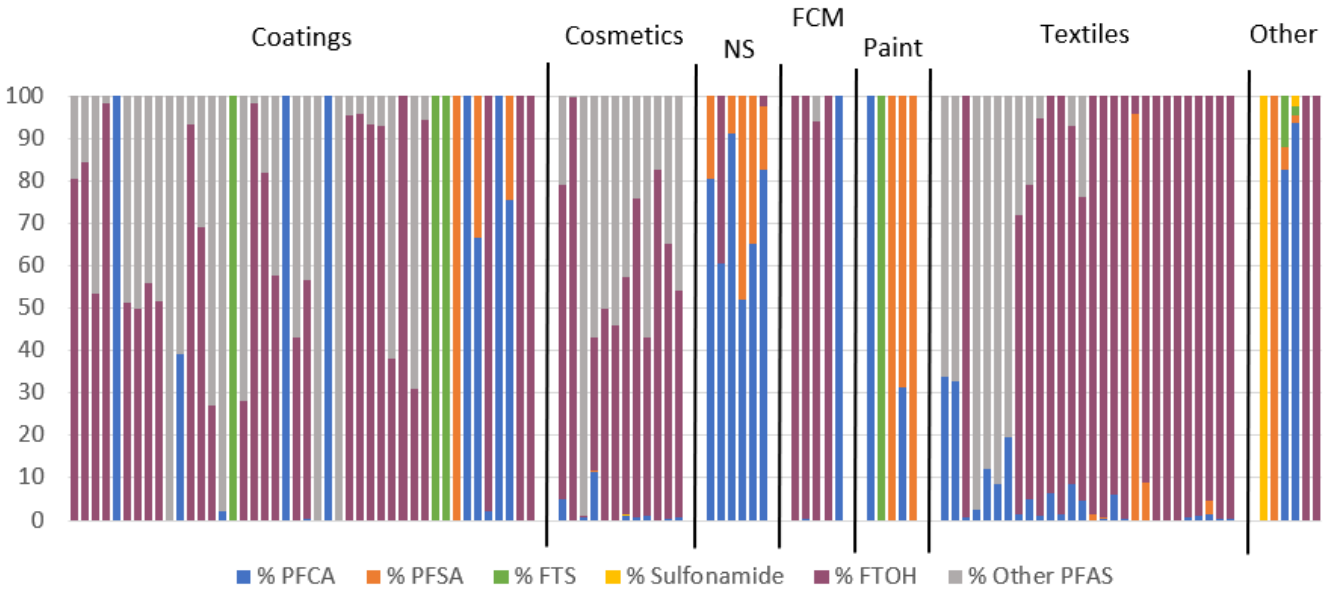
PFAS in daily life

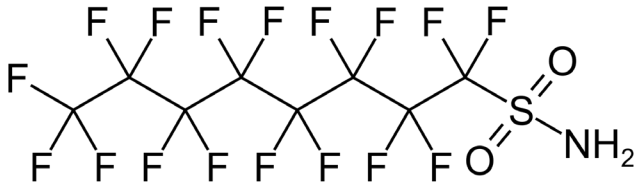
AFFF





For Example:

FOSA



MeFOSA EtFOSA MeFOSE EtFOSE …

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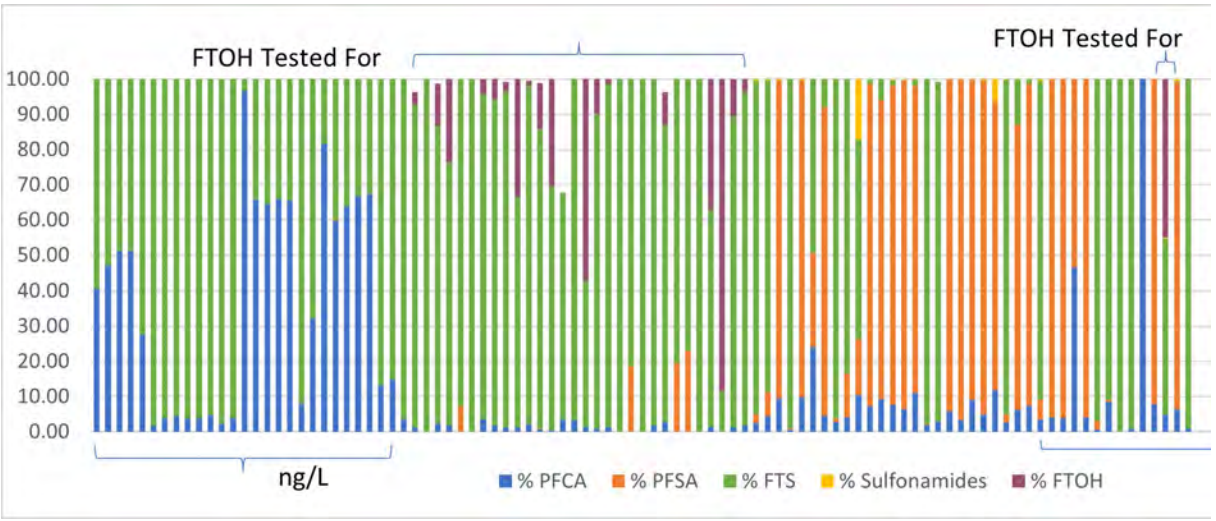
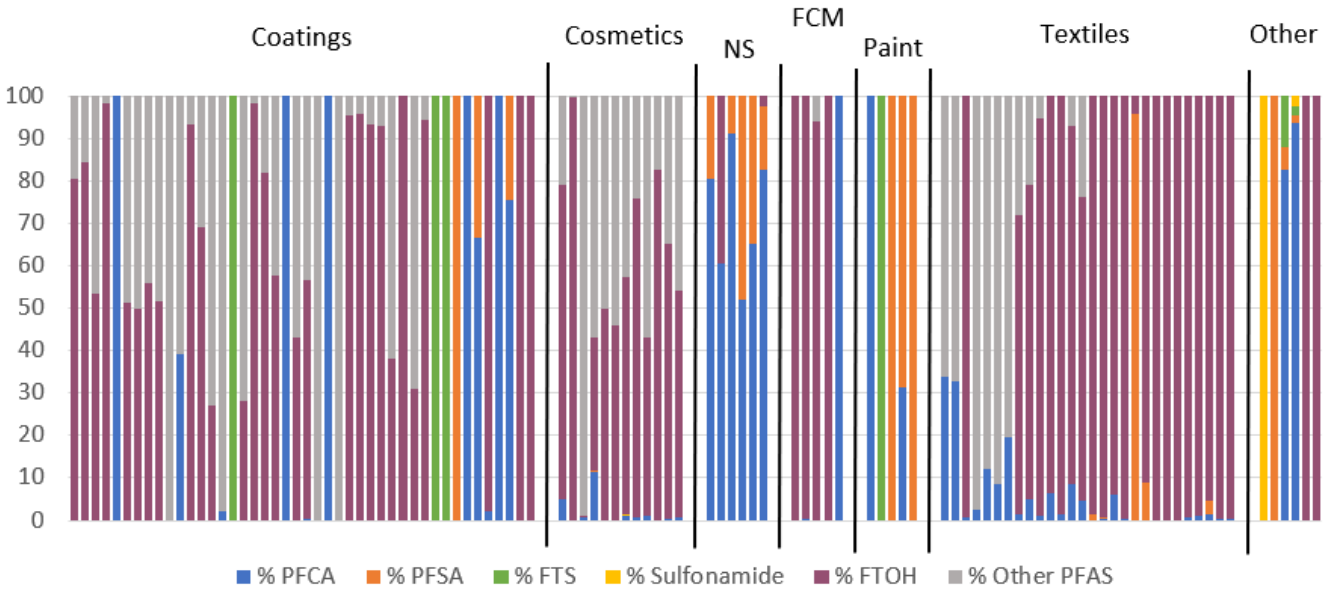
PFAS in daily life

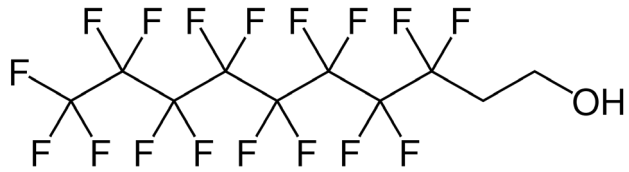
AFFF





For Example:

8:2 FTOH →



4:2 FTOH 6:2 FTOH …

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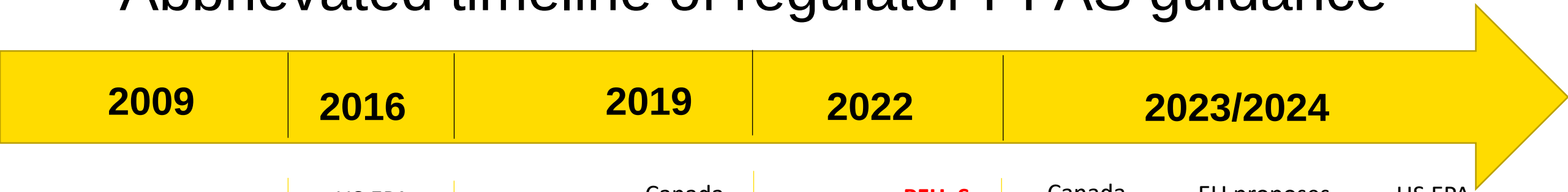
Abbrievated timeline of regulator PFAS guidance



2009

PFOS added to the Stockholm Convention for the protection of human health and the environment from persistent organic pollutants

US EPA drinking water provisional health advisory for **PFOA** (400 ng/L)

2016

US EPA drinking water provisional health advisory for **PFOA and PFOS** (7 ng/L)

2019

PFOA added to the Stockholm Convention for the protection of human health and the environment from persistent organic pollutants

Canada drinking water guidance/ screening values for **PFOS, PFOA, PFBA, PFBS, PFHxS, PFPeA, PFHxA, PFHpA, PFNA, 6:2 FTS, 8:2 FTS** (200 ng/L to 30,000 ng/L)

2022

US EPA drinking water health advisory for **PFOA** (0.004 ng/L) and **PFOS** (0.02 ng/L)

PFHxS added to the Stockholm Convention for the protection of human health and the environment from persistent organic pollutants

2023/2024

Canada proposes drinking water objective that **sum of all PFAS** < 30 ng/L

China drinking water **PFOA and PFOS** (80 & 40 ng/L)

EU proposes drinking water guidance for **sum of all PFAS** < 500 ng/L or **20 select PFAS** < 100 ng/L

US EPA includes **PFBS, GenX, PFHxS and PFNA** in PFAS national primary drinking water regulation

Stockholm Convention for the protection of human health and the environment from persistent organic pollutants currently reviewing **long-chain PFCAs (e.g., PFNA & longer)**

Global Guidance for PFAS in Soil

		PFOA (ng/g)	PFOS (ng/g)
USEPA	Groundwater protection	0.00004	0.015
	Residential soil	0.019	6.3
	Industrial soil	0.078	58
Australia	Residential with garden/accessible soil*	100	10
	Residential with minimal opportunities for soil access*	20,000	2,000
	Public open space*	10,000	1,000
	Industrial/commercial soil	50,000	20,000
Canada	Protection of potable groundwater	--	10
	Agricultural/Residential Parkland Land Use	700	2,000
Netherlands		1,100	110
Norway		13	2.3
Denmark	Soil and GW used as Water Supply* (4 PFAS)	10	10
	Soil and GW used as Water Supply* (22 PFAS)	400	400
NEMP 3.0		3	1.1

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5 years

Deadline for public water utilities to meet US Environmental Protection Agency drinking-water limits for six per- and polyfluoroalkyl substances (PFAS)

4,100–6,700

Number of public water utilities that will need systems to remove PFAS from drinking water, according to US EPA estimates

$15 billion over 10 years

Cost of building advanced treatment systems to meet the drinking-water limits for PFAS, according to US EPA estimates

$9 billion

Amount the US Bipartisan Infrastructure Law provided in 2021 to help communities reduce PFAS in drinking water, of which $4 billion is for state grants to pay for PFAS removal systems

$10.3 billion

Amount 3M will pay over the next 13 years under a settlement with more than 11,000 public water utilities to help them remove PFAS

>90 million kg

Amount of virgin activated carbon that Calgon Carbon produces annually in the US for water treatment and other uses

Getting PFAS out of drinking water (acs.org)

nature geoscience

Article

https://doi.org/10.1038/s41561-024-01402-8

Underestimated burden of per- and polyfluoroalkyl substances in global surface waters and groundwaters

Received: 27 September 2023

Accepted: 15 February 2024

Diana Ackerman Grunfeld[1], Daniel Gilbert[1], Jennifer Hou[1], Adele M. Jones[1], Matthew J. Lee[1], Tohren C. G. Kibbey[2] & Denis M. O'Carroll[1]

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The New York Times

PFAS 'Forever Chemicals' Are Pervasive in Water Worldwide, Study Finds

A global survey found harmful levels even in water samples taken far any obvious source of contamination.

Share full article

The study "sets off alarm bells," one of the authors said. Joshua A. Bickel/Associated Press

By Delger Erdenesanaa

April 8, 2024

PFAS

Australia among hotspots for toxic 'forever chemicals', study of PFAS levels finds

Australian limits on acceptable levels of these toxic chemicals in drinking water 'orders of magnitude' higher than in US

- Follow our Australia news live blog for latest updates
- Get our morning and afternoon news emails, free app or daily news podcast

Tory Shepherd

Tue 9 Apr 2024 01.00 AEST

Share

Many everyday items, including food packaging, contain toxic 'forever' chemicals. Photograph: AAP

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d drinking water

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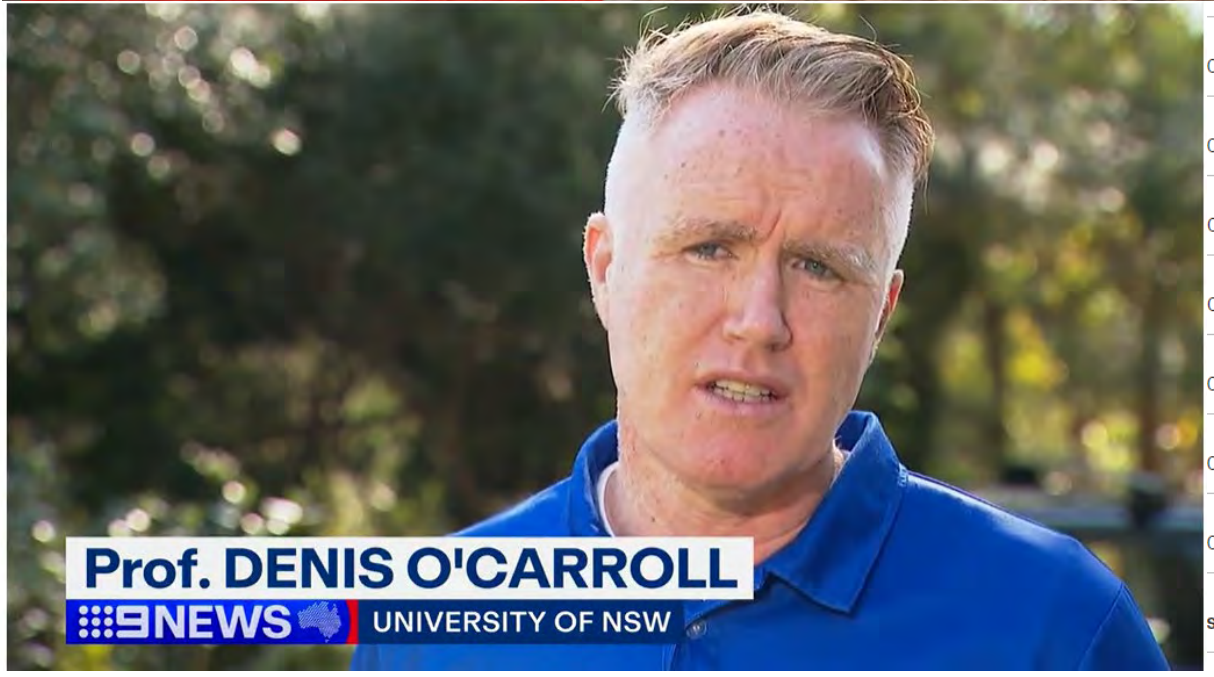
2024

S (µg/L)	PFHxS (µg/L)	PFOA (µg/L)
55	0.0136	< 0.0001
04	0.0142	< 0.0001



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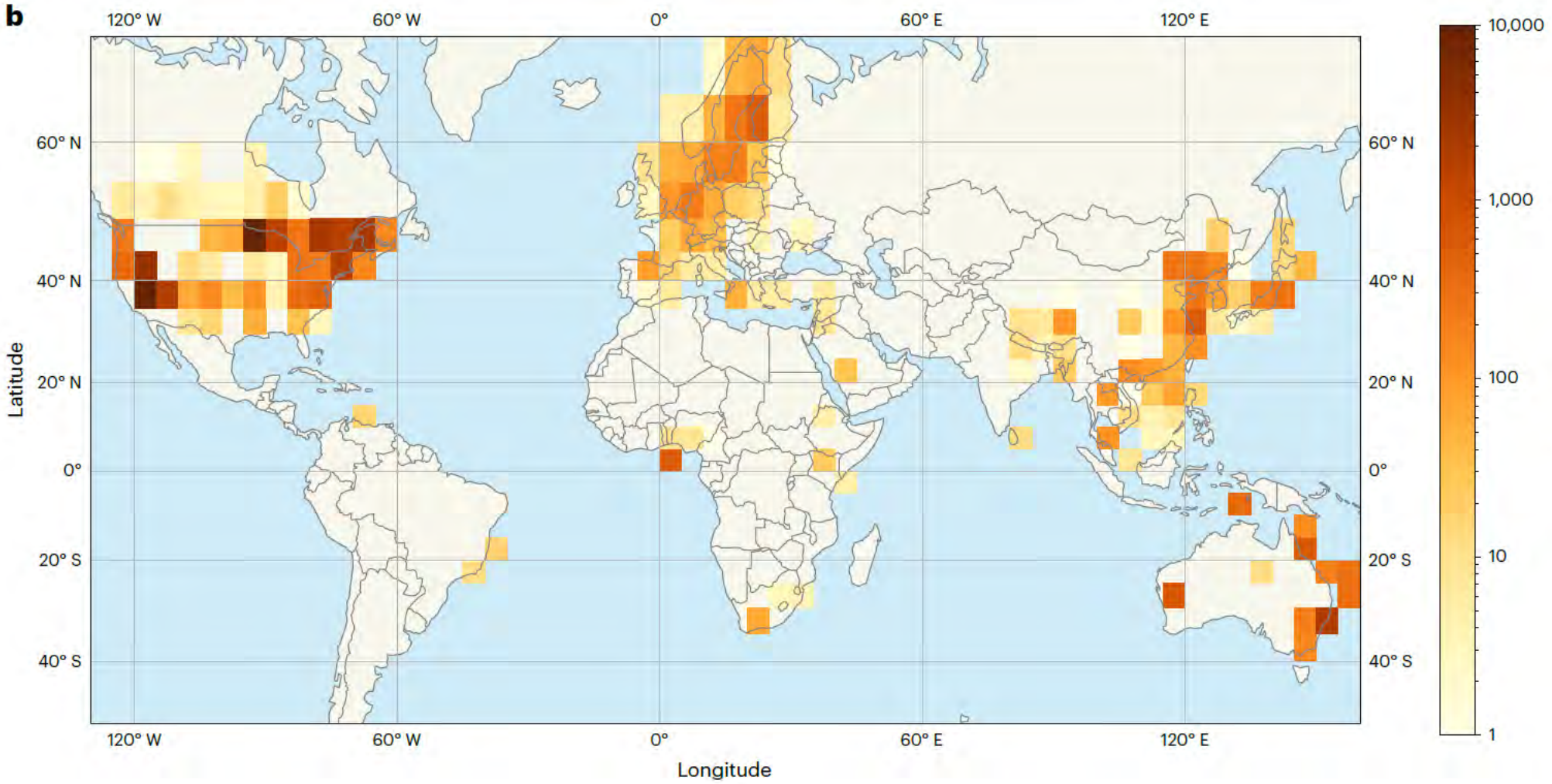

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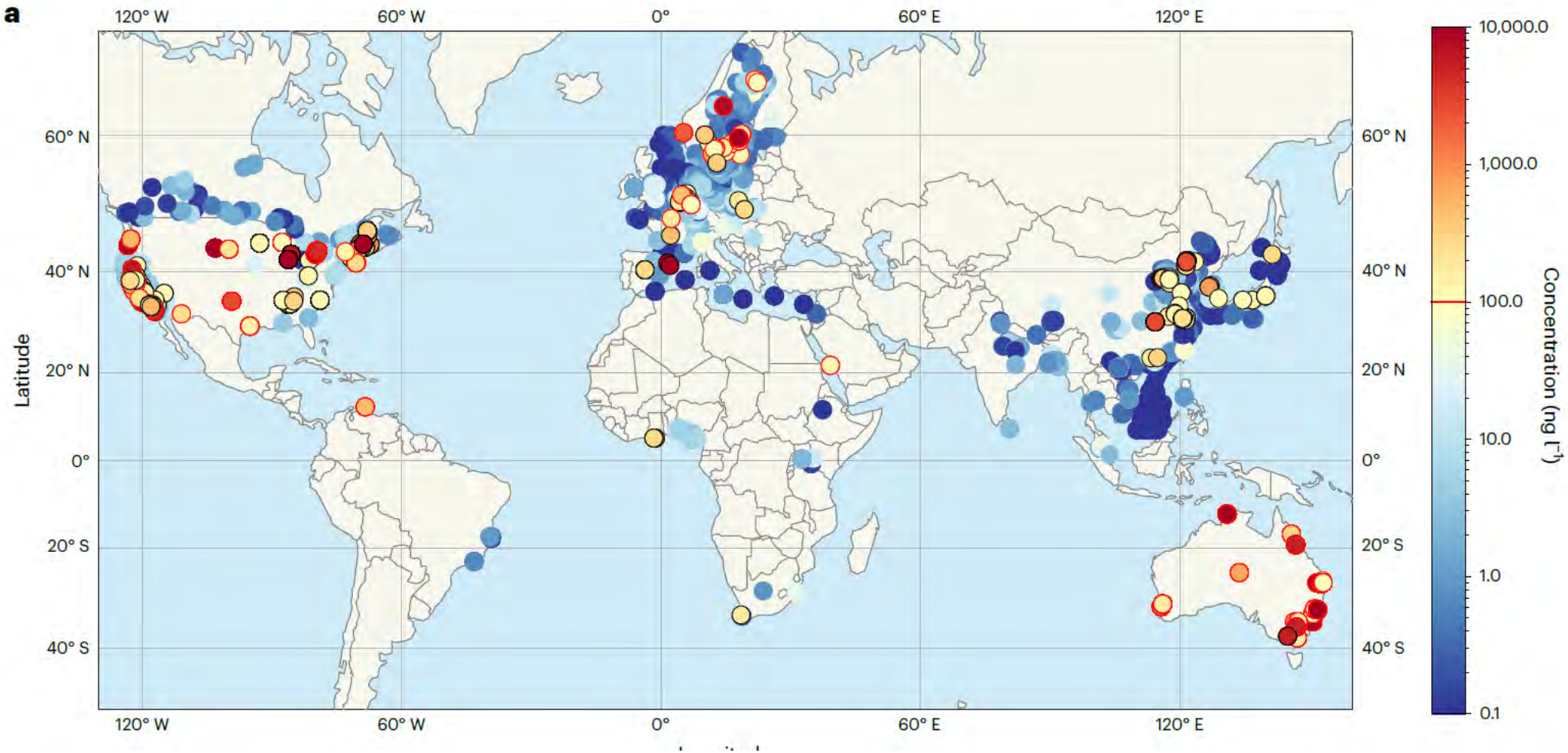
Sum of concentration of 20 PFAS subject to EU guidance in surface water, groundwater and drinking water samples.



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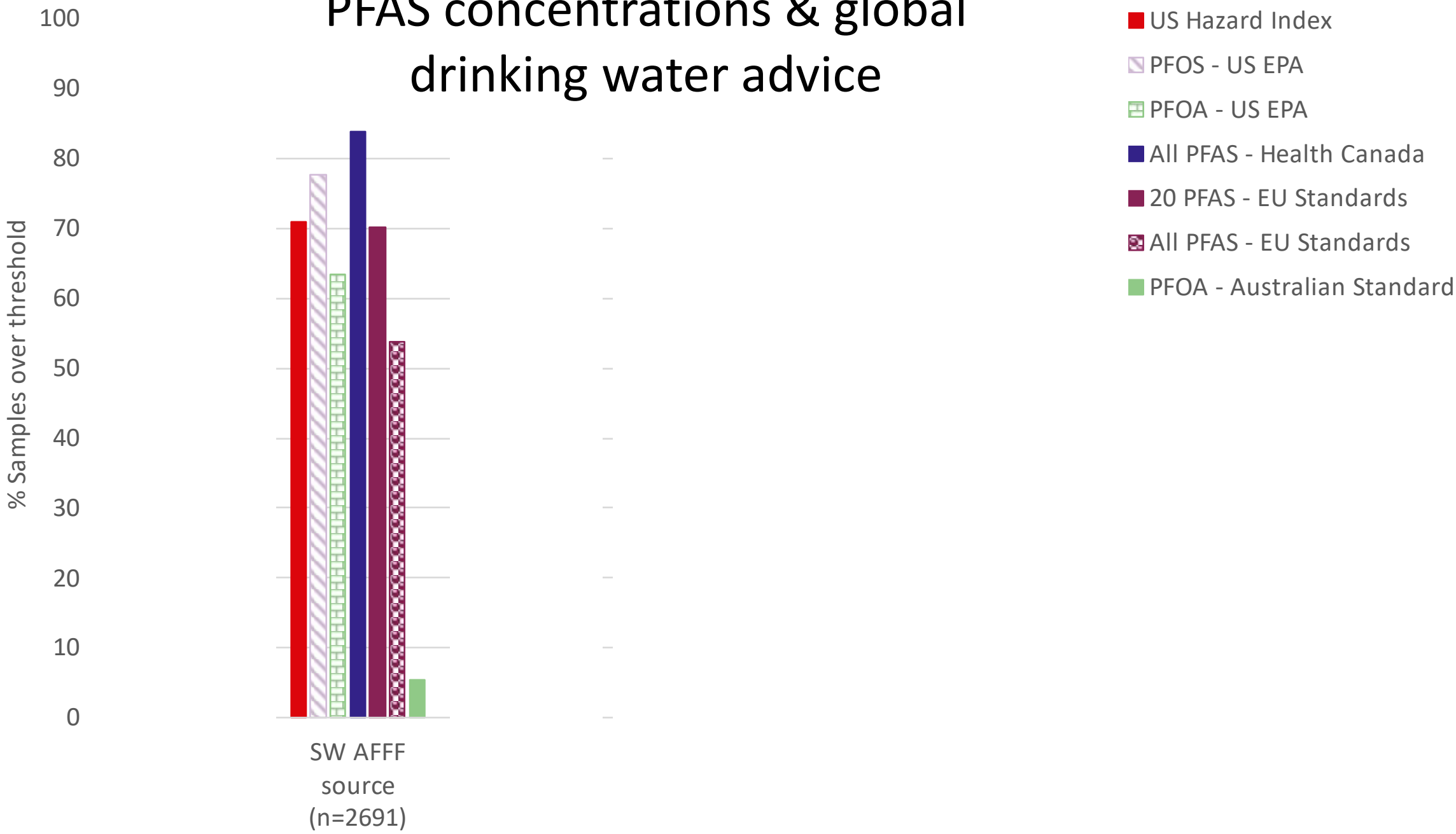
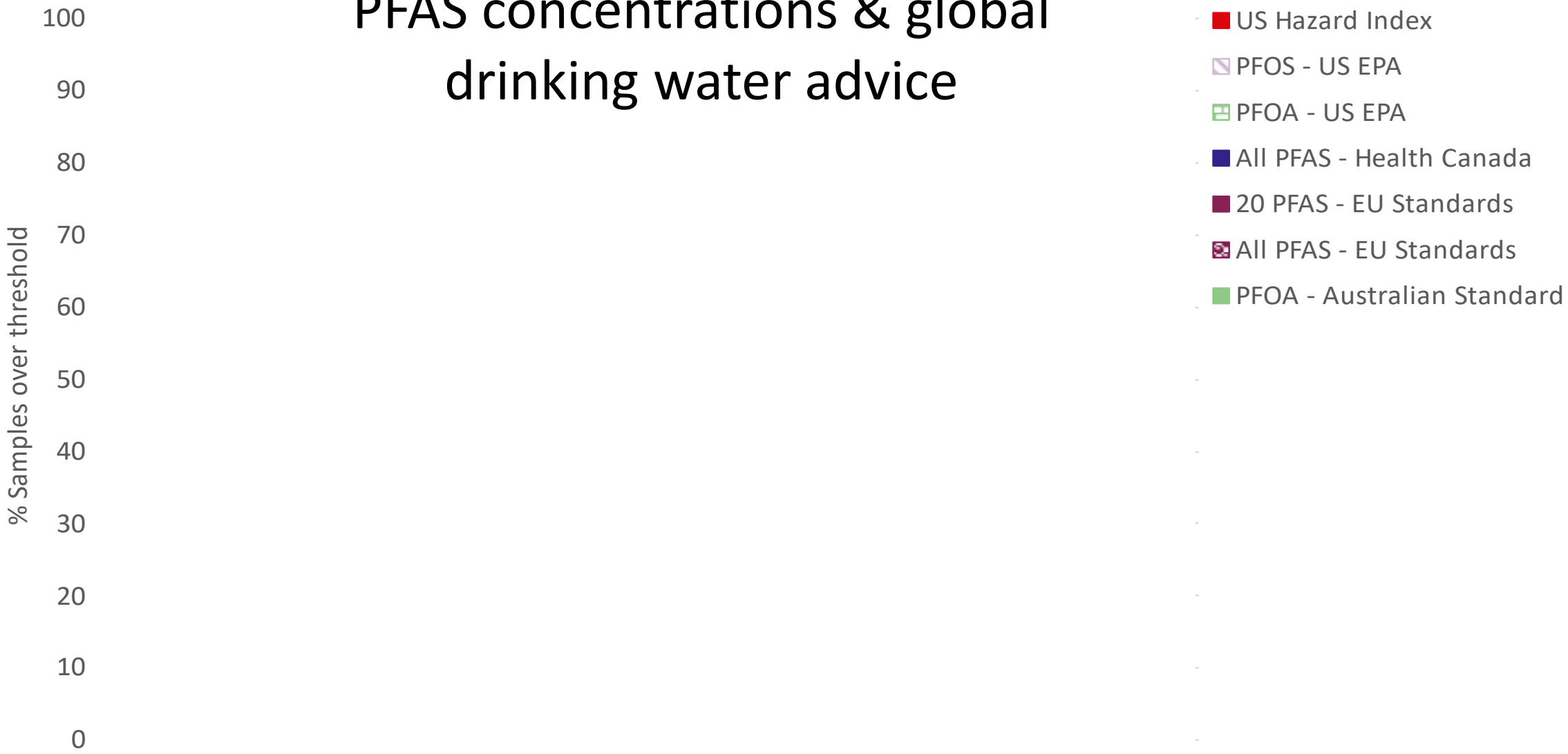
PFAS concentrations & global drinking water advice



arch

PFAS concentrations & global drinking water advice



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NEMP 3.0		3	1.1

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Global Guidance for PFAS in Soil

Background soils often exceed these criteria

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Global Guidance for PFAS in Soil

Biosolids often exceed these criteria

		PFOA (ng/g)	PFOS (ng/g)
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	Residential soil	0.019	6.3
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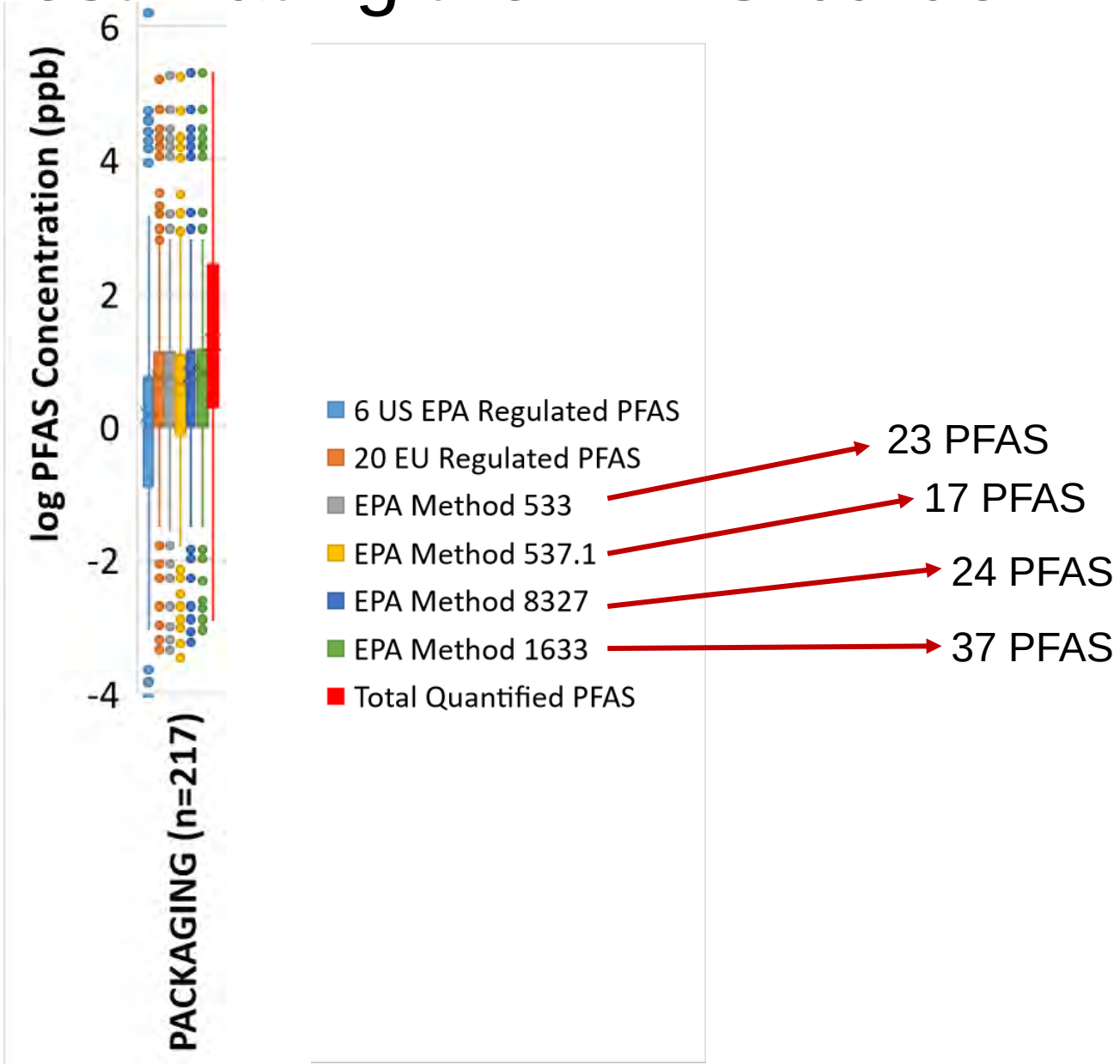
We’re underestimating the PFAS burden



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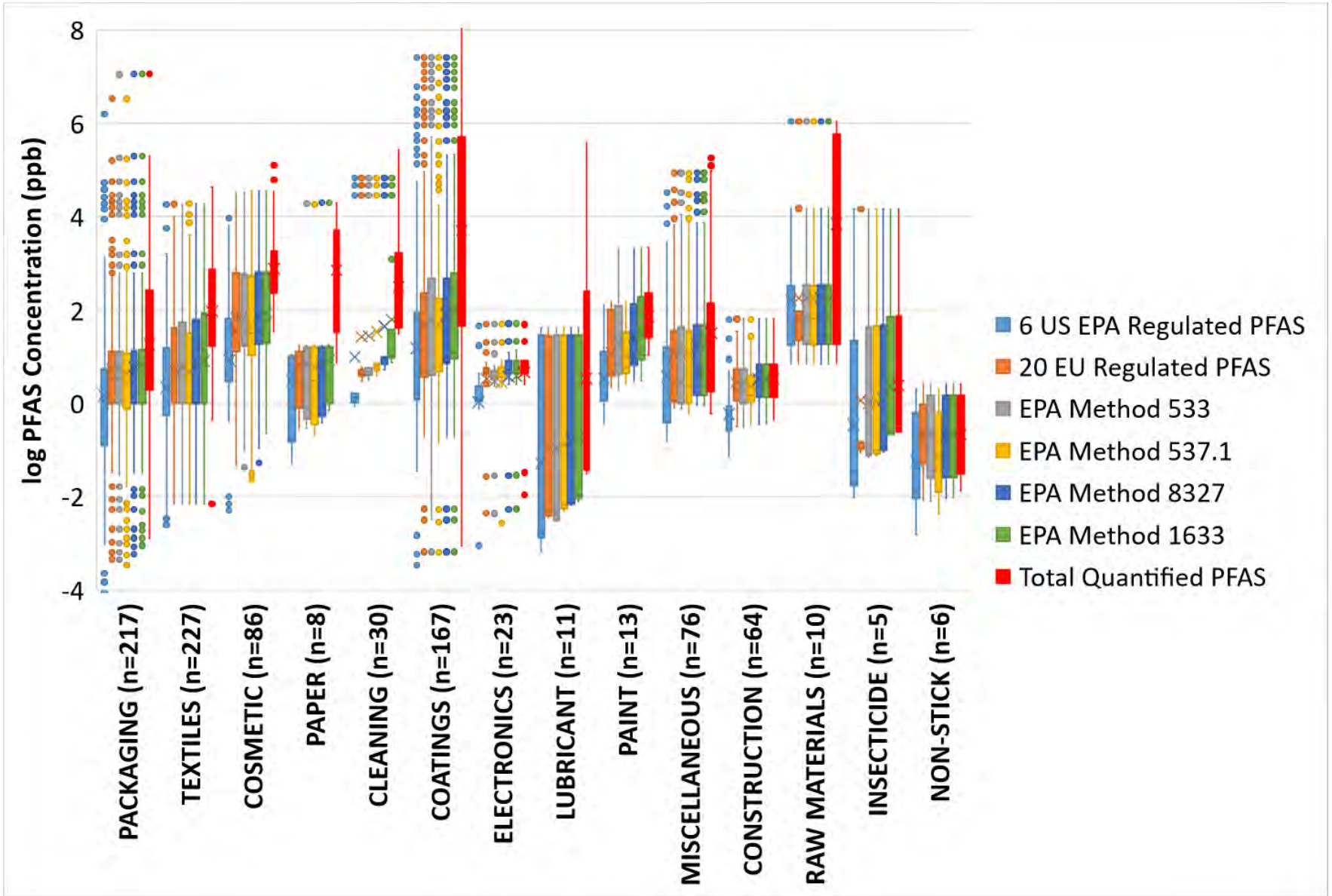

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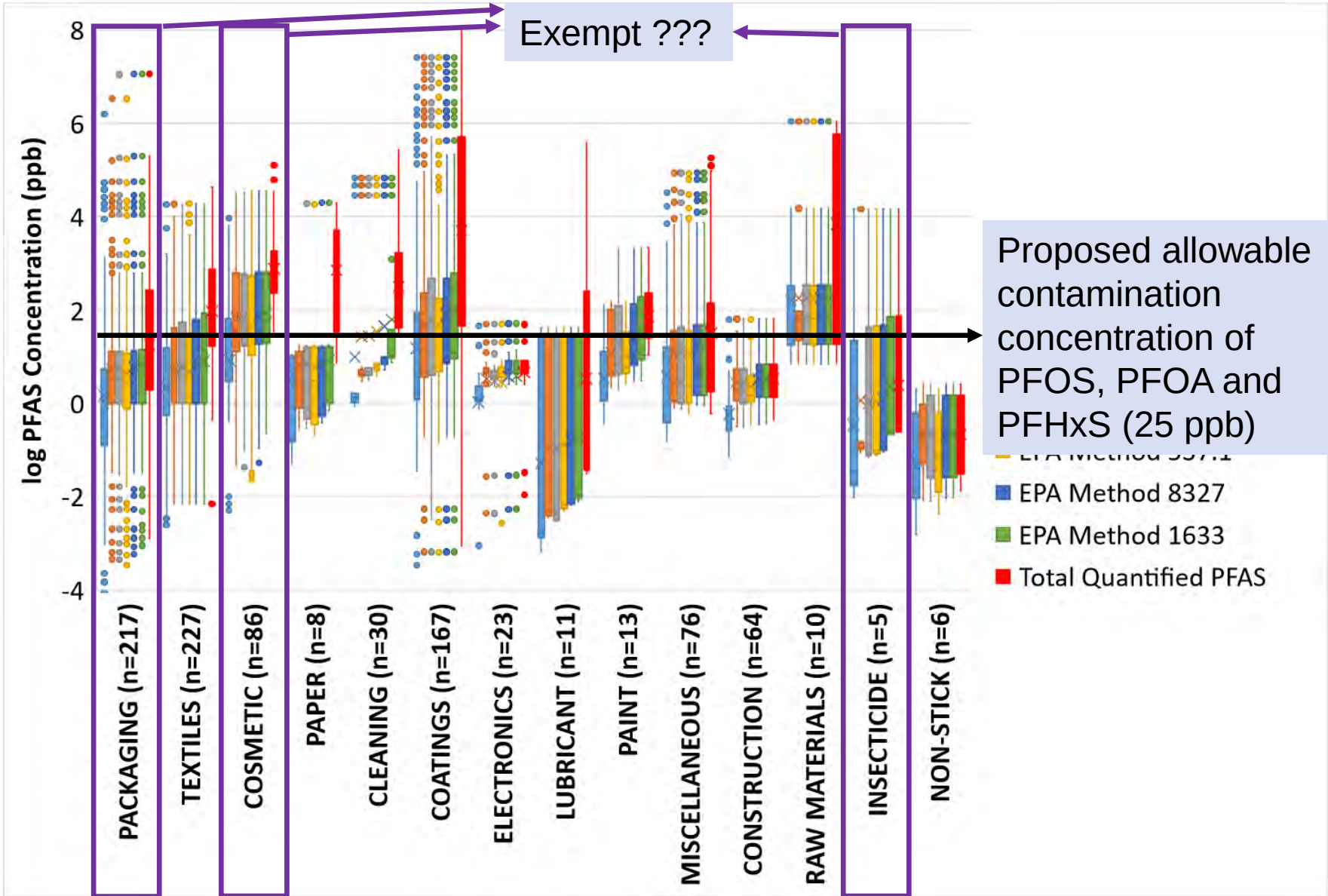
https://documents.packagingcovenant.org.au/public-documents/Quick%20Guide%20to%20APCO's%20Action%20Plan%20to%20Phase%20Out%20PFAS%20in%20Fibre-Based%20Food%20Contact%20Packaging

We're underestimating the PFAS burden



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Degradation of Precursors

ENVIRONMENTAL Science & Technology

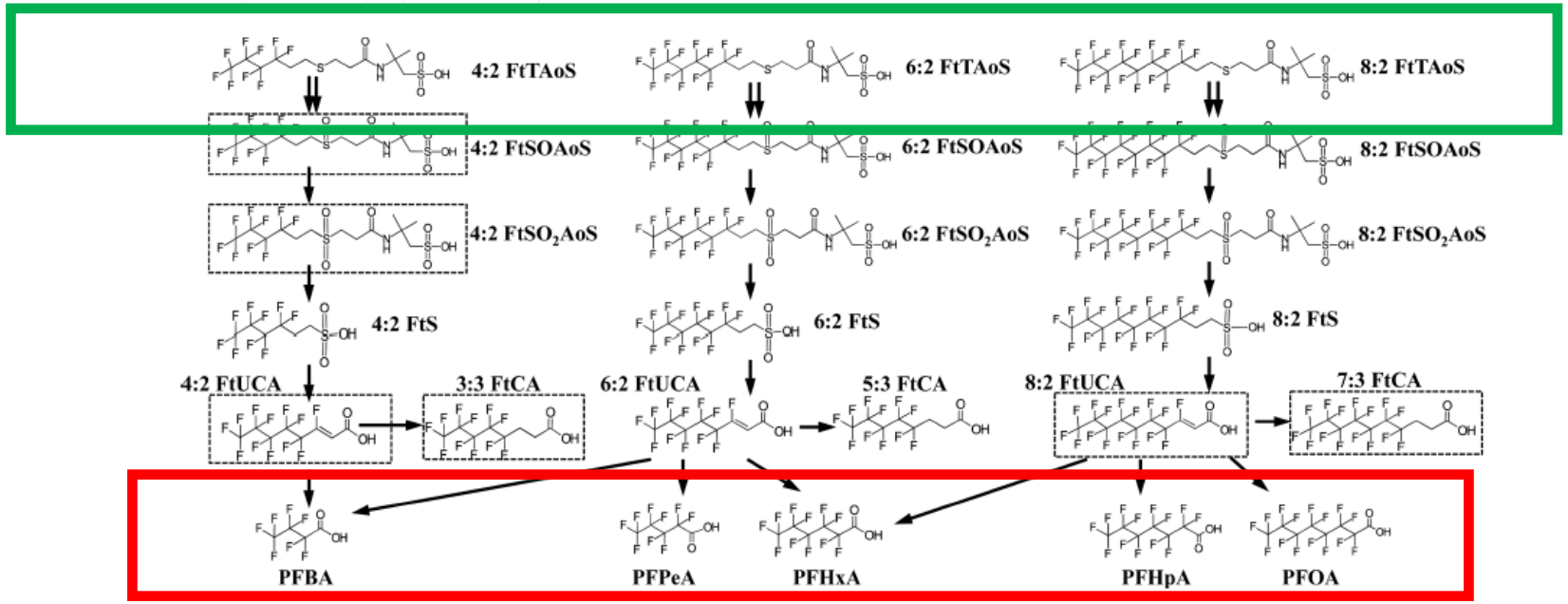
Article

pubs.acs.org/est

Aerobic Biotransformation of Fluorotelomer Thioether Amido Sulfonate (Lodyne) in AFFF-Amended Microcosms

Katie C. Harding-Marjanovic,[†,⊥] Erika F. Houtz,[†,∥] Shan Yi,[†] Jennifer A. Field,[‡] David L. Sedlak,[†] and Lisa Alvarez-Cohen[*,†,§]

[†]Department of Civil and Environmental Engineering, University of California at Berkeley, Berkeley, California 94720, United States
[‡]Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, Oregon 97331, United States
[§]Earth Sciences Division, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, California 94720, United States



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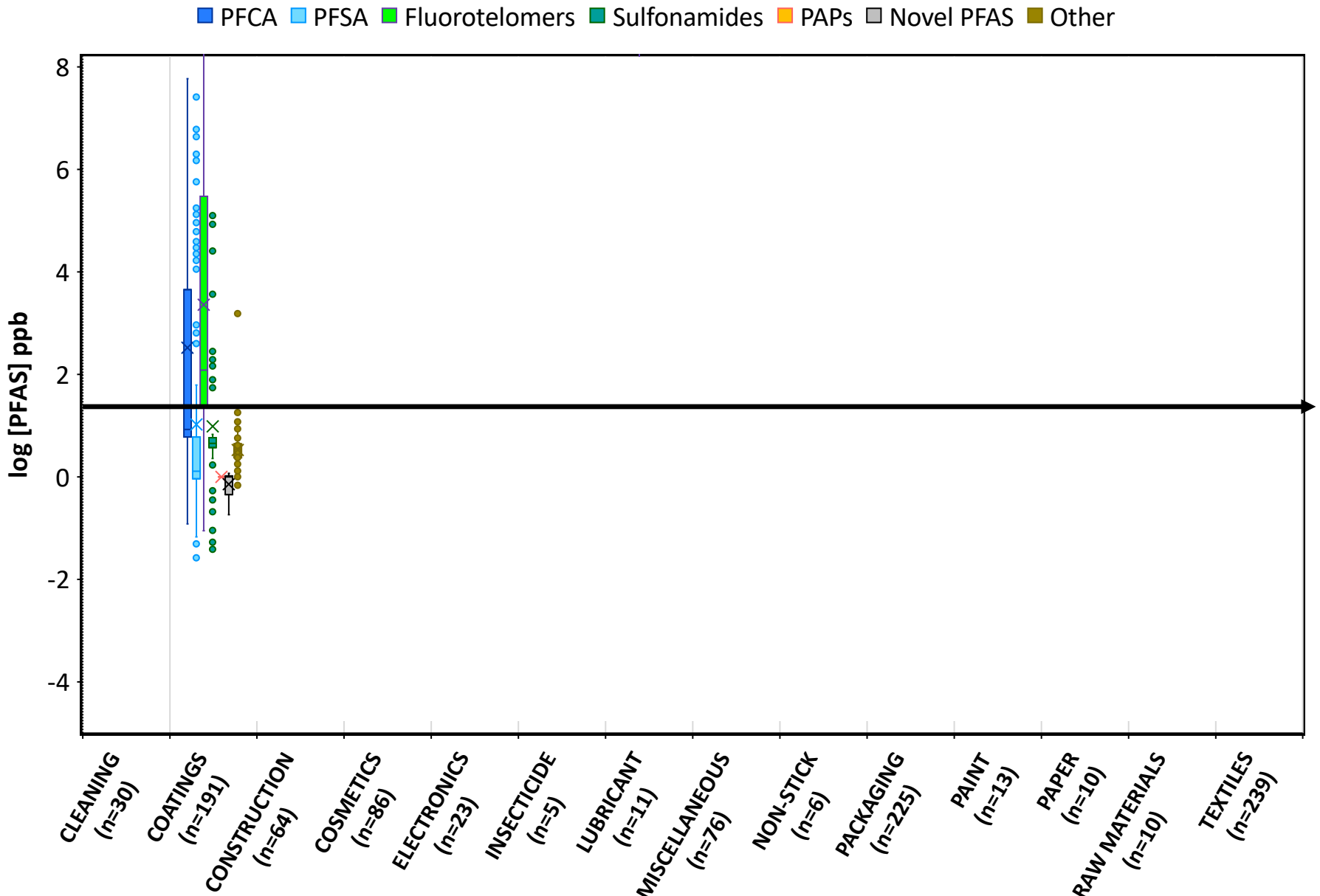
Where does the PFAS come from?



Proposed allowable contamination concentration of PFOS, PFOA and PFHxS (25 ppb)

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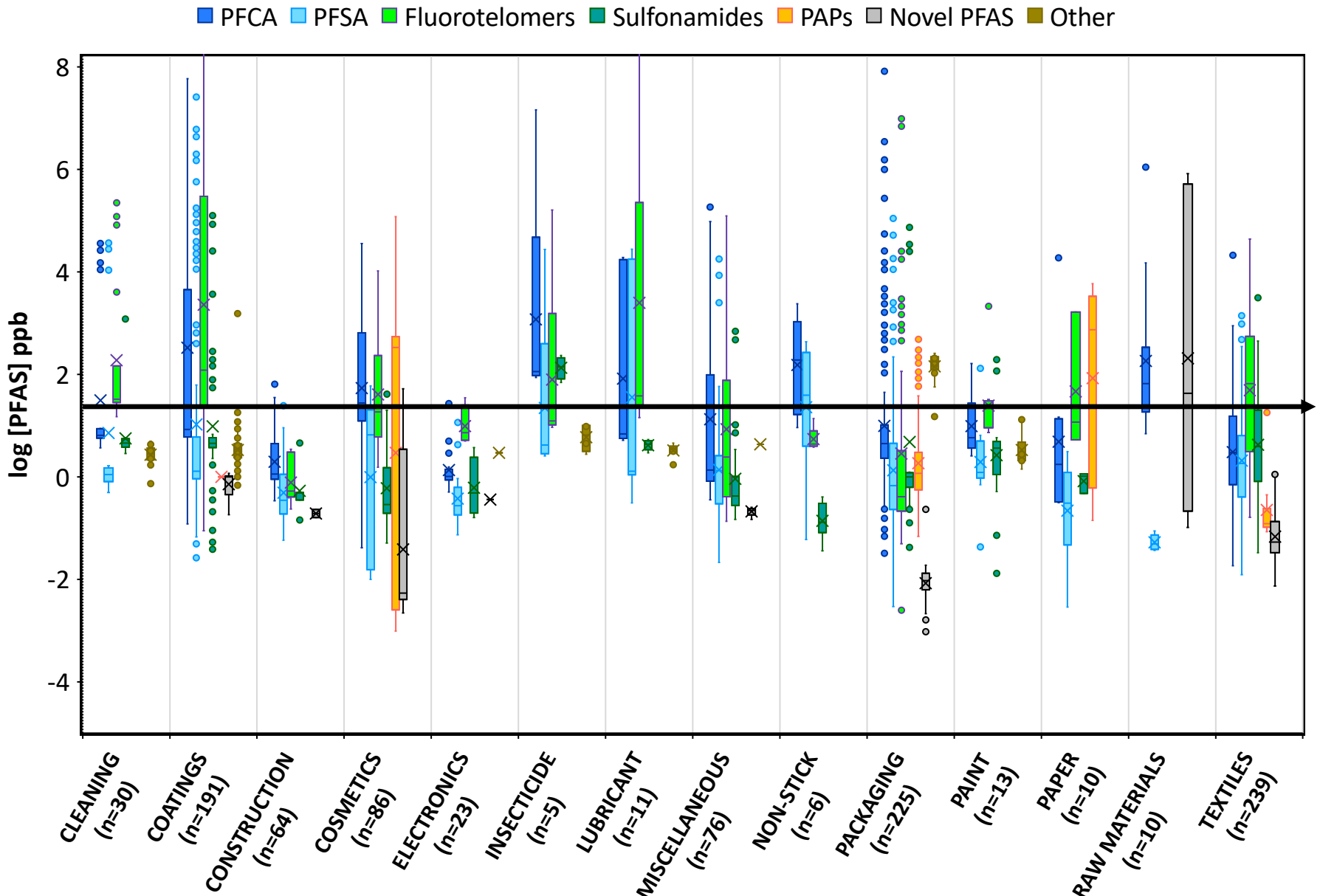
Where does the PFAS come from?



Proposed allowable contamination concentration of PFOS, PFOA and PFHxS (25 ppb)

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Source Control?

Need to quantify mass flux

WWTP

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New Separation and Destructive Technologies

WWTP

Effluent

Biosolids

Circular Economy

Concentrated PFAS?

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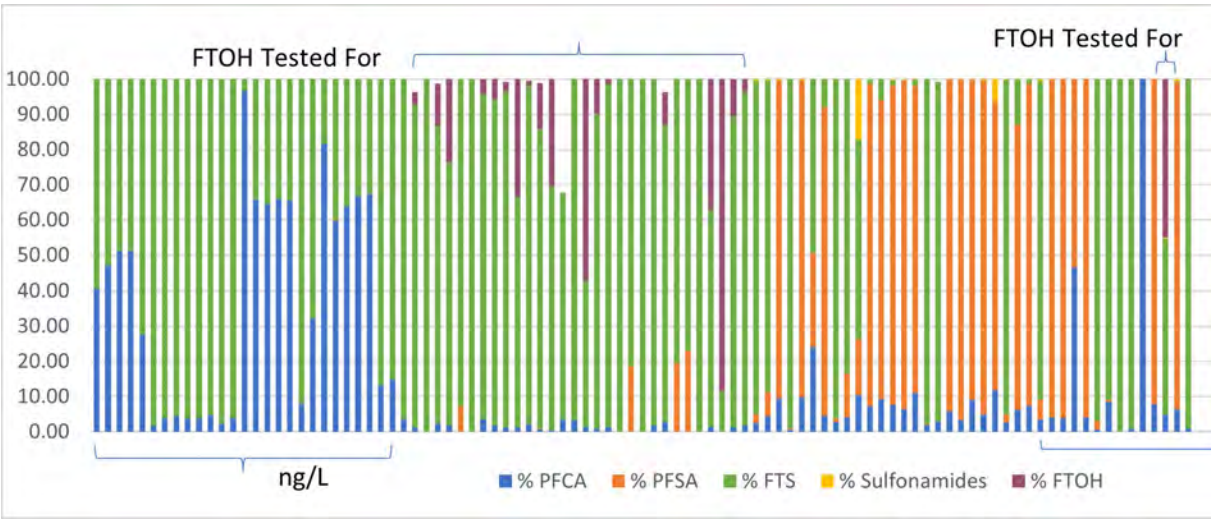
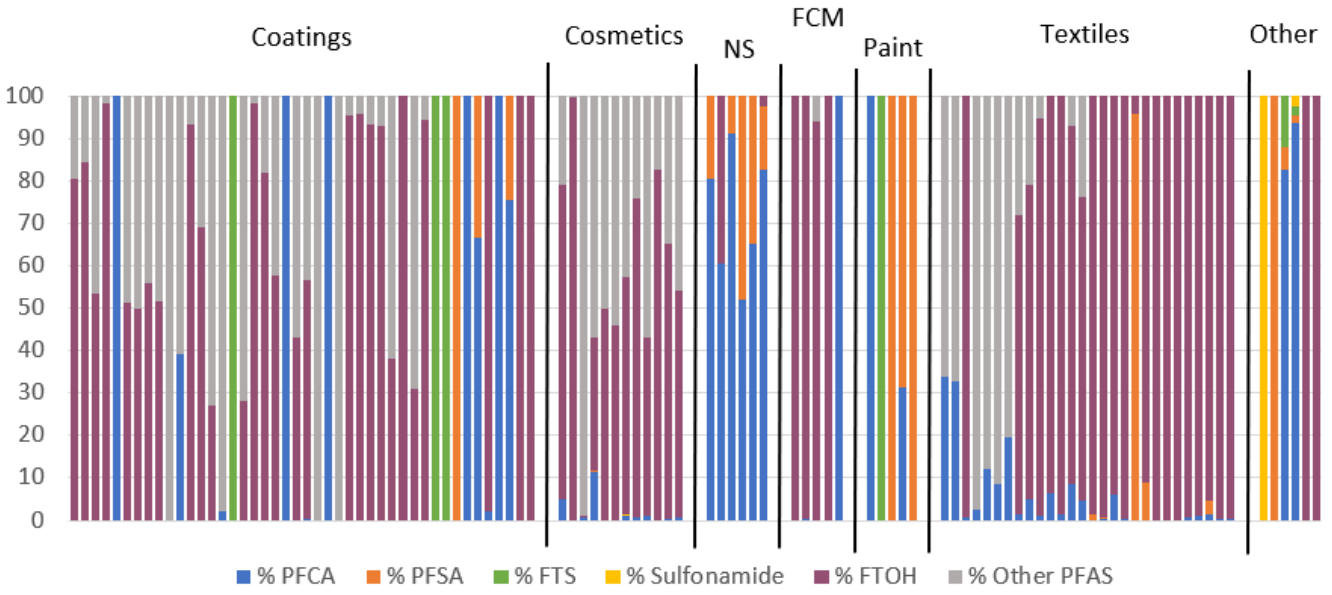
PFAS in daily life

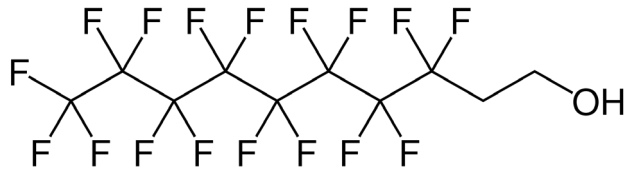
AFFF





For Example:

8:2 FTOH →



4:2 FTOH 6:2 FTOH …

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Unresolved Issues

- We can’t classify all soils globally as PFAS contaminated.
  - We can’t send all soils to a landfill
  - We can’t incinerate all soils
  - How do we proceed?
  - Can we develop a risk framework?
- How do we remove PFAS from our waste stream?
- Need to streamline regulation:
  - Discuss different range of PFAS
  - IChEMS discusses PFOS, PFHxS, PFOA and their precureors
  - Australian Packaging Covenant Organization discusses total fluorine (100 ppm)
- If there are exemptions will PFAS levels remain high in biosolids?
- Would anyone even consider land application of biosolids if even a small fraction of biosolids exceed criteria (e.g., 10% exceedance)

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Summary

- PFAS ubiquitous in our water sources (note I’m not saying drinking water)
- Much of our surface and ground waters exceed a range of drinking water values
- There are potentially 1000s of other PFAS of environmental concern
  - For example fluorotelomer alcohols (FTOH)
- Need to really dig into PFAS source control
- Need to improve our WWTP plants to remove PFAS from biosolids and effluent

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Questions

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