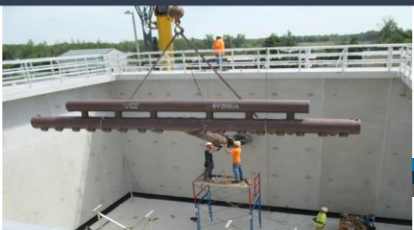


Thank you to our Patrons



We will begin our presentation in a few minutes...



What are the Risks of PFAS? A Practitioner's Overview of Risk Assessment, Management and Communication for Per- and Polyfluoroalkyl Substances in 2024

American Academy of Environmental Engineers and Scientists (AAEES) Webinar Series

Jonathan Petali, PhD, DABT

Human Health Risk Assessor
Environmental Solutions Division
BATTELLE

Wednesday November 20, 2024
12:00-1:30 PM EST

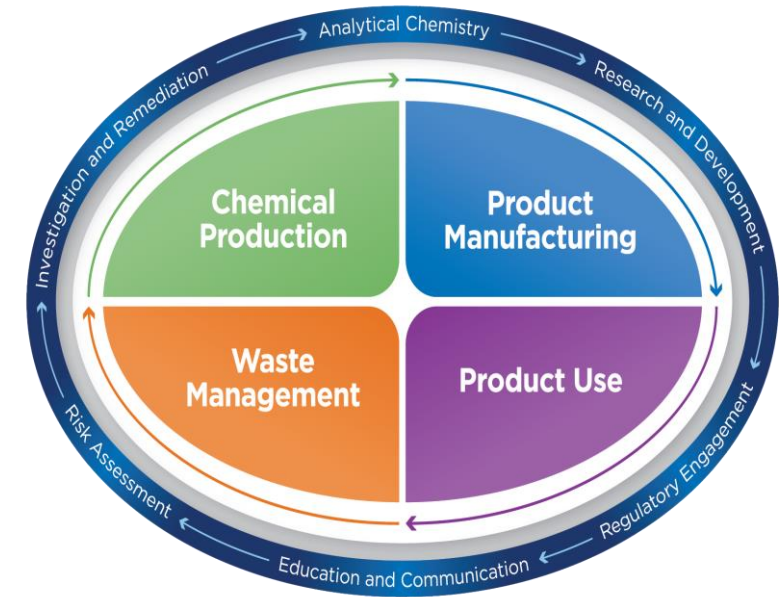
Introductions



Jon Petali, PhD, DABT
Human Health Risk Assessor
Environmental Solutions Division

Battelle Memorial Institute
Philanthropic research non-profit

Our mission is to translate scientific discovery and technology advances into societal benefits.



- Leveraging Battelle-developed technologies to characterize and remediate contaminated (including PFAS) sites.
- Providing analytical chemistry using targeted and non-targeted methods to support investigations, method development, product stewardship and risk assessment.
- Applying environmental chemistry, toxicology, ecology and data science to the management and analysis of complex environmental data.

Agenda

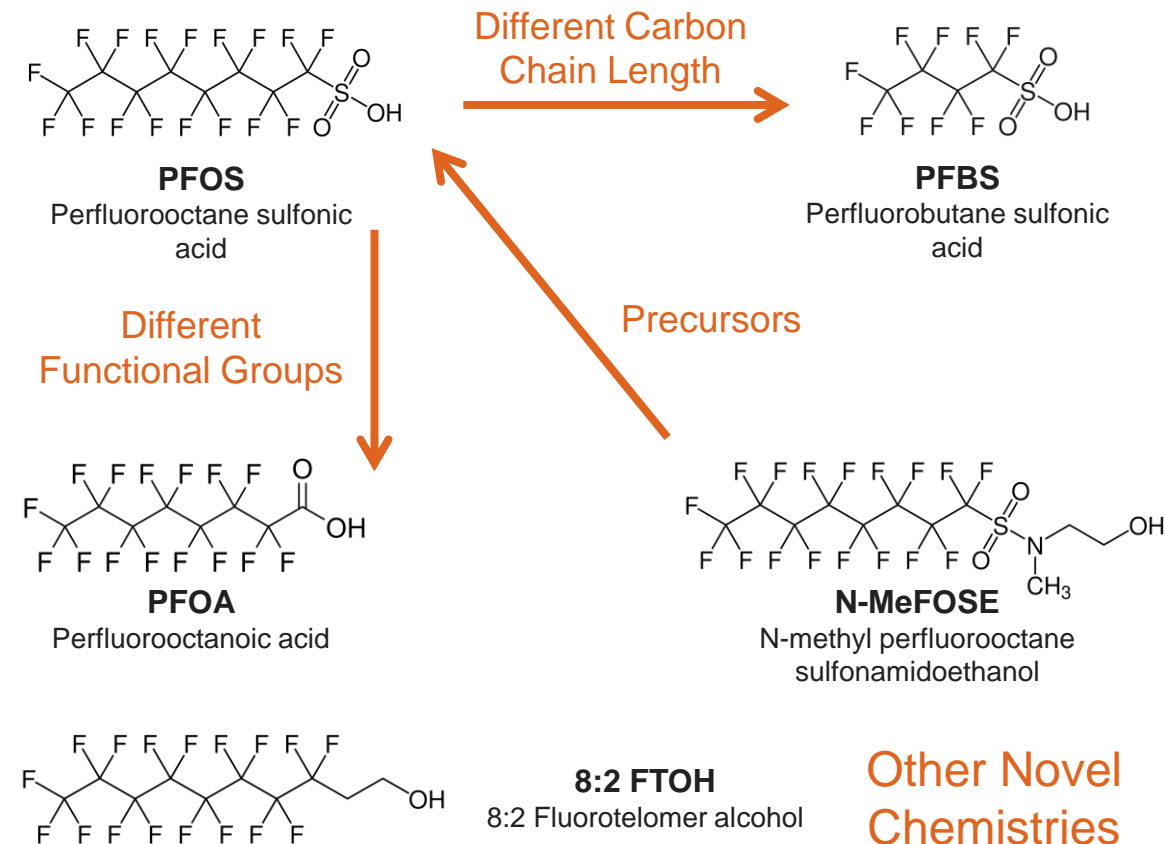
- What are PFAS?
- PFAS Fate & Transport
- Role of Risk Assessment
- Where's the Regulatory Guidance?
- Questions & Discussion

What the F (Fluorine) are Per- & Polyfluoroalkyl Substances?

Technical Description

- Per- and polyfluoroalkyl substances (PFAS) are a large class of fluorinated organic compounds.
 - Formerly called perfluorochemicals (PFCs)
- Depending on your definition, PFAS is a chemical family of >10,000 chemicals.
- Specific PFAS and their properties vary based:
 - Carbon structure
 - Functional group(s)
 - Extent of fluorination (per- versus polyfluorinated)

Example Chemistries

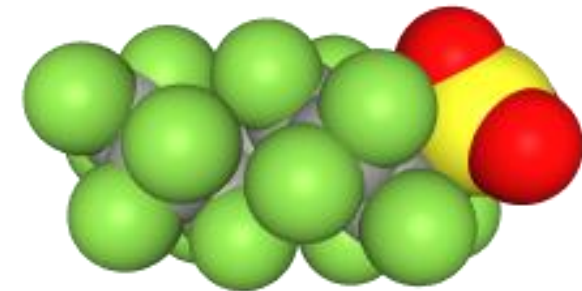
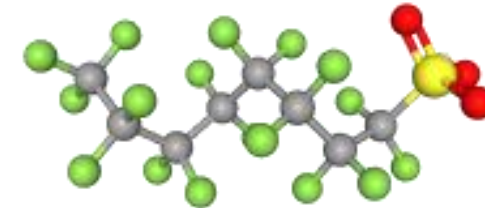
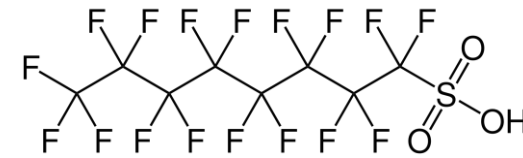


Unique Chemical Properties of PFAS

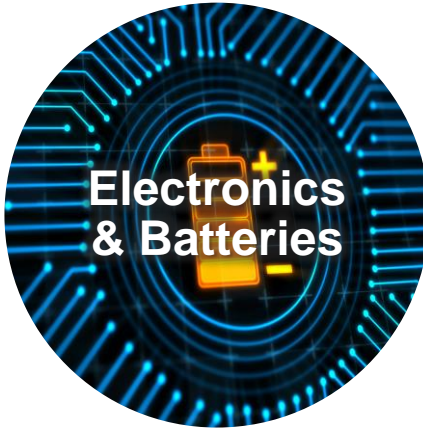
- **Carbon-fluorine bond** makes these chemicals resistant to degradation.
- Functional groups alter utility as well as potential for biological activity.
- Many PFAS behave as **surfactants**.
 - Possess both hydrophilic and hydrophobic behaviors.
 - Creating micelle, films and layers.
- Confers **stain, oil or water-repellant properties** to products and commercial processes.

PFOS

Perfluorooctane sulfonic acid



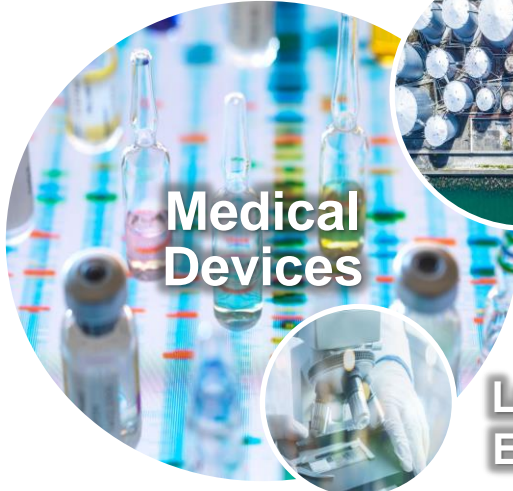
Where are PFAS?



Electronics
& Batteries



Chemical Production &
Manufacturing Aids



Medical
Devices

Laboratory
Equipment



Textiles &
Coatings



Cleaning Supplies &
Stain Repellants



Printing &
Lithography



Food
Packaging &
Cookware



Cosmetics &
Personal Care
Products



PFAS Sources in the Environment

If you test for PFAS, you will likely find PFAS.

- Problem of PFAS in **manufacturing and products** (*upstream sources*).
- Existing **environmental occurrence** of PFAS (*waste management*).
- Because of their physicochemical properties, **PFAS are persistent and mobile in the environment**.
 - Drinking water, groundwater, surface water, soils, air/emissions, animals, plants, waste media

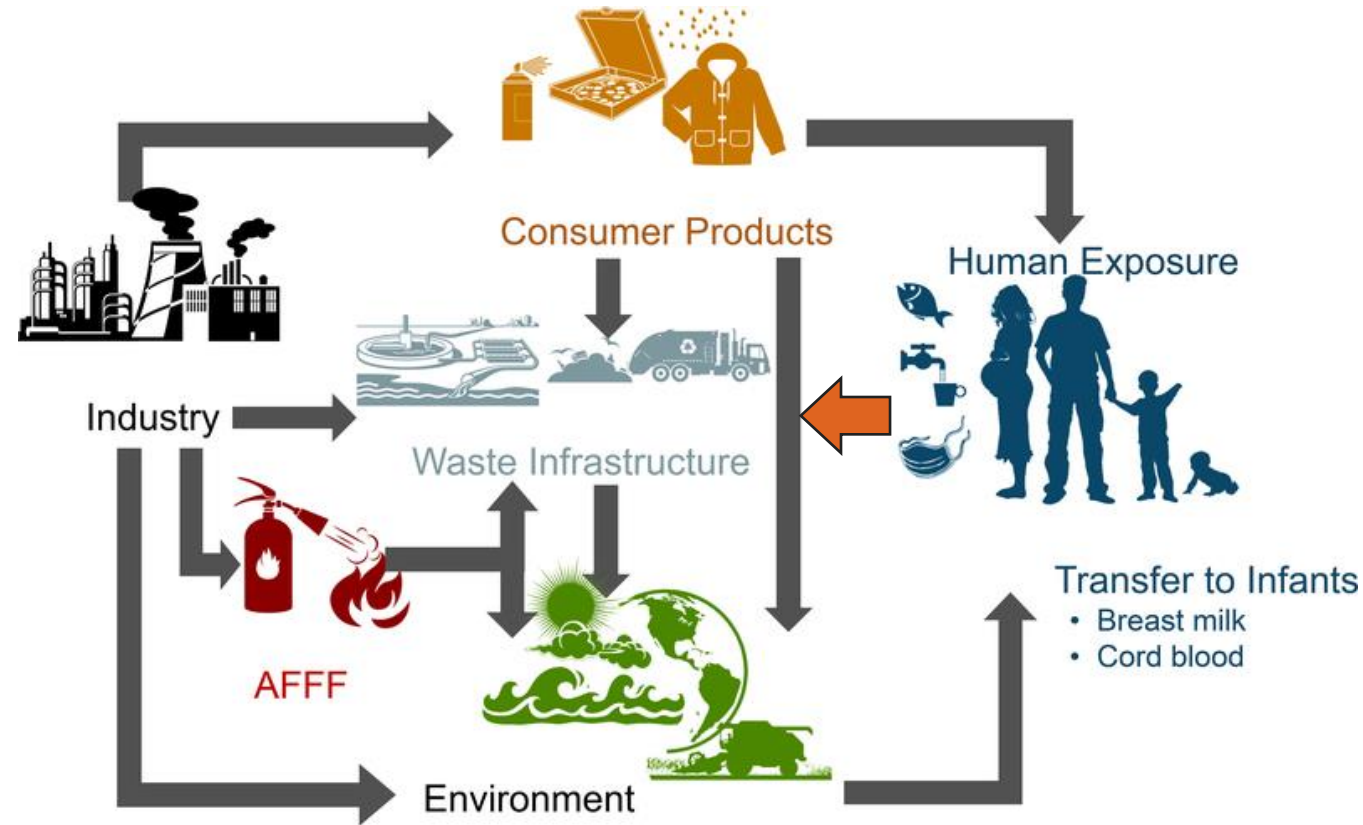
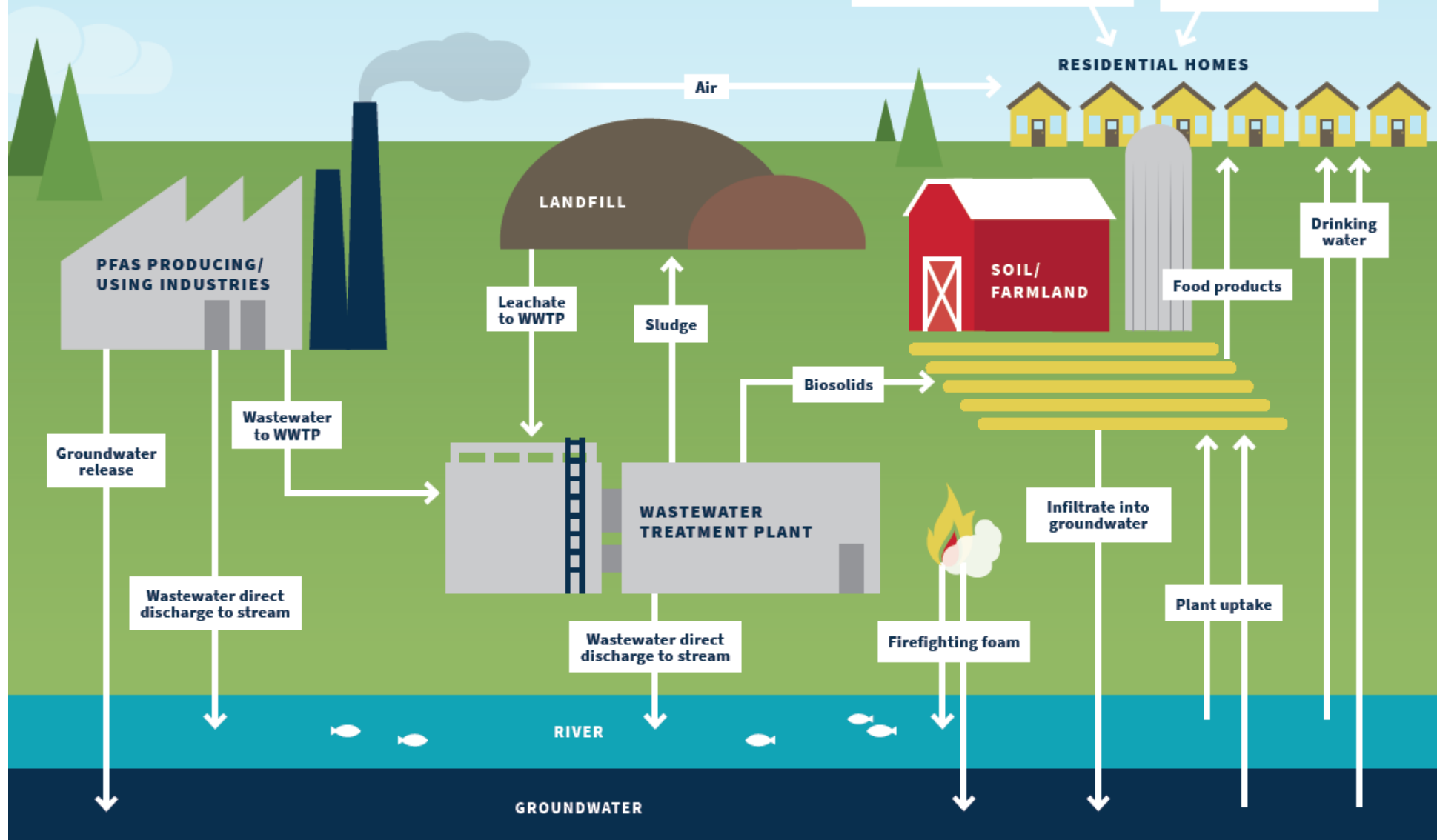


Image Source: Sunderland et al. 2019. A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. *Journal of Exposure Science & Environmental Epidemiology*. doi: [10.1038/s41370-018-0094-1](https://doi.org/10.1038/s41370-018-0094-1).

Orange arrow added to indicate contribution back to waste infrastructure.

PFAS Cycle



What is the role of risk assessment?

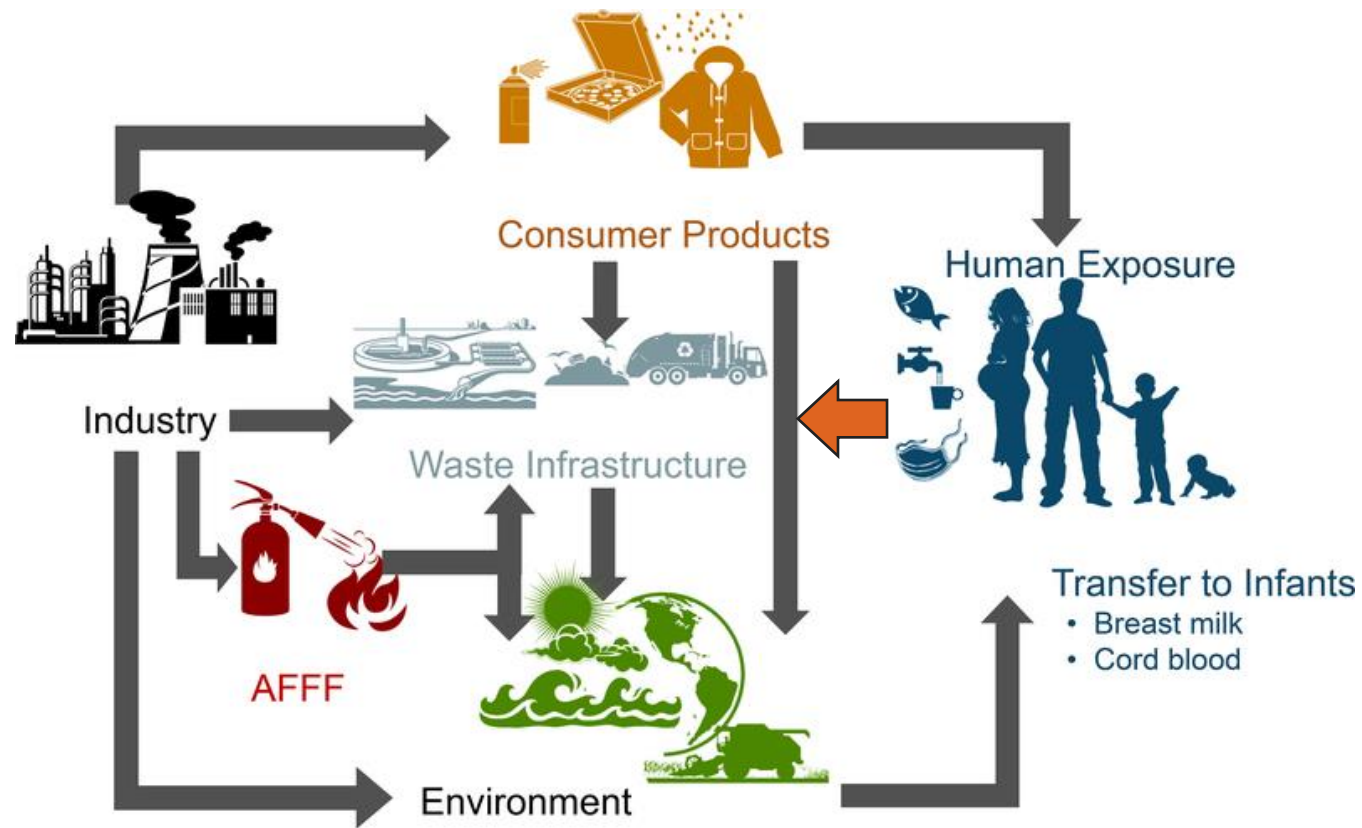


Image Source: Sunderland et al. 2019. A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. *Journal of Exposure Science & Environmental Epidemiology*. doi: [10.1038/s41370-018-0094-1](https://doi.org/10.1038/s41370-018-0094-1).

Orange arrow added to indicate contribution back to waste infrastructure.

— High certainty
- - - Lower certainty

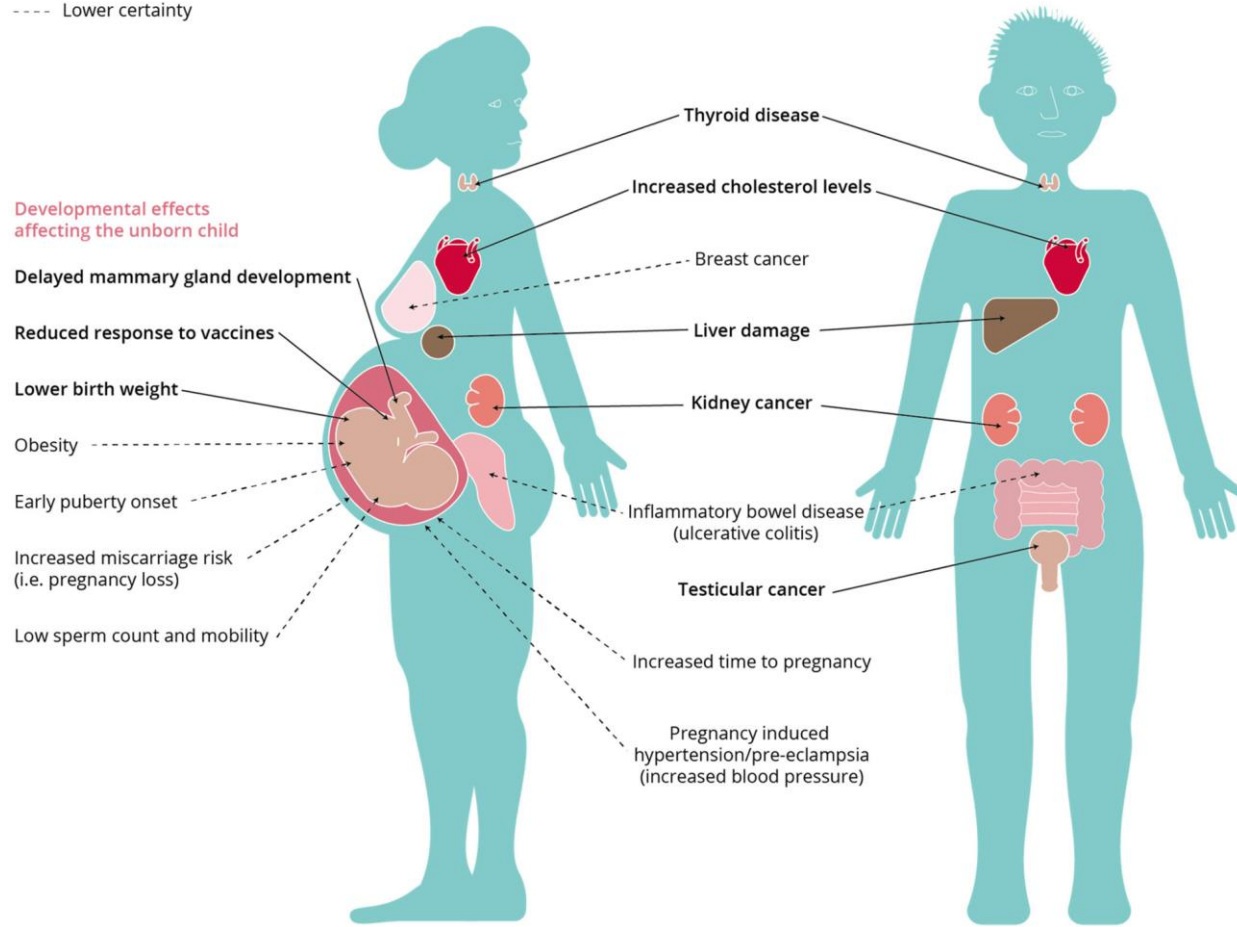


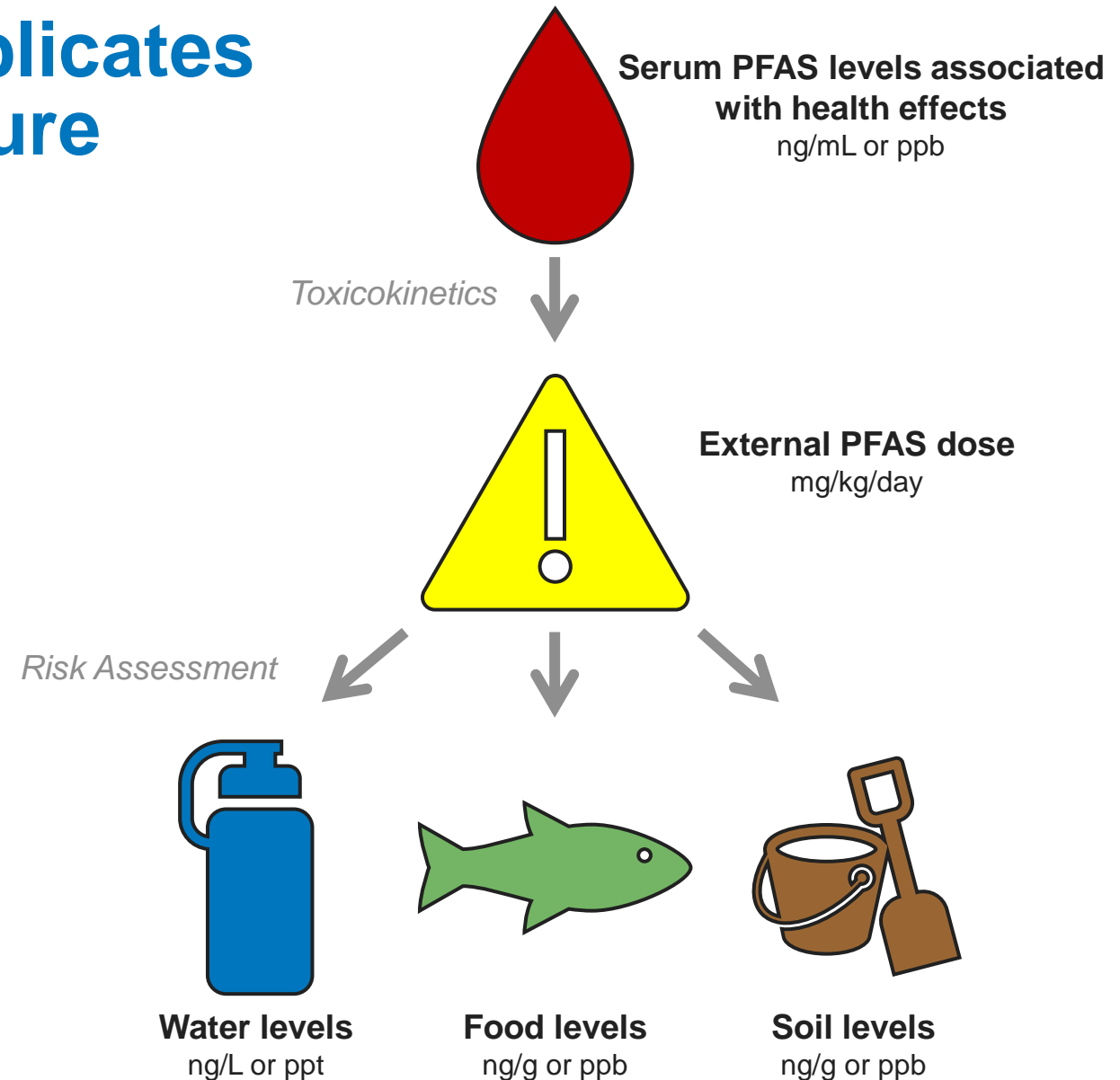
Image Source: Fenton et al. 2021. Per- and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research. *Environmental Toxicology & Chemistry*. doi: [10.1002/etc.4890](https://doi.org/10.1002/etc.4890).

Human & Ecological Health Risks of PFAS

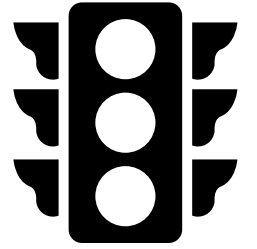
- Chronic exposure is associated with altered clinical markers and increased risk of certain health outcomes.
- Extensive review conducted by the [Agency for Toxic Substances and Disease Registry \(ATSDR\), 2021](#)
- The [National Academies of Science, Engineering and Medicine, 2023](#), provided recommendations to ATSDR.
- To learn more, register for the [PFAS: Toxicology AAEES Webinar](#). January 15, 2025

PFAS Bioaccumulation Complicates Our Understanding of Exposure

- Certain PFAS are highly **bioaccumulative**, others less so.
 - PFOA physiological half-life is between 2-4 years
- Extrapolating “safe” doses for PFAS is the subject of ongoing research and debate.
 - PFOA, 0.00000003 mg/kg/day (USEPA, 2024)
 - PFBA, 0.001 mg/kg/day (USEPA, 2024)
- Differences in estimated **Reference Doses (RfDs)** contributes to variability in regulatory standards worldwide.



Risk Assessment Provides Benchmarks for Evaluating Contaminant Data



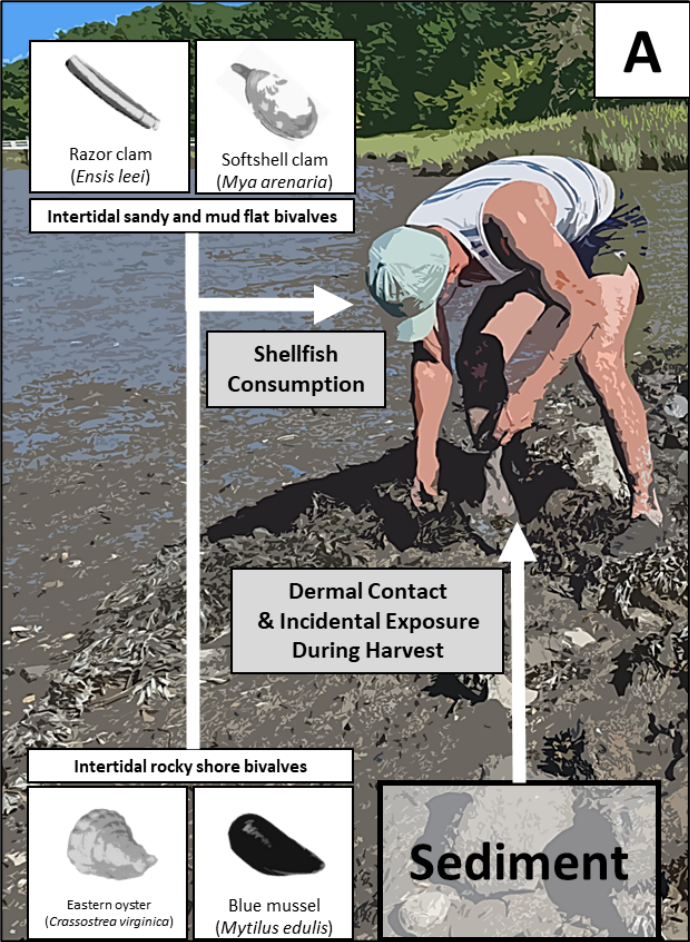
- You can develop **Screening Levels** with a basic risk assessment formula.
 - Reference Dose for PFOA is 0.03 ng/kg/day
 - Other factors can be added better characterize exposure or risks (i.e., carcinogen risk).
- **Regulatory limits** developed for large populations are inherently *conservative*.
 - Also considers feasibility to treat and detect, as well as costs.
- **Site-specific risk assessments** can be more nuanced.

$$\frac{0.03 \text{ ng/kg/day} \times 80 \text{ kg}}{2 \text{ L/day}} \times 0.1 = 0.12 \text{ ng/L}$$

USEPA MCL for PFOA = 4.0 ng/L

**Who? How often? What media?
What else, what else, what else?**

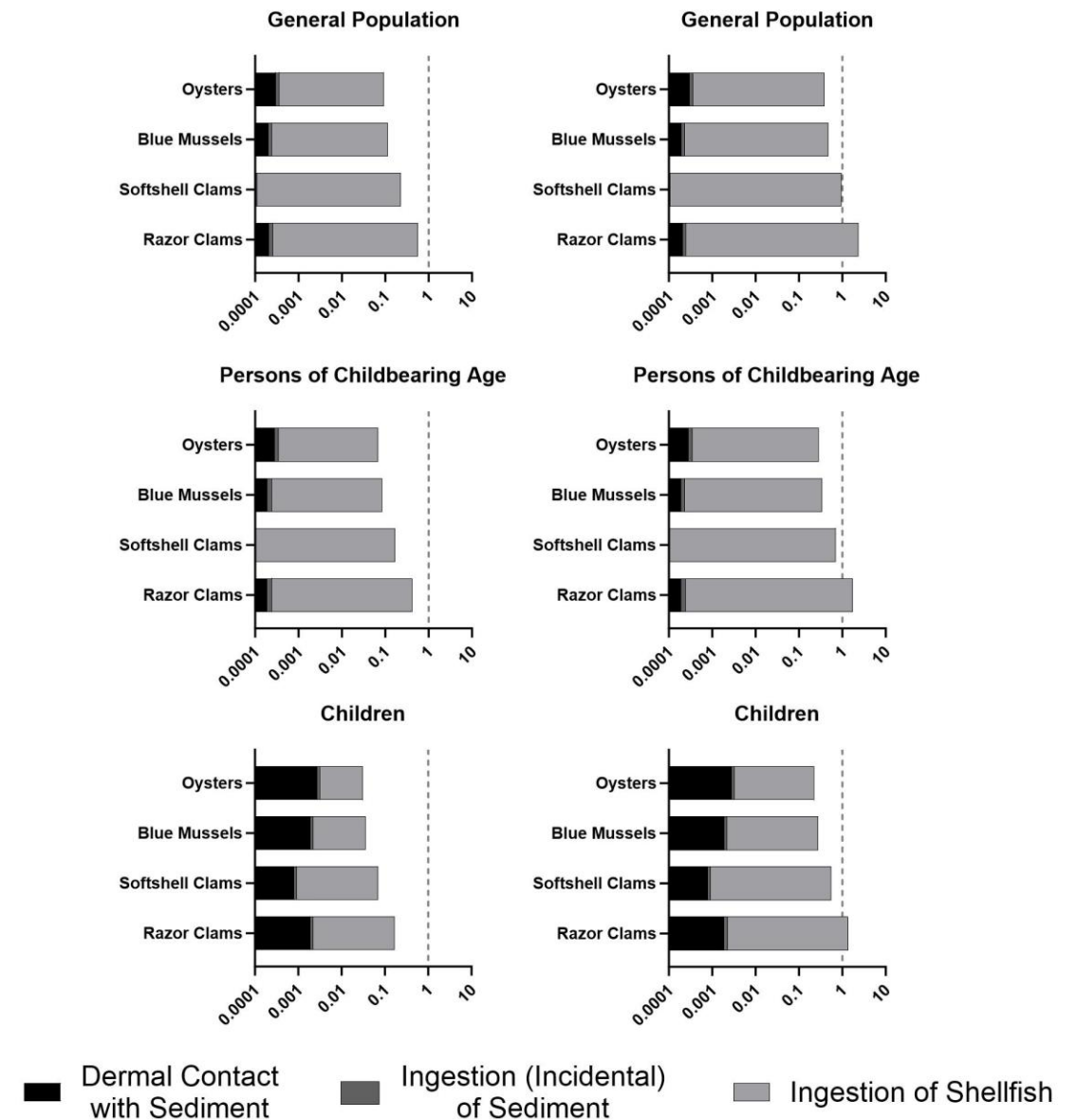
Example Risk Assessment for Recreational Shellfish Harvesters



Example Risk Assessment for Recreational Shellfish Harvesters

- Hazard quotients for PFOS exposure from multiple routes of exposure.
 - >1 indicates unacceptable risks
- In this scenario, the risk from PFOS is primarily from **consumption**.
- If management resources are limited, prioritize:
 - Risk communication and notification to recreational harvesters.
 - Investigating bioaccumulation processes of PFOS and PFAS into shellfish.

50th Percentile Consumers 90th Percentile Consumers



Regulatory Activities to Address Contamination

USEPA Actions

- 2024 **Maximum Contaminant Levels (MCLs)** for 6 PFAS
 - Enforceable drinking water standards.
 - MCLs evaluate risks, costs & benefits.
 - Currently facing legal challenge.
- **CERCLA Designation** of PFOA and PFOS as Hazardous Substances
 - Raised questions, concerns and urban legends about potential litigation.
- **Ambient Water Quality Criteria** (Surface Water) and Benchmarks for 10 PFAS

State-Level Actions

- 11 States have MCLs
 - ME, MA, MI, NH, NJ, NY, PA, RI, VT, WA, and WI
- 12 States have **non-enforceable drinking water guidance**
 - AK, CA, CT, CO, HI, IL, MD, MN, NC, NM, OH and OR
- Some states are designating PFAS as Hazardous Substance
- Standards, Screening Levels and Remedial Guidance are changing.
 - Soils, groundwater, surface water, fish, wildlife agricultural products

Drinking Water Guidance & Limits (2024)

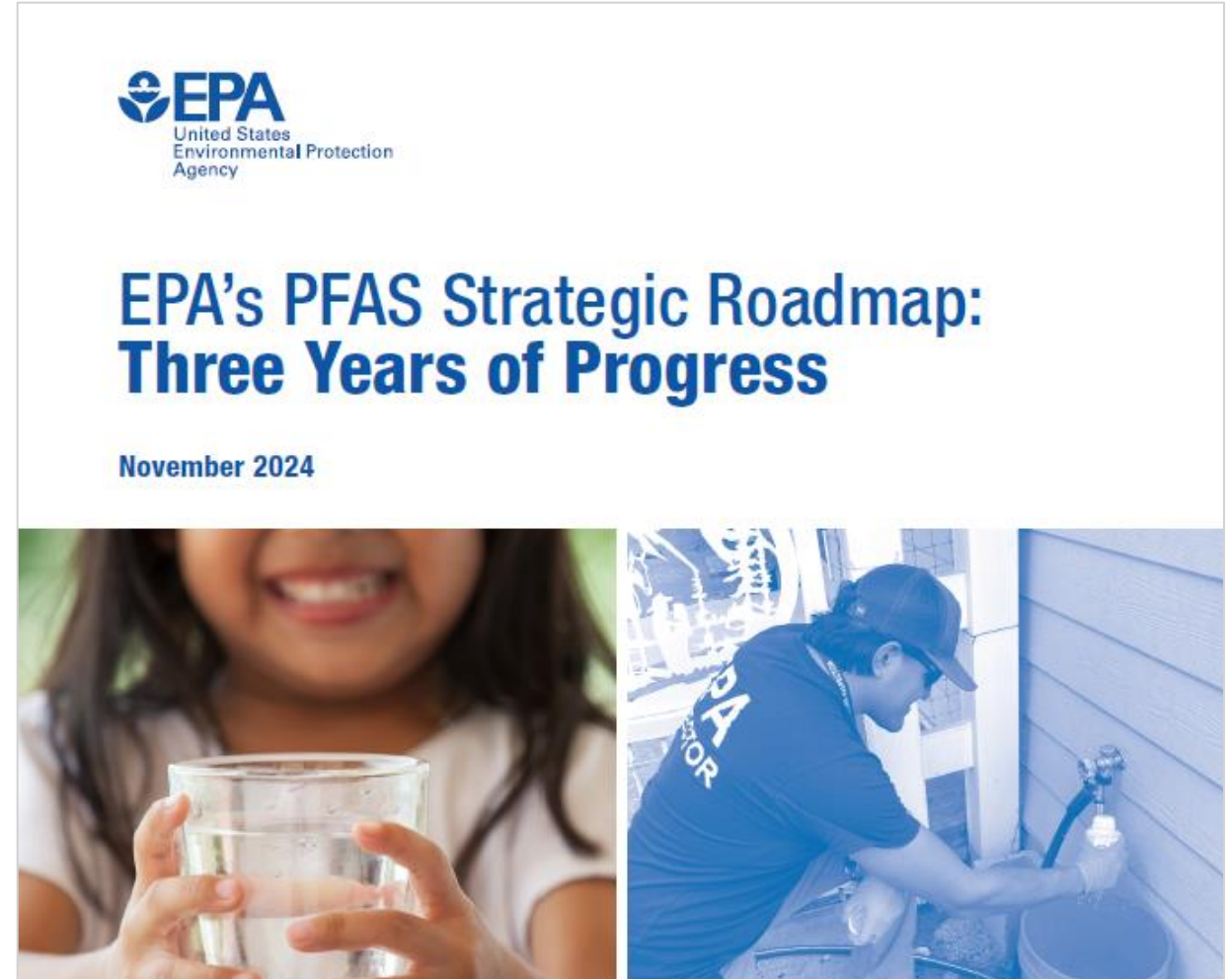
Specific PFAS	USEPA Maximum Contaminant Levels (ng/L or ppt)	USEPA Regional Screening Levels (ng/L or ppt)	Department of Defense Guidance (ng/L or ppt)
PFOS	4	0.2	12
PFOA	4	0.00027	12
PFHxS*	10	39	30
PFNA*	10	5.9	30
PFBS	2,000	600	-
GenX	10	1.5	30
Hazard Index**	1	1	3

* USEPA Integrated Risk Information System (IRIS) has drastically lower draft values under review for PFHxS and PFNA, may be finalized this fall or next year (2025).

** Hazard Index (HI) for the combination of PFHxS, PFNA, PFBS and GenX. USEPA exclude PFOS and PFOA from the HI.

Source Reduction – Get Ahead of Potential Cleanup

- [USEPA's PFAS Strategic Roadmap](#)
- Department of Defense **Fluorine Foam Phaseout** required this year (2024).
 - [Government Accountability Office \(GAO\) Report](#)
 - May be extended to 2026 for some cases.
- Toxic Substances Control Act (TSCA) Reporting Requirements
- **PFAS in Consumer Products Bans**
 - Several exemptions that differ by state.
 - AK, CA, CO, CT, ME, MD, MA, NH, NJ, RI, VT
- **Reporting is challenging** for manufacturers and supply chains.



Current Technical Definitions of PFAS are Diverse

National Defense Authorization Act (NDAA), 2019

- Organic chemicals containing at least 1 fully fluorinated carbon atom
- Currently applied in several states to define PFAS for legislated product bans in various commercial/consumer goods.

Organization for Economic Co-operation and Development (OECD), 2021

- "...fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group ($-\text{CF}_3$) or a perfluorinated methylene group ($-\text{CF}_2-$) is a PFAS."

Glüge et al. 2020

- In addition to substances containing $\text{C}_n\text{F}_{2n+1}$, where $n \geq 1$, it also "includes (i) substances where a perfluorocarbon chain is connected with functional groups on both ends, (ii) aromatic substances that have perfluoroalkyl moieties on the side chains, and (iii) fluorinated cycloaliphatic substances. Additionally, "polymeric PFAS with the $-\text{CF}_2-$ moiety and non-polymeric PFAS with the $-\text{CF}_2-\text{CF}_2-$ moiety [excluding] non-polymeric substances that only contain a $-\text{CF}_3$ or $-\text{CF}_2-$ moiety, with the exception of perfluoroalkylethers and per- and polyfluoroalkylether-based substances. For these two PFAS groups, substances with a $-\text{CF}_2\text{OCF}_2-$ or $-\text{CF}_2\text{OCFHCF}-$ moiety are also included."

Non-governmental Organizations (NGOs) & Advocacy Groups, 2021-present

- All organic compounds containing at least one fluorine atom should be classified as PFAS.

USEPA's Definitions of PFAS are Also Diverse

Office of Pollution Prevention Toxics (OPPT), 2021

- “a structure that contains the unit $R-CF_2-CF(R')(R'')$, where R, R', and R'' do not equal “H” and the carbon-carbon bond is saturated (note: branching, heteroatoms, and cyclic structures are included).”

Drinking Water Contaminant Candidate List 5 (CCL5), 2022

- “chemicals that contain at least one of these three structures: (1) $R-(CF_2)-CF(R')R''$, where both the CF_2 and CF moieties are saturated carbons, and none of the R groups can be hydrogen; (2) $R-CF_2OCF_2-R'$, where both the CF_2 moieties are saturated carbons, and none of the R groups can be hydrogen; (3) $CF_3C(CF_3)RR'$, where all the carbons are saturated, and none of the R groups can be hydrogen.”

Data Reporting and Recordkeeping Under the Toxic Substances Control Act (TSCA), 2024

- PFAS is defined as including at least one of these three structures:
 - $R-(CF_2)-CF(R')R''$, where both the CF_2 and CF moieties are saturated carbons;
 - $R-CF_2OCF_2-R'$, where R and R' can either be F, O, or saturated carbons;
 - And $CF_3C(CF_3)R'R''$, where R' and R'' can either be F or saturated carbons.

Reminder...

National Defense Authorization Act (NDAA), 2019

- Organic chemicals containing at least 1 fully fluorinated carbon atom
- Currently applied in several states to define PFAS for legislated product bans in various commercial/consumer goods.

Risk Communication is Critical: Now More Than Ever

- *Underestimate a community's understanding at your peril.*
- PFAS have characteristics that complicate risk communication.
 - Manmade, emerging information, lack of control
- Others have developed materials that can be adapted for your communities.
 - [ITRC Risk Communication Toolkit](#)
 - [MPCA Communications Toolkit](#)
 - [USEPA PFAS Risk Communication](#)
 - [MPART Resources](#)
 - Many more...

NHPR. 2018. *As PFAS Plans Progress, Merrimack Residents Spar With State Regulators*



YouTube pfas nhdes

Topics

- PFAS Characteristics in WW
- PFAS Fractionation in WW
- Implications for Discharge to Surface Water

UNH TODAY

Research Snapshot: Protecting Great Bay
Wastewater sampling tracks contaminants in environment

Thursday, September 16, 2021

Cassidy Nolan '20, now a master's student in environmental engineering, samples wastewater from a treatment facility near New Hampshire's Great Bay. Nolan is working with her advisor Jim Malley, professor of civil and environmental engineering, and project collaborator Paula Messer, associate professor of civil and environmental engineering, to investigate how contaminants of emerging concern (CECs) such as perfluorinated alkyl substances (PFAS) are removed or transformed by wastewater treatment disinfection processes and ultimately released into the environment. By collecting and testing samples from wastewater treatment facilities discharging treated effluent into the Great Bay, the researchers can understand the flow of CECs into our environment and the best ways to limit their introduction in the future. Funded by New Hampshire Sea Grant, the project will help protect our swimming and drinking water sources from further contamination.

WRITTEN (Tim Briggs) | NH Sea Grant | BY: Tim.Briggs@unh.edu

The Future of PFAS Risks, Management & Regulations

- Challenging, but hopeful.
- Management strategies will change.
- Collaboration in this space is enabling innovation.
- Closing data gaps continues to be crucial.



Addressing PFAS Requires Diverse Teams

Battelle is addressing the problem from several angles.

Careers with Battelle:

<https://www.battelle.org/careers>



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Questions & Discussion



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LinkedIn: www.linkedin.com/in/jonpetali

Highlighted Resources

USEPA PFAS: <https://www.epa.gov/pfas>

Interstate Technology & Regulatory Council (ITRC)

ITRC PFAS Guidance: <https://pfas-1.itrcweb.org/>

ITRC PFAS Training: <https://pfas-1.itrcweb.org/pfas-training/>

SERDP & ETSCP: <https://www.serdp-estcp.mil/focusareas/e18ec5da-d0de-47da-99f9-a07328558149>

Battelle: <https://www.battelle.org/markets/environment/pfas-and-emerging-chemicals>

Thank you for attending our event today.

Would you like to attend our next event?

We have several webinars happening in the near future. Go to <https://www.aaees.org/events> to reserve your spot.

Would you like to watch this event again?

A recording of today's event will be available on our website in a few weeks.

Need a PDH Certificate?

You will be emailed a PDH Certificate for attending this event within the next week.

Questions?

Email Marisa Waterman at mwaterman@aaees.org with any questions you may have.

