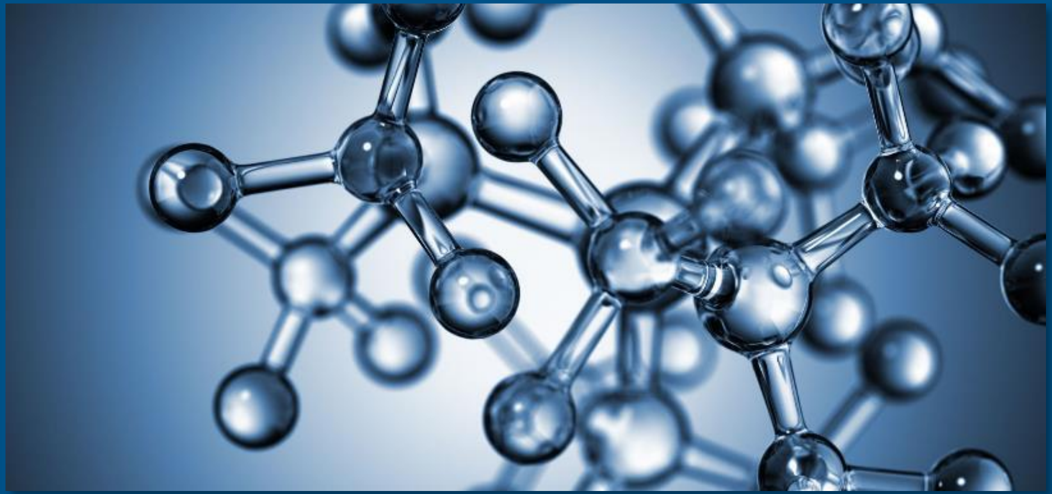
# Expanding the Scientific Foundation for Understanding and Addressing Risks from PFAS

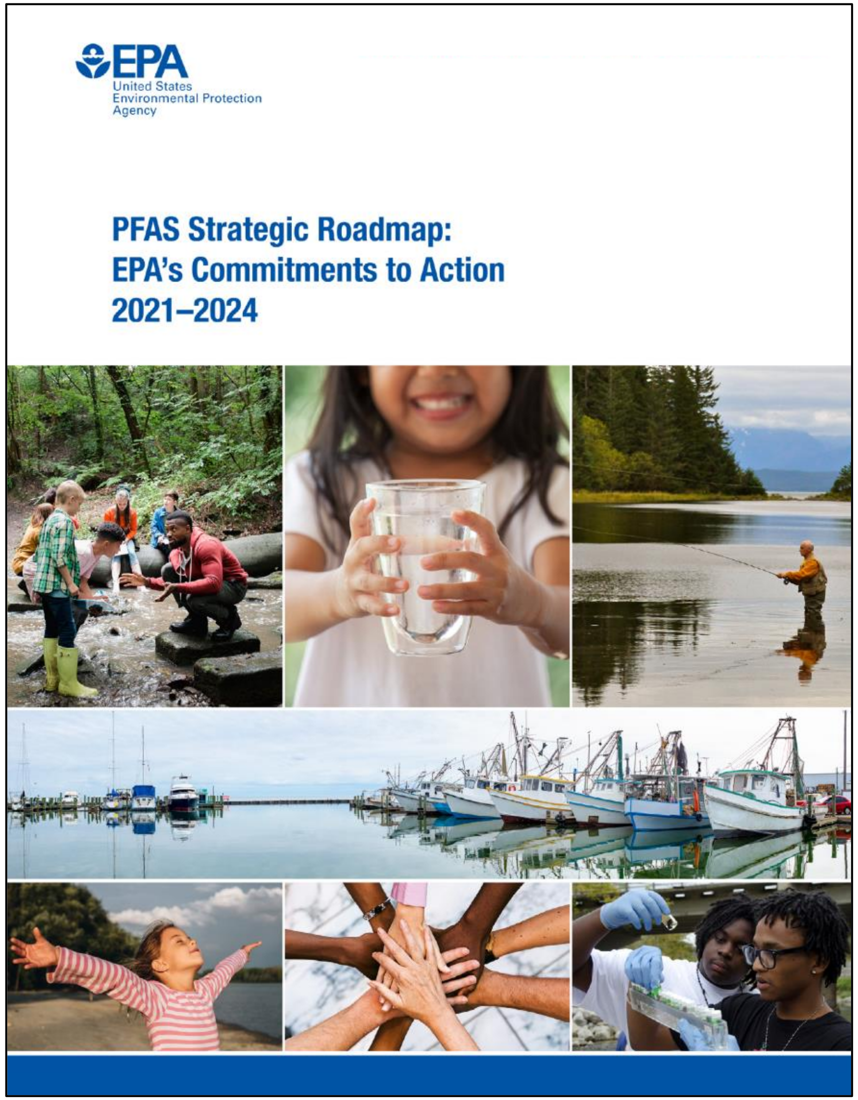
Susan Burden, Ph.D.



*The views expressed in this presentation are those of the author and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.*

# EPA PFAS Strategic Roadmap

- Released October 2021
- Presents EPA’s whole-of-agency approach to protect public health and the environment from the impacts of PFAS
- EPA’s approach is centered around the following principles:
  - Consider the lifecycle of PFAS
  - Get upstream of the problem
  - Hold polluters accountable
  - **Ensure science-based decision making**
  - Prioritize protection of disadvantaged communities



# PFAS Research and Development

***EPA is rapidly expanding the scientific foundation for understanding and addressing risk from PFAS***

- EPA's Office of Research and Development (ORD) provides the best available environmental science and technology to inform and support human health and environmental decision making
- ORD is conducting scientific research to:
  - **Develop methods and approaches for measuring PFAS in the environment**
  - **Advance the science to assess human health and environmental risks from PFAS**
  - **Evaluate and develop technologies for reducing PFAS in the environment**

*ORD collaborates with other federal agencies, states, tribes, utilities and academic institutions on PFAS research and technical assistance activities*

# Environmental Measurement

***Reliable analytical methods are needed to identify and measure PFAS in air, water and land***

**Targeted Methods** measure a defined set of known analytes

- OTM-45 (air emissions)
- Methods 533 and 537.1 (drinking water)
- SW-846: Method 8327 (water)
- Draft Method 1633 (water, solids, tissue)

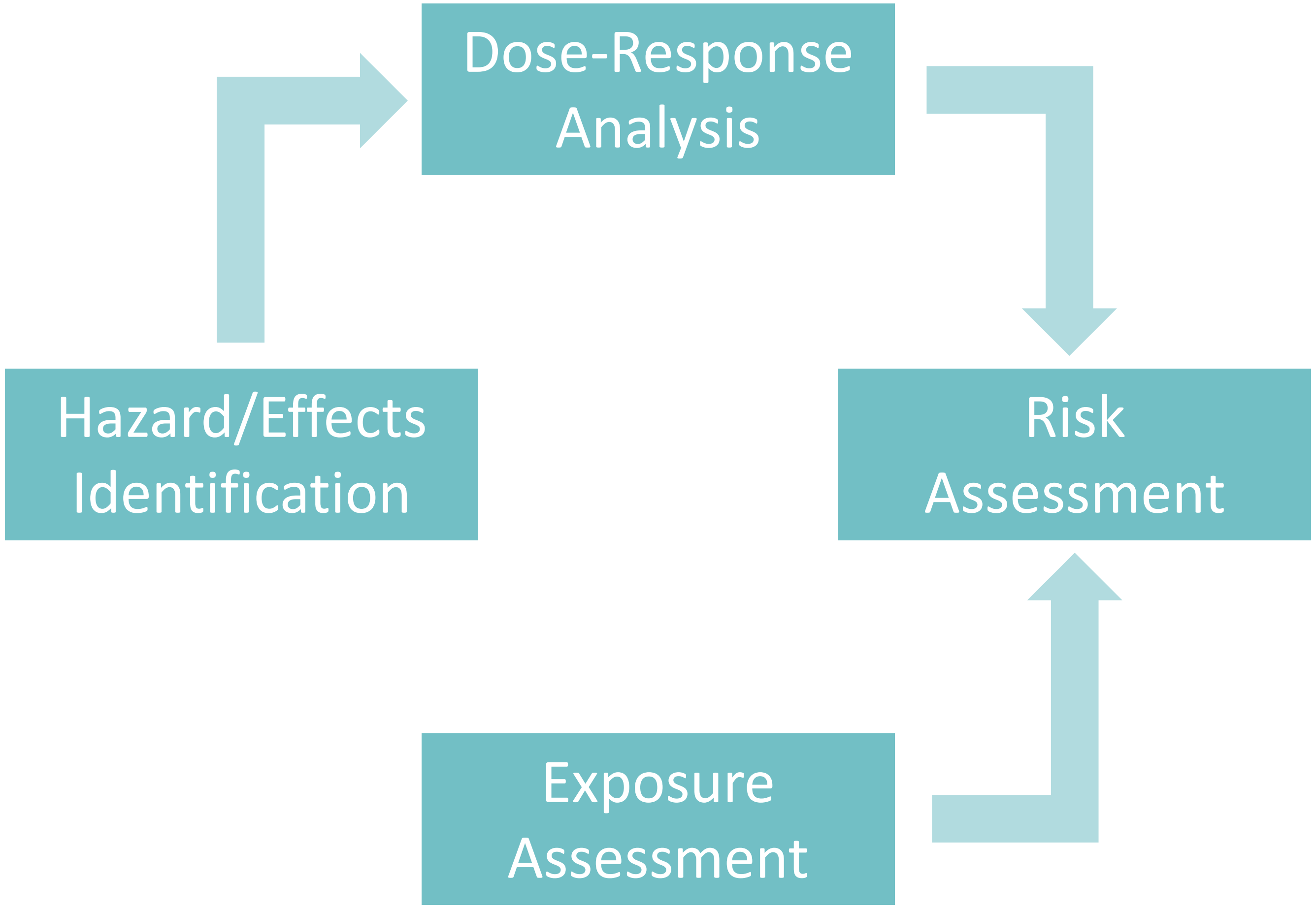
**"Total PFAS" Methods** isolate and measure organic fluorine

- Draft Method 1621 (wastewater)

**Non-Targeted Methods** identify known and unknown analytes

- No standard methods exist
- Working to increase technology transfer

# Understanding PFAS Risk




**Research Needs**

- Human health toxicity and toxicokinetic studies
- Ecotoxicity and bioaccumulation studies
- Occurrence studies
- Fate and transport studies
- Exposure studies

**Research Approaches**

- Data curation
- Toxicity testing
- Toxicity assessments
- Modeling

# Human Health Toxicity Assessments

## *Toxicity values are needed to inform risk analysis, risk management decisions and risk communication*

| | PFAS | Chemical Formula | Toxicity Value? |
|---|---|---|---|
| CARBOXYLIC ACIDS | PFBA | $C_3F_7COOH$ | Draft |
| | PFHxA | $C_5F_{11}COOH$ | Draft |
| | PFOA | $C_7F_{15}COOH$ | Yes (2016) |
| | PFNA | $C_8F_{17}COOH$ | 2023* |
| | PFDA | $C_9F_{19}COOH$ | 2022* |
| SULFONIC ACIDS | PFBS | $C_4F_9SO_2OH$ | Yes (2021) |
| | PFOS | $C_8F_{17}SO_2OH$ | Yes (2016) |
| | PFHxS | $C_6F_{13}SO_2OH$ | 2023* |
| GEN-X | HFPO-DA | $C_3F_7{-}O{-}C_2F_4COOH$ | Yes (2021) |

Increasing chain length

* *Estimated timing for draft assessment. IRIS Program Outlook.*

Updates underway to inform drinking water regulation

# Human Health Effects: Research

***Most PFAS have limited or no toxicity data to inform hazard assessment***

## CURATE EXISTING DATA

- Hazard
- Dose-response
- Chemical and physical properties

- ➢ CompTox Chemicals Dashboard – >10,000 PFAS
  - – Assembly and curation of lists of PFAS to support environmental science research (2022)
- ➢ HERO Database – >200,000 PFAS references
- ➢ Systematic evidence maps for ~150 PFAS

## GENERATE NEW DATA

- ✓ Created chemical library of 480 PFAS samples
- ✓ Selected 150 PFAS to represent structural diversity of PFAS
- Testing using a battery of toxicological and toxicokinetic new approach methods (NAMs)
  - – Bioactivity profiling of PFAS identifies potential toxicity pathways related to molecular structure (2021)
- Testing using traditional *in vivo* approaches
  - – Developmental toxicity of NB2 in the Sprague-Dawley rat with comparisons to HFPO-DA and PFOS (2022)

- Group PFAS into categories based on structural, toxicological and toxicokinetic similarity
- Prioritize PFAS for further toxicity testing and assessment

# Ecological Effects

***Bioaccumulation and ecotoxicity data are needed to inform ecological hazard assessments and benchmark development***

## Recent Accomplishments

**Bioaccumulation**

- Evaluation of published bioconcentration and bioaccumulation factors (2021)
- Integrative computational approaches to inform relative bioaccumulation potential of PFAS across species (2021)

**Ecotoxicity**

- Understanding the dynamics of physiological changes, protein expression and PFAS in wildlife (2022)
- Tissue-specific distribution of legacy and novel PFAS in juvenile seabirds (2021)

## Current & Ongoing Efforts

**Bioaccumulation**

- Evaluate and develop approaches and data (e.g., partitioning, metabolism) to predict bioaccumulation

**Ecotoxicity**

- Update the ECOTOX Knowledgebase
- Use new approach methods (NAMs) to prioritize and categorize data-poor PFAS for further toxicity testing
- Develop approaches to support predicting effects of untested PFAS in different species (e.g., adverse outcome pathways)

# Exposure

***Data on sources, occurrence, environmental fate and transport, and human exposure are needed to identify key exposure pathways***

## Recent Accomplishments

**Fate and Transport**

- PFAS in the environment (2022)
- Transport and fate of AFFF in an urban estuary (2022)
- Case Study: Emissions, transport and deposition from a fluoropolymer manufacturing facility (2021)

**Human Exposure**

- Human exposure pathways to PFAS from indoor media: A systematic review (2022)

## Current & Ongoing Efforts

**Fate and Transport**

- Conduct multimedia sampling and analysis
- Identify and generate data on physical and chemical properties

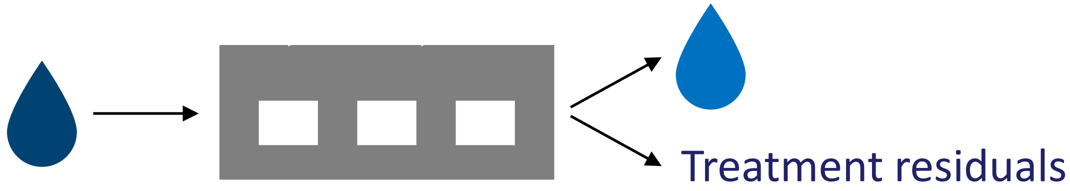
**Human Exposure**

- Characterize PFAS exposure from non-drinking water sources
- Collection of concordant multimedia measurements to evaluate PFAS human exposure pathways

# Risk Management

## Water Treatment

**Goal:** Remove or reduce PFAS in drinking water and wastewater



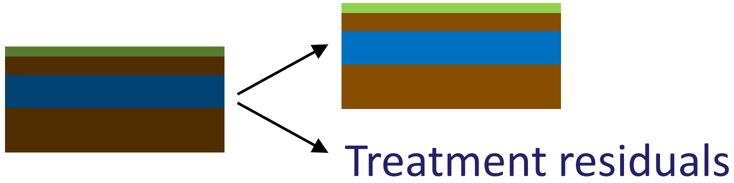

**Example Technologies**

*Drinking water* – Granular activated carbon (GAC), ion exchange resin, reverse osmosis (RO)

*Wastewater* – Sedimentation/partitioning, GAC

## Site Remediation

**Goal:** Remove or reduce PFAS at contaminated sites (e.g., in soil, sediment, groundwater)




**Example Technologies**

Soil excavation, stabilization, pump and treat

## Destruction and Disposal

**Goal:** Prevent re-introduction of PFAS into the environment through destruction or containment


**Example Technologies**

*"Conventional"* – Incineration, landfilling, underground injection control, GAC reactivation

*"Innovative"* – Supercritical water oxidation, pyrolysis/gasification, electrochemical oxidation, mechanochemical destruction

# Treatment and Remediation

***Treatment and remediation approaches should be cost-effective and tailored to specific situations***

## Recent Accomplishments

**Drinking Water Treatment**

- Modeling PFAS removal using GAC for full-scale system design (2022)

**Wastewater Treatment**

- Pilot Study: Pyrolysis processing of PFAS-impacted biosolids (2022)

**Contaminated Sites**

- Remediation and mineralization processes for PFAS in water: A review (2021)
- Investigation of an immobilization process for PFAS contaminated soils (2021)

## Current & Ongoing Efforts

**Drinking Water Treatment**

- Update the Treatability Database
- Evaluate treatment efficacy and approaches for managing residuals and spent materials

**Wastewater Treatment**

- Determine fate and transformation in conventional wastewater treatment
- Evaluate approaches for managing residuals

**Contaminated Sites**

- Identify approaches for site characterization and remediation

# Destruction and Disposal

**Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances**

*INTERIM GUIDANCE FOR PUBLIC COMMENT*
*DECEMBER 18, 2020*

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. This guidance is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

- Interim guidance released in 2020
- Three waste management approaches
  - Thermal treatment
  - Landfilling
  - Underground injection
- Significant uncertainties identified
  - Products of incomplete combustion
  - Fate and transport in landfills

**Recent Accomplishments**

- PFAS Thermal Treatment Database (2022)
- Combustion of $C_1$ and $C_2$ PFAS: Kinetic modeling and experiments (2022)
- Municipal solid waste incineration ash co-disposal: Influence on PFAS concentration in landfill leachate (2022; STAR)

# PFAS Research and Development

***Advance the science to assess human health and environmental risks from PFAS***

**Hazard**
- Human health and ecological effects
- Dose-response

**Exposure**
- Chemical identity and concentration
- Source-to-receptor pathways

**Risk Assessment**

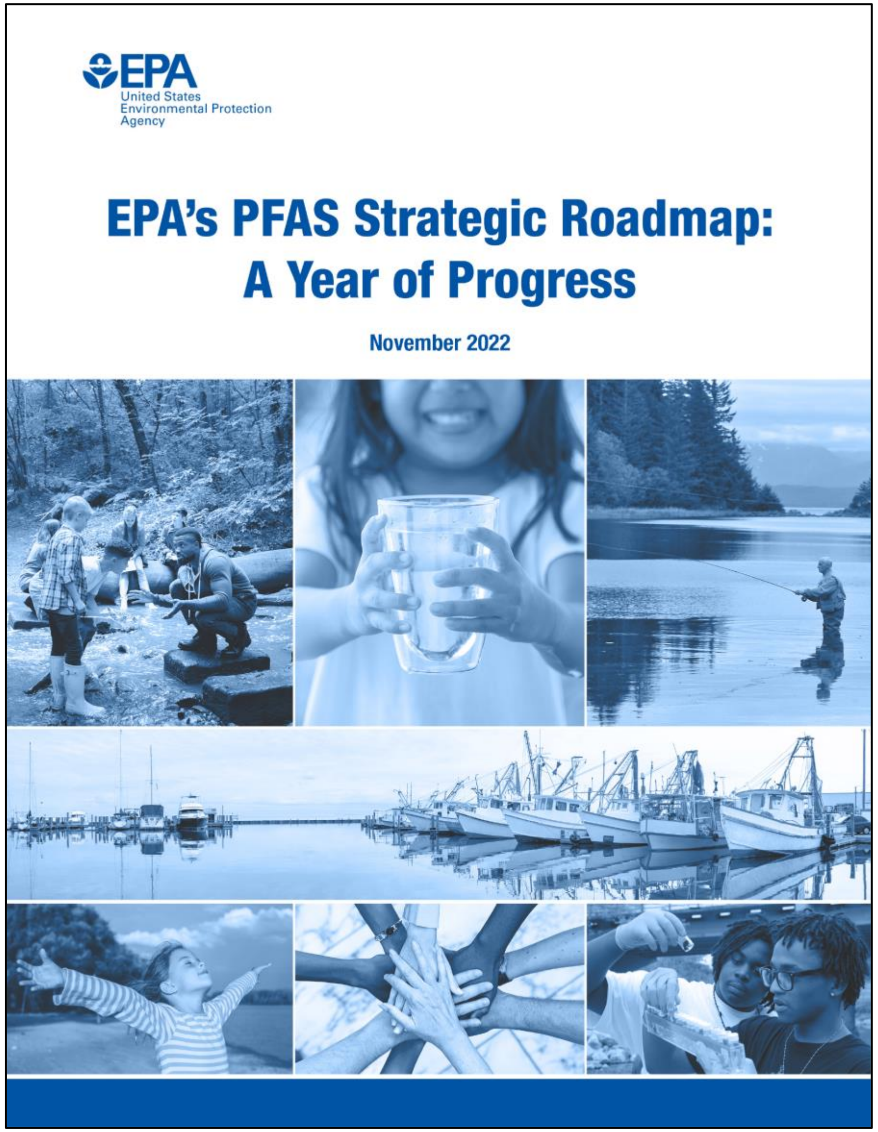
***Evaluate and develop technologies for reducing PFAS in the environment***

- Drinking water and wastewater treatment
- Site remediation
- Destruction (e.g., incineration)
- Disposal (e.g., landfills)

***Develop methods and approaches for measuring PFAS***

Targeted methods | "Total PFAS" methods | Non-targeted methods

**Susan Burden, Ph.D.**
Executive Lead for PFAS
Office of Research and Development
U.S. Environmental Protection Agency
burden.susan@epa.gov




**EPA PFAS Activities** – www.epa.gov/pfas