PFAS: The Road to Perdition or Salvation

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My Background

- President & Owner of KFE & Associates, LLC
- Oklahoma State University-Tulsa: Professor & Director for the PSM Environmental Science Graduate Program
- American Airlines, Inc.: Environmental Health & Safety Manager for American Airlines, Inc. (TUL, AFW, MCI) Superfund Sites $43 MM

Serve as a member of the following committees:

- Hazardous Waste Management Advisory Council for the State of Oklahoma
- Environmental Federation of Oklahoma (EFO) Hazardous/Solid Waste Committee
- State of Oklahoma PFAS Committee
- Authored numerous articles on PFAS
- Directed and co-authored the first PFAS sampling guidelines for the State of Oklahoma

"Doc Brown's"- Background

Audra S. Liggenstoffer, Ph.D.

- **President & Owner of BROWN Environmental, LLC**
  - **Bringing Total PFAS testing to Oklahoma & the First Mobile Unit in the USA.**
- **American Airlines, Inc.: Environmental Program Manager**
  - **Aerospace PFAS Program Management, including Aqueous Film Forming Foams (AFFFs) and Chromium Plating/Metal Finishing Industries.**
  - **Technical Manager, Permitting Specialist and Laboratory Supervisor for Three (3) Industrial Wastewater Treatment Facilities.**
- **Fifteen (15) years, Direct Laboratory Experience and Research.**
- **Twenty (20)+ years an Environmental Scientist - Consultant, Researcher, and Innovator.**

Translating Science for the Non-Scientist.

Legal Disclaimer

- This presentation is provided for informational purposes only and should not be construed as legal or other professional advice on any subject matter.
- You should not act or refrain from acting on the basis of any content included in this document without seeking advice specific to your circumstances from an attorney or environmental professional.

The Original Seven Deadly Sins: Pope Gregory I, 540 AD

1. Γαστριμαργία (*luxuria*)
2. Πορνεία (*gula)*
3. Φιλαργυρία (*avaritia)*
4. Λύπη (*acedia)*
5. Ὀργή (*ira)*
6. Ἀκηδία (*Invidia)*
7. Κενοδοξία (*superbia)*
8. **NY Yankees**

The Seven Deadly Sins of PFAS

- **Sin #1: Underestimating the resolve of the USEPA to control and ban PFAS**

EPA Administrator, Michael S. Regan

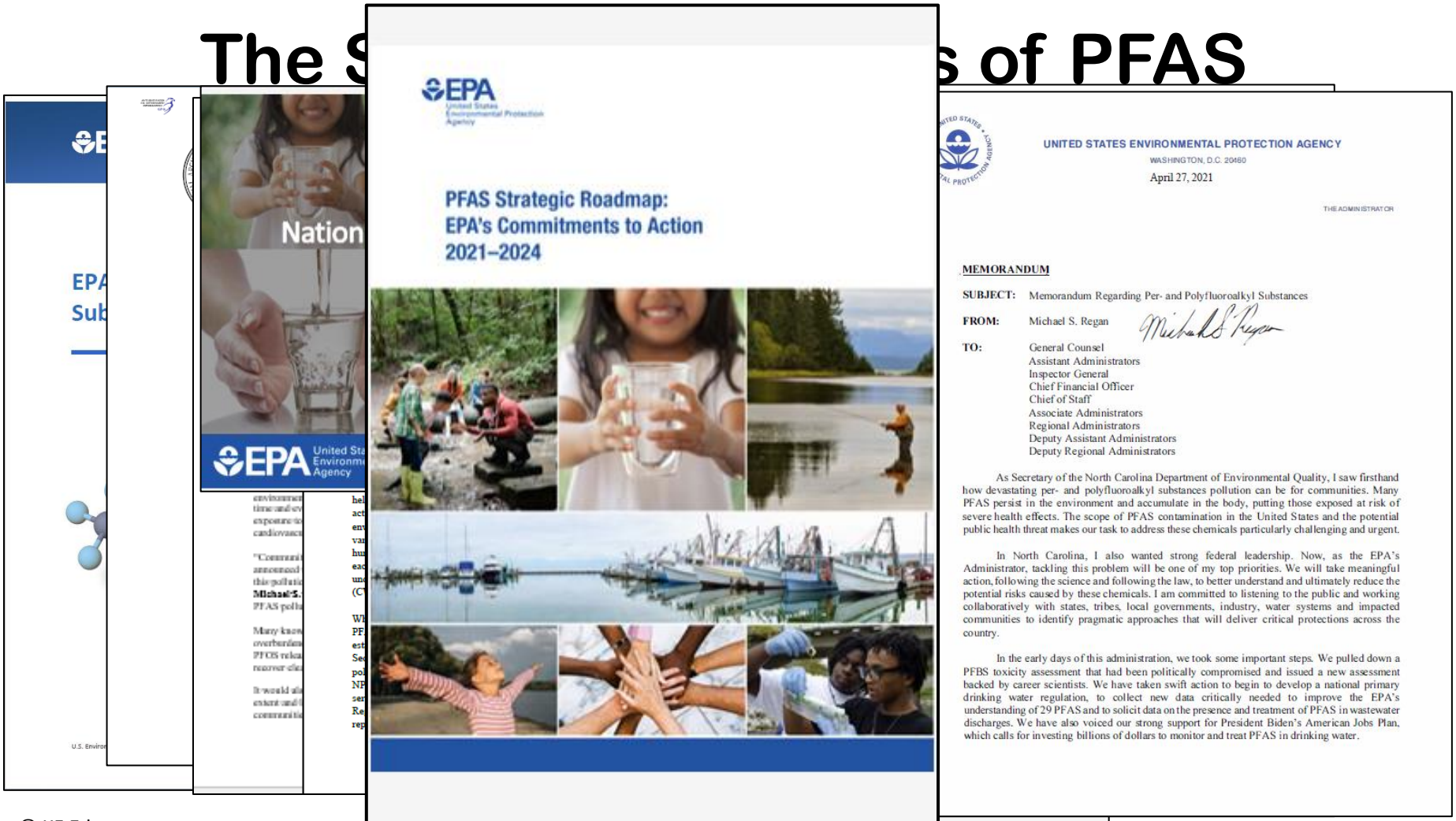
- 2020 President Biden is elected
- Appoints Michael Regan
- Formerly served as the secretary of North Carolina's Department of Environmental Quality
- **PFAS crusader**
- Michael Regan led complex negotiations regarding the clean-up of the Cape Fear River, which had been contaminated for years with PFAS

David Uhlmann, Assistant Administrator, Office of Enforcement and Compliance Assurance

- **FY 2024 – 2027 National Enforcement and Compliance Initiatives memo ranked:**

1. **Mitigating Climate Change**
2. **Addressing Exposure To PFAS**

The S s of PFAS



PFAS Regulations:

1. Resource Conservation and Recovery Act (RCRA)
2. Safe Drinking Water Act (SDWA)
3. Clean Water Act (CWA)
4. CERCLA (Superfund): Reopen old sites?
5. Toxics Release Inventory (TRI)
6. Consumer Products Safety Commission (CPSC)
7. Toxic Substances Control Act (TSCA)
8. Clean Air Act (HAP)
9. OSHA?
10. DOT?

The Seven Deadly Sins of PFAS

- **Sin #2: Using Safety Data Sheets or Technical Sheets to determine PFAS in your products or raw materials**

The Seven Deadly Sins of PFAS

- **PFAS substances are not considered a known carcinogen, therefore the manufacturer of the chemical* does not need to report PFAS as an active ingredient unless it exceeds 1%**

*Appendix A to 29 CFR § 1910.1200

PFAS Document Assessment

- 1% ≈ 10 000 000 000 PPT =
- 10 billion parts per trillion
- And PFAS does NOT need to reported on the SDS!
- EPA's health advisories for PFOA = 0.004 PPT

Sometimes you are lucky: Key Avoid Fluoro

- Perfluorononyl Dimethicone Phosphate
- Perfluorodecalin
- C9-15 fluoroalcohol
- Octafluoropentyl methacrylate
- Perfluorohexane
- Pentafluoropropane
- Polyperfluoroethoxymethoxy
- Difluoroethyl Peg Phosphate
- Methyl perfluorobutyl ether
- Perfluorononylethyl
- Perfluorodimethyl-cyclohexane
- Polytetrafluoroethylene (PTFE)
- Perfluoroperhydro-phenanthrene
- Polyperfluoromethy-lisopropyl Ether
- Perfluoroalkylethy-phosphate

Brand names for PFAS in Makeup

1. Peg-2
2. Carboxydecyl Peg-10
3. DEA-C8-18

1. Polyperfluoro-ethoxy methoxy Phosphate
2. Perfluorononylethyl Carboxydecyl Dimethicone
3. Perfluoroalkylethyl Phosphate

Brand names for PFAS in Electroplating

1. Tridol
2. ANKOR wetting agent F
3. Clepo Chrome Mist Control
4. Fumetrol 140 Mist Suppressant
5. Benchmark Benchbrite STX
6. Benchmark CFS
7. MacDermid Proquel B
8. MacDermid Macuplex STR
9. Femetrol-140

The Seven Deadly Sins of PFAS

- **Sin #3: Assuming that you do not use PFAS in your operations.**

Industries "***EXPECTED***" or "***SUSPECTED***" of Discharging PFAS

Industry NAICS codes identified in proposed rulemaking *Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances*

488119	Aviation operations
314110	Carpet manufacturers
811192	Car washes
325	Chemical manufacturing
332813	Chrome electroplating, anodizing, and etching services
325510	Coatings, paints, and varnish manufacturers
325998	Firefighting foam manufacturers
562212	Landfills
339112	Medical Devices
922160	Municipal fire departments and firefighting training centers, including Federal agencies that use, trained with, and tested firefighting foams.
322121 and 322130	Paper mills
325320	Pesticides and Insecticides
324	Petroleum and coal product manufacturing
324110 and 424710	Petroleum refineries and terminals
352992	Photographic film manufacturers
325211	Polymer manufacturers
323111 and 325910	Printing facilities where inks are used in photolithography
313210, 313220, 313230, 31324, 313320	Textile mills (textiles and upholstery)
562	Waste management and remediation services
221320	Wastewater treatment plants

Sources of PFAS

- **EPA Plans to Gather New Data on Significant Sources of PFAS through:**

1. Updated Toxics Release Inventory (TRI) reporting requirements for 189 PFAS
2. New Toxic Substances Control Act (TSCA) reporting for nearly 1,500 types of PFAS
3. POTW Influent Studies
4. Both Federally-Issued and State-Issued National Pollutant Discharge Elimination System (NPDES) permits with PFAS monitoring requirements

The Seven Deadly Sins of PFAS

- **Sin #4: Not testing your Sanitary Sewer (Pre-Treatment Permit) or Storm Water (NPDES) for PFAS before your City or State does.**

EPA

United States
Environmental Protection
Agency

Effluent Guidelines Program Plan 15

January 2023

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

December 5, 2022

MEMORANDUM

SUBJECT: Addressing PFAS Discharges in NPDES Permits and Through the Pretreatment Program and Monitoring Programs

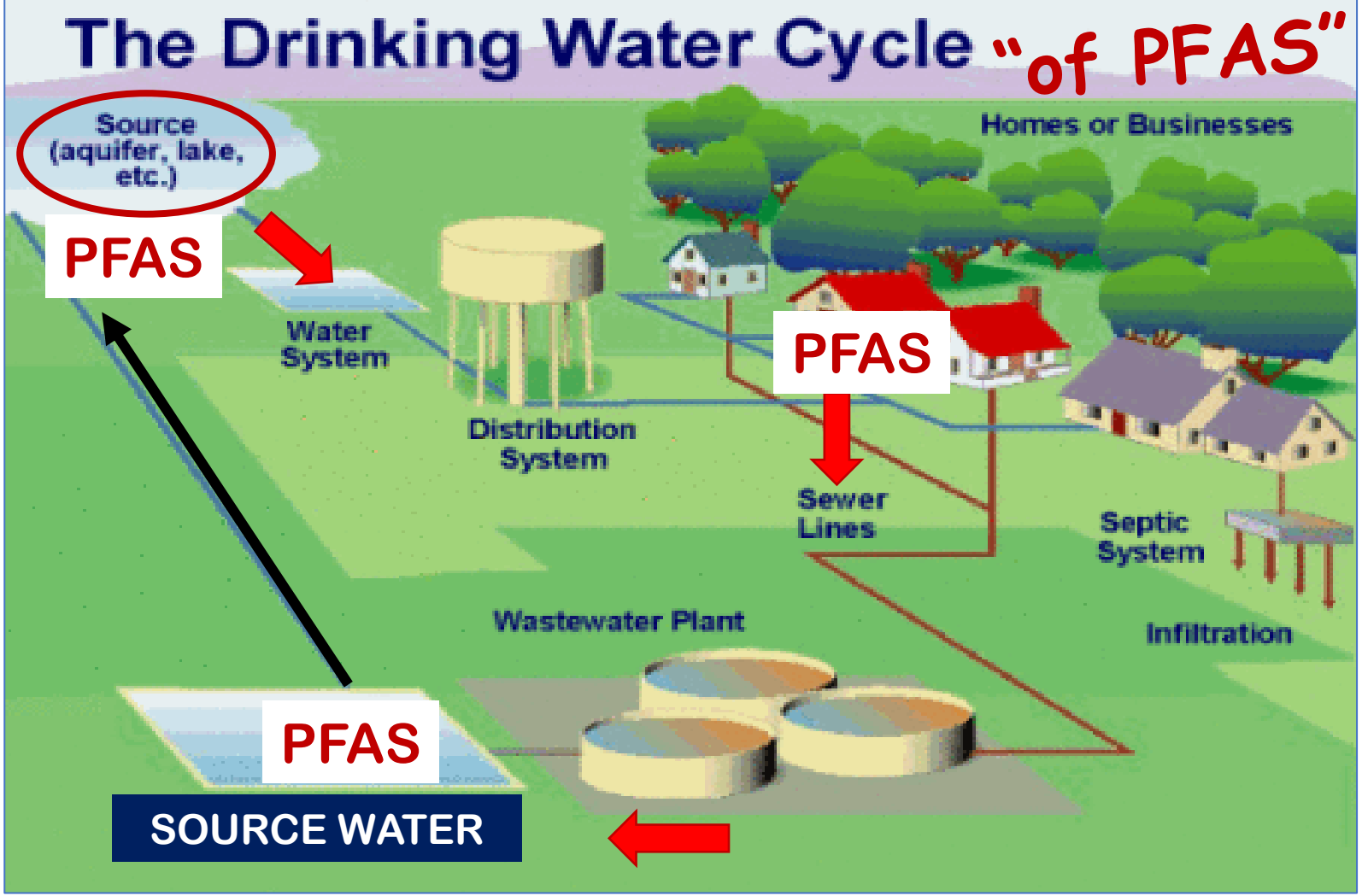
FROM: Radhika Fox
Assistant Administrator

TO: EPA Regional Water Division Directors, Regions 1-10

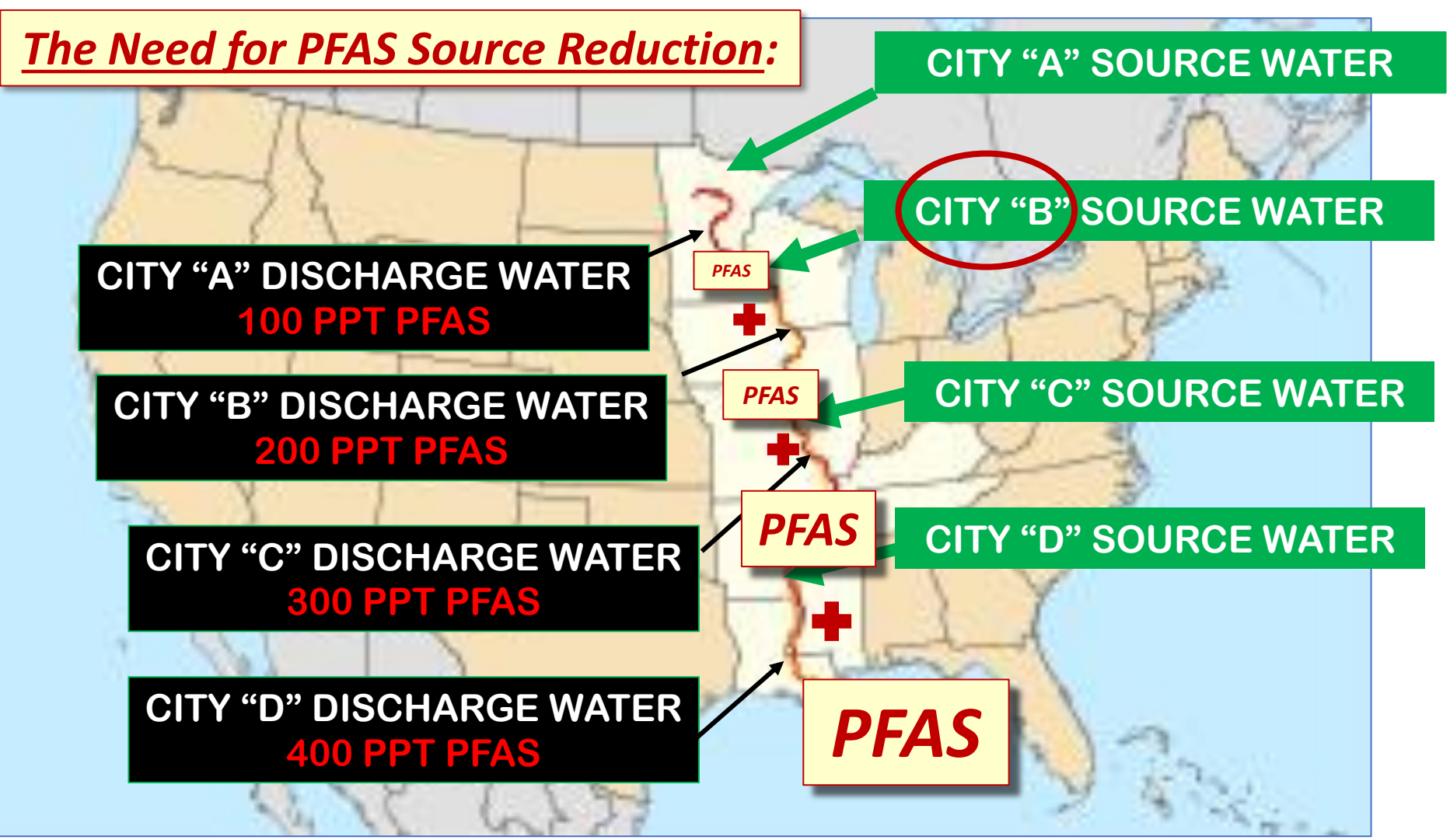
The National Pollutant Discharge Elimination System (NPDES) program is an important tool established by the Clean Water Act (CWA) to help address water pollution by regulating point sources that discharge pollutants to waters of the United States. Collectively, the U.S. Environmental Protection Agency (EPA) and states issue thousands of permits annually, establishing important monitoring and pollution reduction requirements for Publicly Owned Treatment Works (POTWs), industrial facilities, and stormwater discharges nationwide. The NPDES program interfaces with many pathways by which per-and polyfluoroalkyl substances (PFAS) travel and are released into the environment, and ultimately impact water quality and the health of people and ecosystems. Consistent with the Agency's commitments in the October 2021 *PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024 (PFAS Strategic Roadmap)*, EPA will work in cooperation with our state-authorized permitting authorities to leverage the NPDES program to restrict the discharge of PFAS at their sources. In addition to reducing PFAS discharges, this program will enable EPA and the states to obtain comprehensive information on the sources and quantities of PFAS discharges, which can be used to inform appropriate next steps to limit the discharges of PFAS.

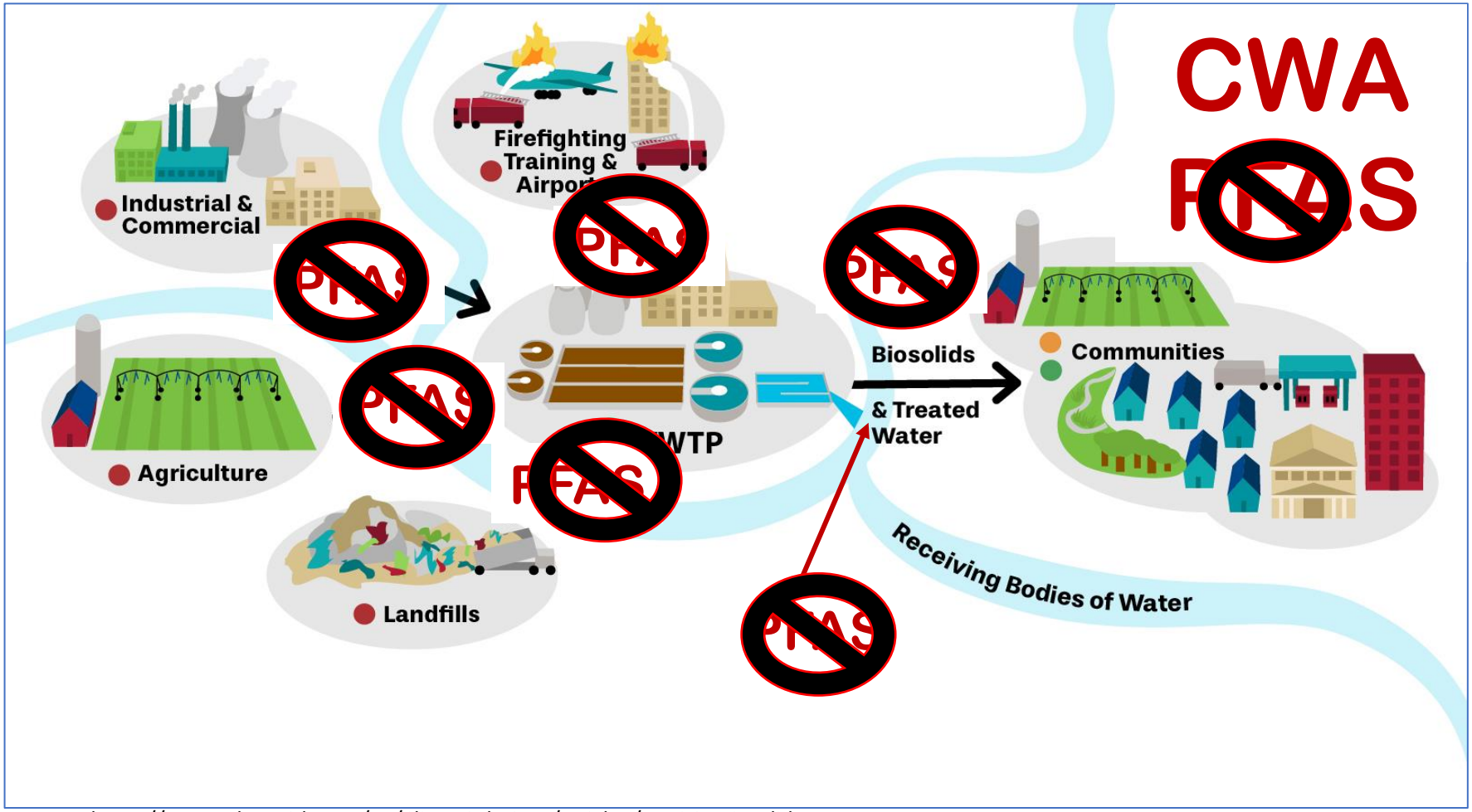
This memorandum provides EPA's guidance to states and updates the April 28, 2022 guidance[1] to EPA Regions for addressing PFAS discharges when they are authorized to administer the NPDES permitting program and/or pretreatment program. These recommendations reflect the Agency's commitments in the PFAS Strategic Roadmap, which directs the Office of Water to leverage NPDES permits to reduce PFAS discharges to waterways "*at the source and obtain more comprehensive information through monitoring on the sources of PFAS and quantity of PFAS discharged by these sources.*" While the Office of Water works to revise Effluent Limitation Guidelines (ELGs) and develop water quality criteria to support technology-based and water quality-based effluent limits for PFAS in NPDES permits, this memorandum describes steps permit writers can implement under existing authorities to reduce the discharge of PFAS.

[1] Addressing PFAS Discharges in EPA-Issued NPDES Permits and Expectations Where EPA is the Pretreatment Control Authority, https://www.epa.gov/system/files/documents/2022-04/npdes_pfas-memo.pdf.


The Drinking Water Cycle "of PFAS"
Source (aquifer, lake, etc.)
PFAS
Water System
Distribution System
Homes or Businesses
PFAS
Sewer Lines
Septic System
Infiltration
Wastewater Plant
PFAS
SOURCE WATER

The Need for PFAS Source Reduction:





https://www.cdmsmith.com/en/Client-Solutions/Insights/PFAS-in-Biosolids

CLEAN WATER ACT

- In summary,

EPA wants a reduction of PFAS in both:

- Sanitary Sewer (Pre-Treatment Permit)
- Storm Sewer (NPDES Permit)
- Which will reduce PFAS in surface waters and Biosolids

The Seven Deadly Sins of PFAS

- **Sin #5: Using a non-approved test protocols for PFAS**

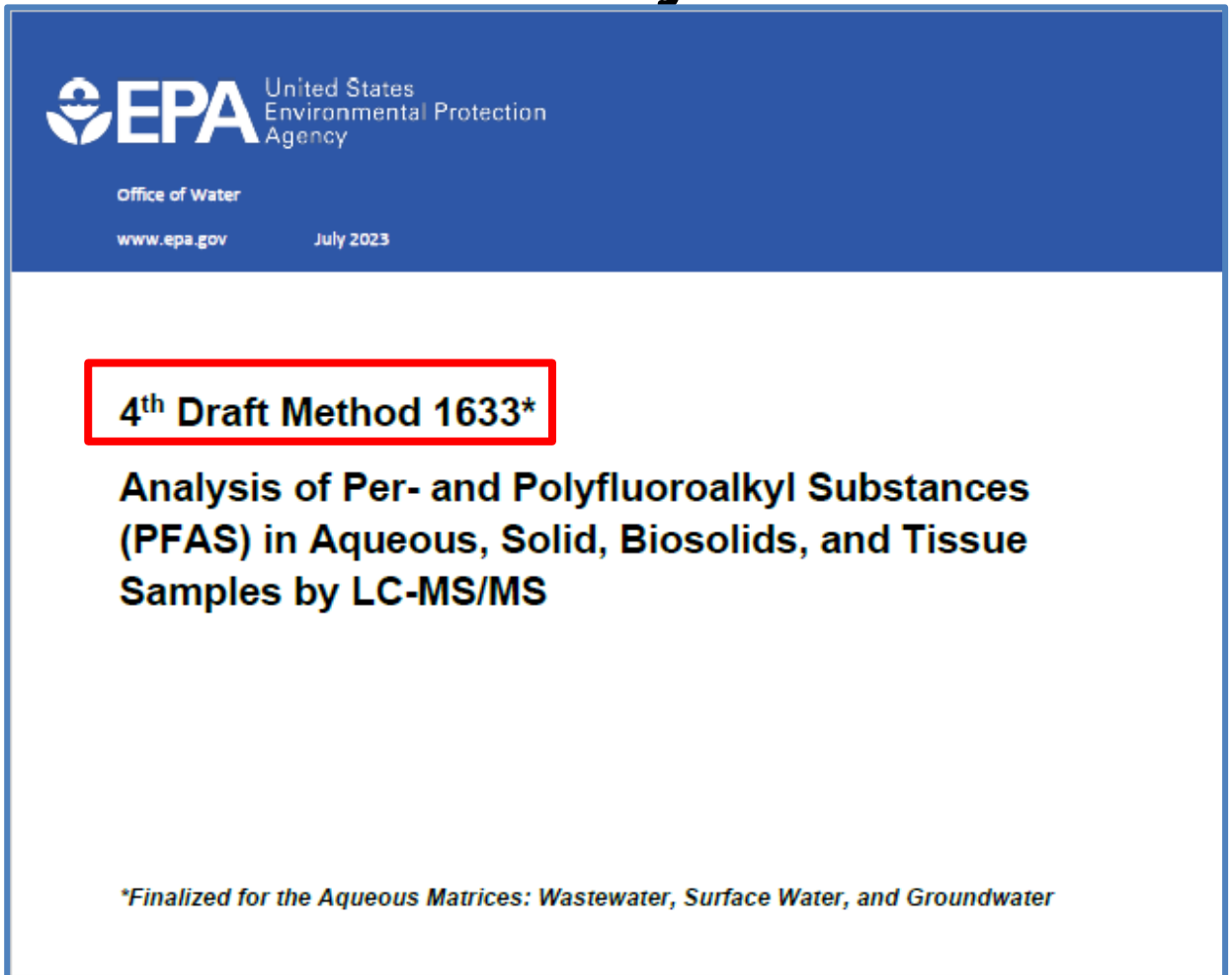
- **Key issue: Admissibility in a court of law**

The Seven Deadly Sins of PFAS

- Under *Daubert*, the Court considers four factors to when determining the admissibility:

1. Whether the lab protocol has been tested;
2. Whether lab protocol has been subject to peer review;
3. The known or expected rate of error; and
4. Whether the lab protocol is generally accepted in the relevant scientific community.

The Seven Deadly Sins of PFAS



Which PFAS Analysis should I use?

Method
USEPA 533
USEPA 537.1
USEPA Draft Method 1633
USEPA SW-846 Method 3512
USEPA SW-846 Method 8327
USEPA Draft Method 1621
ISO 21675:2019
ISO 25101:2009
ASTM D7979-20
ASTM D7968-17a
FDA CAM Method: C-010.01, Version 2019
CDC: 6304.09
DoD AFFF01

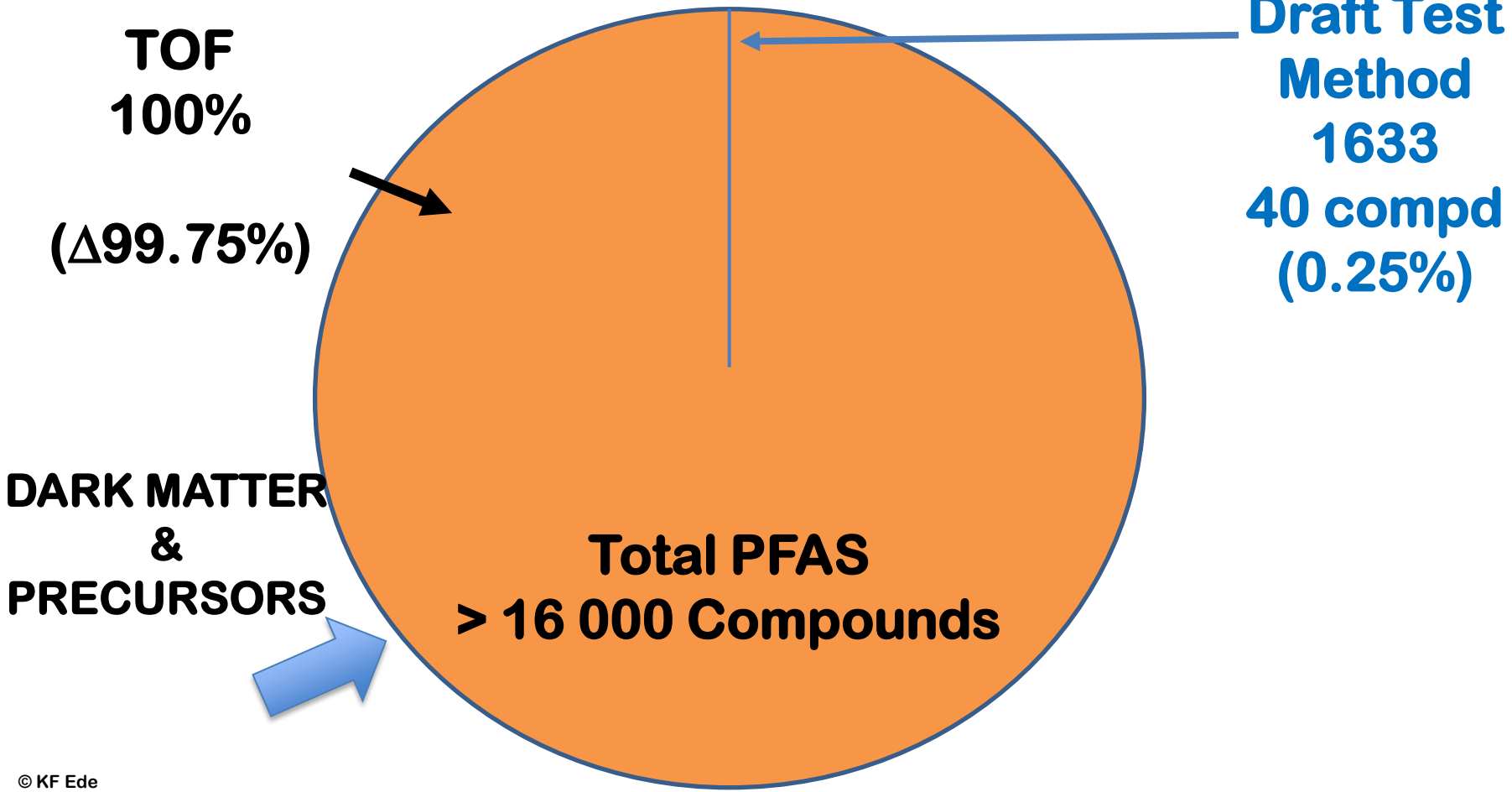
Which PFAS Analysis should I use?

Media	Method
Drinking water	USEPA 533
Drinking water	USEPA 537.1
Surface water, groundwater, wastewater, landfill leachate, soil, sediment, biosolid, and tissue	USEPA Draft Method 1633
Surface water, groundwater, and wastewater	USEPA SW-846 Method 3512
Surface water, groundwater, and wastewater	USEPA SW-846 Method 8327
Aqueous Matrices/All Matrices	USEPA Draft Method 1621/TOF
Unfiltered drinking water, groundwater, and surface water	ISO 21675:2019
Unfiltered drinking water, groundwater, surface water, and wastewaters containing less than 2 g/L solid particulate material	ISO 25101:2009
Water sludge, influent, effluent, and wastewater	ASTM D7979-20
Soil	ASTM D7968-17a
Food (Bread, Lettuce, Milk, and Fish)	FDA CAM Method: C-010.01, Version 2019
Blood Serum	CDC: 6304.09
AFFF Concentrates	DoD AFFF01

Which PFAS Analysis should I use?

Media	Method
Drinking water	USEPA 533 25 compounds
Drinking water	USEPA 537.1 18 compounds
Surface water, groundwater, wastewater, landfill leachate, soil, sediment, biosolid, tissue	USEPA 1633 (Draft) 40 compounds
Everything	USEPA 1621 (Draft) Total Organic Fluorine (TOF) Adsorbable Organic Fluorine (AOF) $\sum$ > 16 000 compounds

Total PFAS v. Draft Test Method 1633



The Seven Deadly Sins of PFAS

- **Sin #6: Not Testing for PFAS Precursors & Dark Matter**

Chemical Analysis

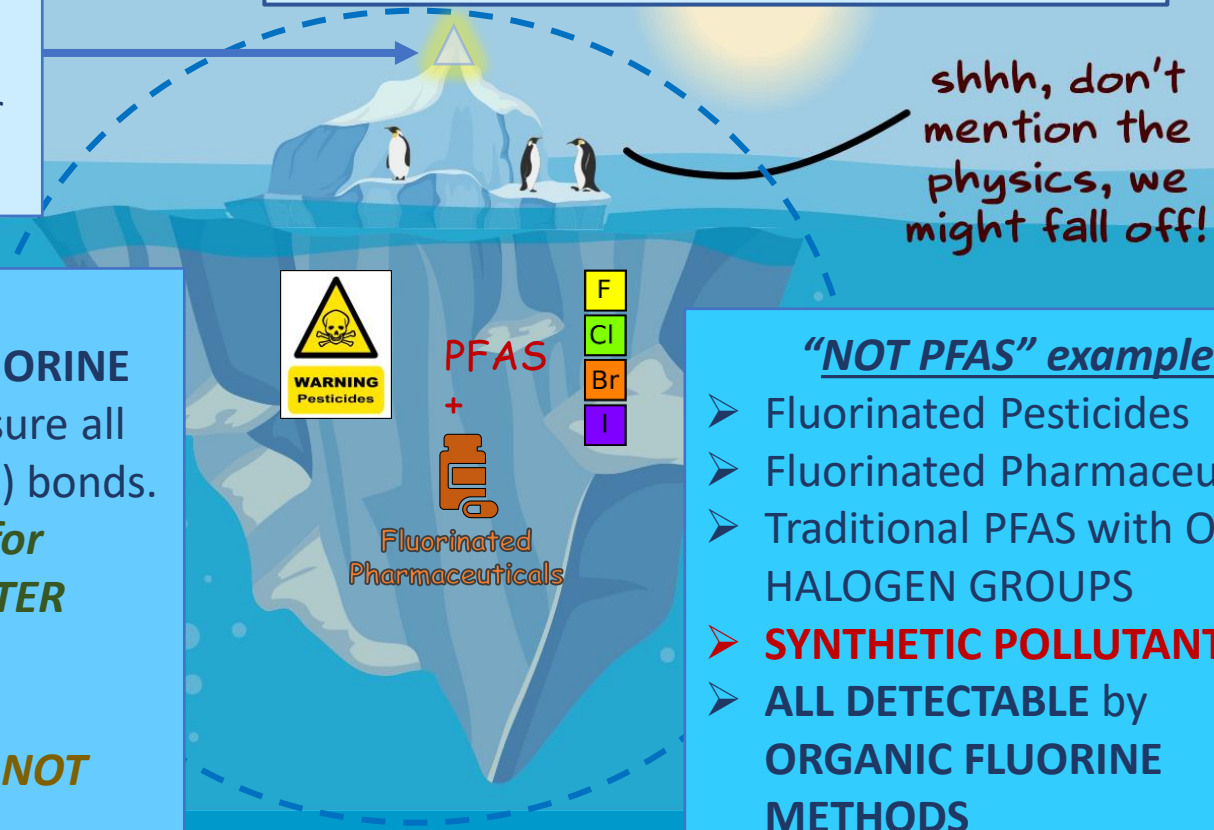
- USEPA will start analyzing using both Test Method 1633 and TOF (total organic fluorine)
- Why?
- Two reasons:

1. Draft Test method 1633 only analyzes for 0.25% of PFAS presently known (*no* PFAS dark matter)
2. Draft Test method 1633 does not test for precursors of PFAS (e.g., telomer alcohols)

The PFAS "ICEBERG" Dilemma: Capturing <1% or >100%

TIP OF THE ICEBERG:

- Target PFAS Testing Methods identify **< 1%** of PFAS Types.
- *Draft* Method 1633 for **40 PFAS** Compounds.



ENTIRE ICEBERG:

- **TOTAL ORGANIC FLUORINE (TOF)** Methods measure all Carbon-Fluorine (C-F) bonds.
- ***Best Proxy Method for TOTAL & DARK MATTER PFAS.***
- Incl. ***Precursor PFAS***
- Detects Compounds ***NOT CONSIDERED PFAS****

"NOT PFAS" examples:

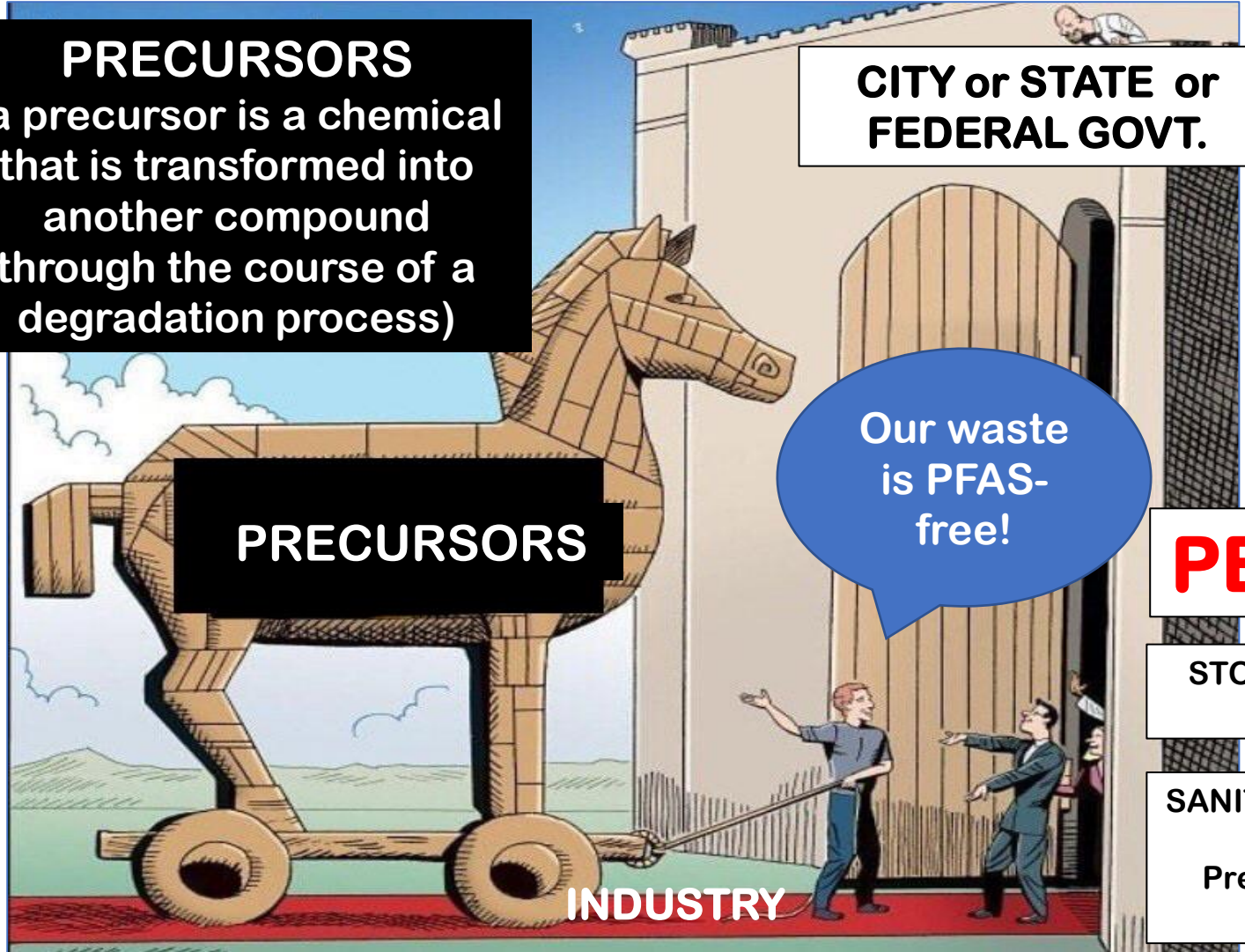
- Fluorinated Pesticides
- Fluorinated Pharmaceuticals
- Traditional PFAS with OTHER HALOGEN GROUPS
- **SYNTHETIC POLLUTANTS**
- **ALL DETECTABLE** by **ORGANIC FLUORINE METHODS**

Sin #6: Not Testing for PFAS precursors

- **Chemical Precursor:**
- **A precursor is a chemical that is transformed into another compound through the course of a degradation process**

Precursors

- Why is USEPA so concerned with precursors?
- Assume EPA was checking for wine (ethanol) in your waste
- The analysis shows ZERO
- However, the analysis shows grape juice, yeast and water in your waste
- Any fermentation of:
- Grape juice + yeast + water = WINE
- Precursors + microbes + water = PFAS


PRECURSORS
(a precursor is a chemical that is transformed into another compound through the course of a degradation process)
CITY or STATE or FEDERAL GOVT.
PRECURSORS
Our waste is PFAS-free!
PERMIT
STORM SEWER: NPDES
SANITARY SEWER: POTWs Pre-Treatment Permit
INDUSTRY

Environ. Sci. Technol. **2005**, *39*, 7516–7528

Fluorotelomer Alcohol Biodegradation—Direct Evidence that Perfluorinated Carbon Chains Breakdown

NING WANG,*,† BOGDAN SZOSTEK,‡
ROBERT C. BUCK,§
PATRICK W. FOLSOM,†
LISA M. SULECKI,† VLADIMIR CAPKA,∥
WILLIAM R. BERTI,† AND
JOHN T. GANNON†

DuPont Central Research and Development, Glasgow Business Community 301, P.O. Box 6101, Newark, Delaware 19714, DuPont Haskell Laboratory for Health and Environmental Sciences, Newark, Delaware 19714, and DuPont Chemical Solutions Enterprise, Wilmington, Delaware 19803

accounted for 1% of initial ^{14}C in activated sludge with continuous air flow at day 1 and increased over time. In closed bottles, $^{14}CO_2$ in the headspace of activated sludge medium increased to 12% of the available ^{14}C over 135 days with periodic addition of ethanol, as compared to 3% when no additional ethanol was added. These results show that replenishment of organic carbon enhanced microbial mineralization of multiple $-CF_2-$ groups in the fluorocarbon chain of ^{14}C-8-2 FTOH. At day 90 the net increase of fluoride ion in the mixed bacterial culture was 93 $\mu g\ L^{-1}$, equivalent to 12% of total mineralization (destruction) of the ^{14}C-8-2 FTOH. These results demonstrate that perfluorinated carbon bonds of ^{14}C-8-2 FTOH are defluorinated and mineralized by microorganisms under conditions which may occur in a wastewater treatment plant, forming shorter fluorinated carbon metabolites.

Introduction

Environ. Sci. Tech

Fluorotelomer Alcohol Biodegradation—Direct Evidence that Perfluorinated Carbon Chains Breakdown

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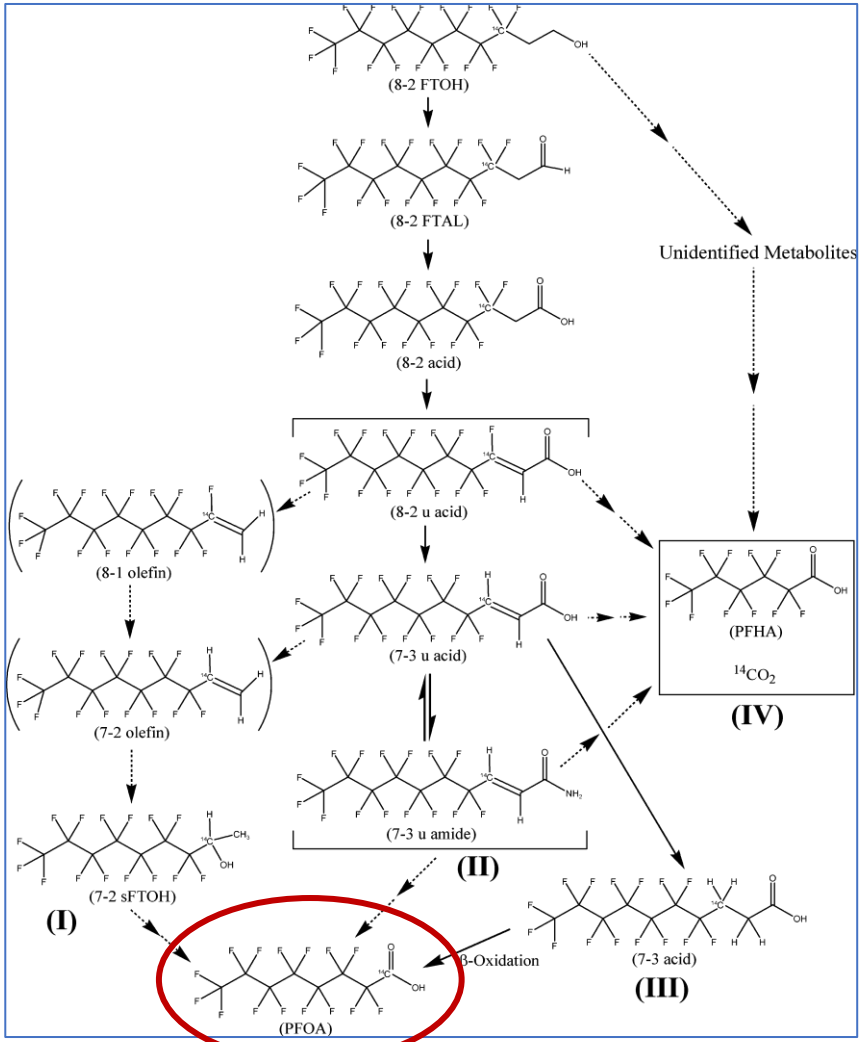

The Seven Deadly Sins of PFAS

- **Sin #7: Reusing any piping, pump, etc. that contained PFAS**

The Seven Deadly Sins of PFAS

- Many facilities that use firefighting foams are transitioning away from Class B foams such as aqueous film forming foams (AFFF) which contain PFAS
- PFAS adheres to fire suppression system walls in the form of supramolecular assemblies
- January 01: Rinse piping 10X; PFAS = below detection limits
- February 01: Rebound→ PFAS

TAKE-AWAY: GREEN CHEMISTRY

Use the principles of Industrial Ecology to eliminate the PFAS chemical

- **One of the most important underpinnings of Industrial Ecology is**
- **Green Chemistry**

Industrial Ecology

- Bottomline: Work with your chemical vendors to find non-PFAS substitutes
- Just like we did years ago with:
- Asbestos:
- PCBs
- Halogenated Solvents for degreasing
- Etc.

JFK's Advice

- January 11, 1962
- State of the Union Address
- President Kennedy stated the following:

"The time to repair the roof is when the sun is shining"

KFE's Advice

"The time to start eliminating PFAS is now!"

"Find the PFAS source and address it by product substitution!"

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QUESTIONS?
Plymouth Rock
National
DRAFT KINGS
Fanatics
BANK OF AMERICA
CITGO
new balance
CLEAResult
Ford
TRULY
Aspiration
Aspiration