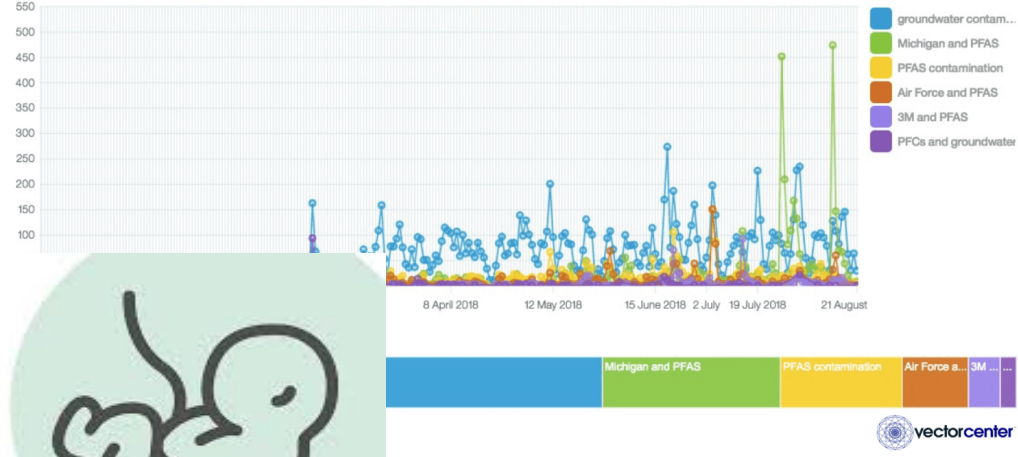


# PFAS:

- What We Know
- What We Don't
- Considerations for Composting and Recycling

John McCabe  
MI Dept. of Environment, Great Lakes, and Energy (EGLE)  
Materials Management Division  
Hazardous Waste Section



**EWG TESTING OF CORD BLOOD SHOWS BABIES ARE PRE-POLLUTED WITH PFAS CHEMICALS.**



# PFAS

- ▶ What Is This Stuff?
- ▶ Why Is It A Problem?
- ▶ What Do We Know About It?
- ▶ What Are We Doing About It?
- ▶ How Does It Affect Me?

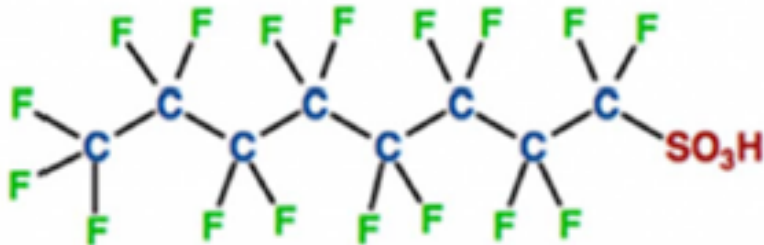
# PFAS: What It Is

(scary chemistry explanation)

## ► Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

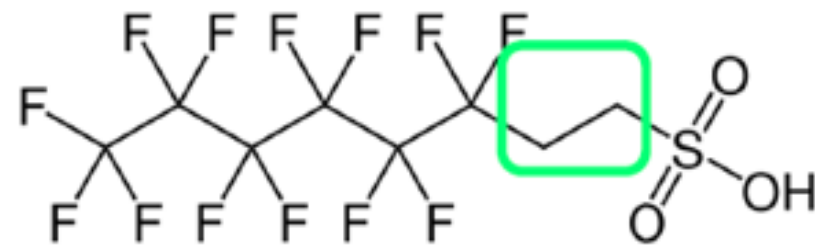
### Perfluorinated

All carbon atoms fully fluorinated

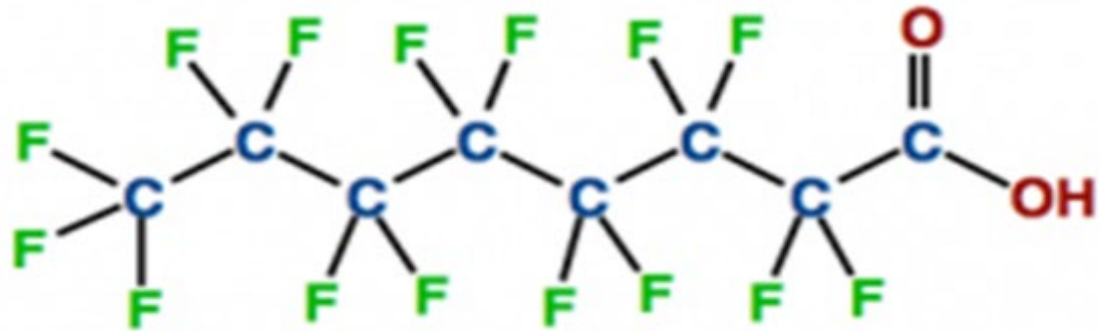


### Polyfluorinated

Some carbons are not fully fluorinated



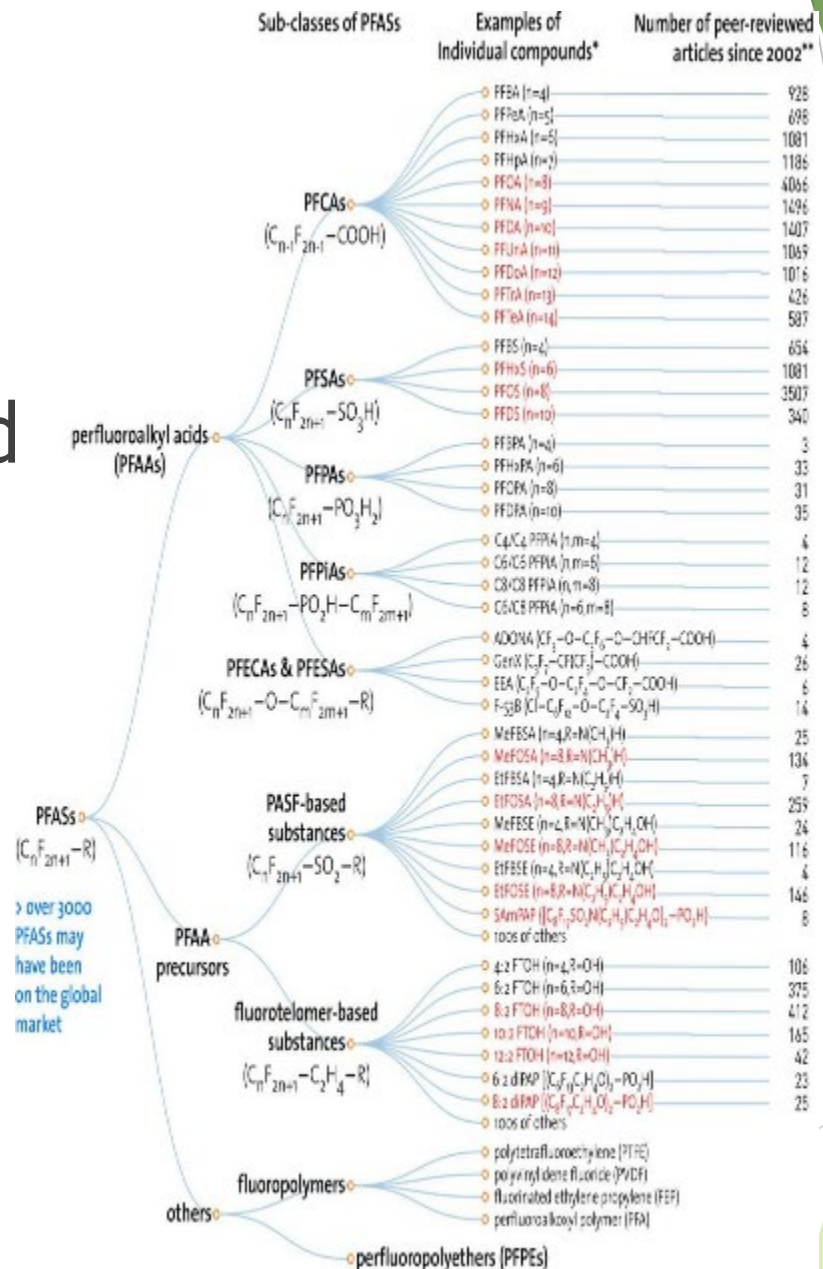
# PFAS Are A Class of Compounds; Not An Individual Chemical



**PFOA - perfluorooctanoic acid**

- Consists of a chain of carbon molecules with each carbon in the chain but the last having fluorine molecules attached to every chemical bonding site.
- The last carbon in the chain has a functional group or “head” bonded to the carbon/fluorine “tail”.
- The number of carbons in the tail and the type of head define which of the individual PFAS compounds we’re dealing with.

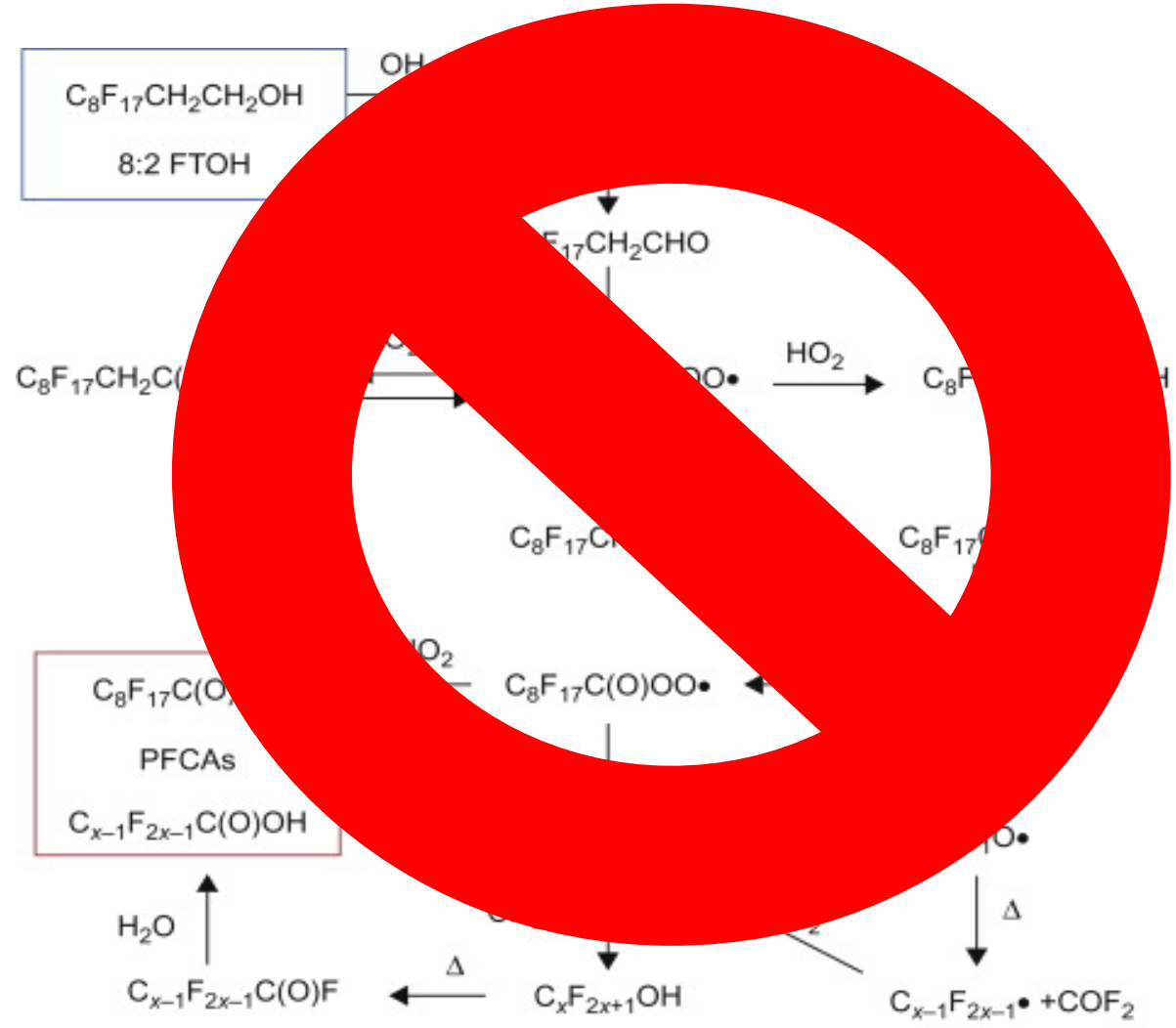
- Over 3000 PFAS produced
- Numerous Subclasses
- 100+ homologues



Wang et al., 2017, ES&T, 51:2508–2518

\* PFASs in RED are those that have been restricted under national/regional/global regulatory or voluntary frameworks, with or without specific exemptions (for details, see OECD (2015), Risk reduction approaches for PFASs. <http://oe.cd/1AM>).  
 \*\* The numbers of articles (related to all aspects of research) were retrieved from Scifinder® on Nov. 1, 2016.

# The Telomerization Process for PFAS Manufacture



# PFAS Uses and Sources





# So, Why Is This Stuff A Problem?

- **Associated With Adverse Health Effects**
- **Bioaccumulation**
- **Extreme Persistence**
- **Health Effects at Extremely Low Levels**
- **Environmental Fate and Transport**
- **Scarcity of Scientific Information**
- **Incomplete Regulatory Structure**

# Health effects

## C8 HEALTH PROJECT (PFOA)

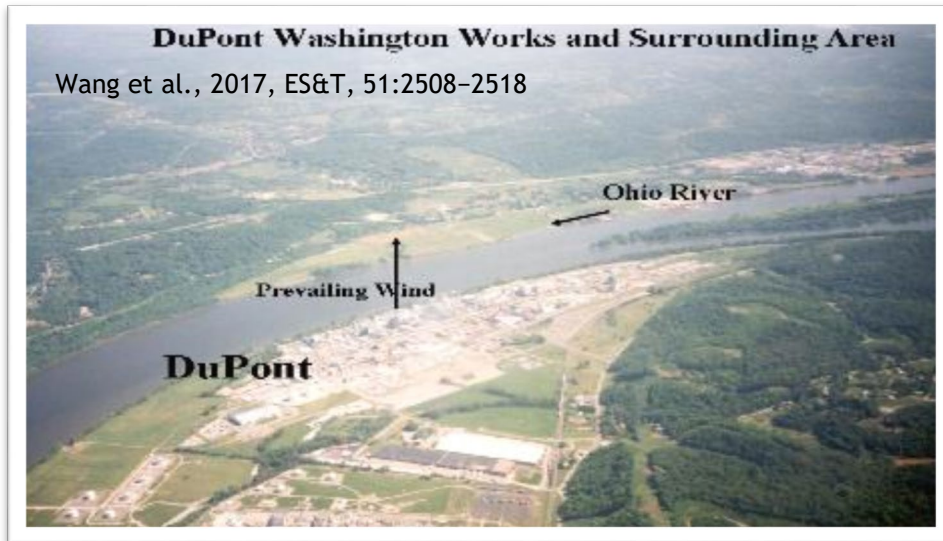
- RESULT OF PFOA RELEASED IN THE OHIO RIVER VALLEY BY DUPONT

## ATSDR STUDY (PERFLUOROALKYLS)

- PFOA, PFOS, PFH<sub>x</sub>S, PFNA, PFDeA

### Potential Health effects:

- ▶ Change in immune Response
- ▶ Cancer – Particularly Testicular & Kidney Cancer
- ▶ Thyroid disease
- ▶ High cholesterol
- ▶ High Blood pressure in pregnant women



# Animal Studies

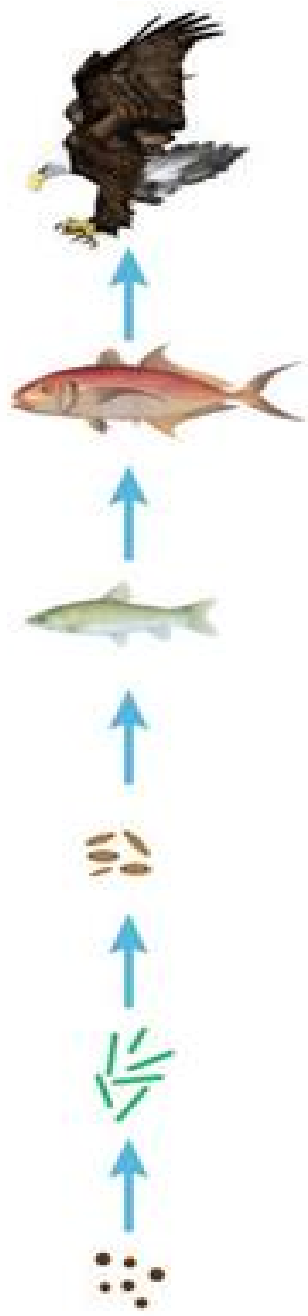
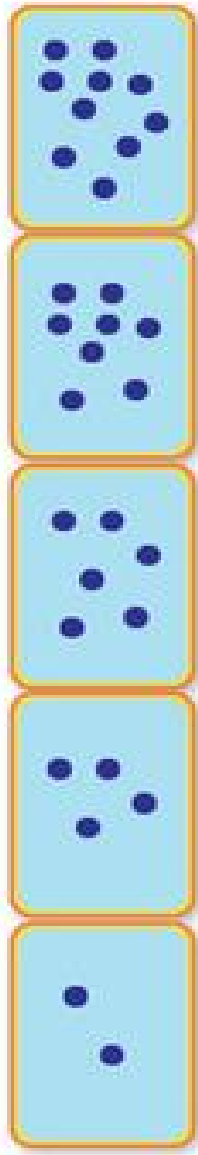
Studies in animals help us understand what could happen in people. Animals given high amounts of PFOA and PFOS (types of PFAS), showed:

- Harm to the liver
- Harm to the body's ability to fight off sickness
- Birth defects, slow growth, and newborn deaths

# Bioaccumulation

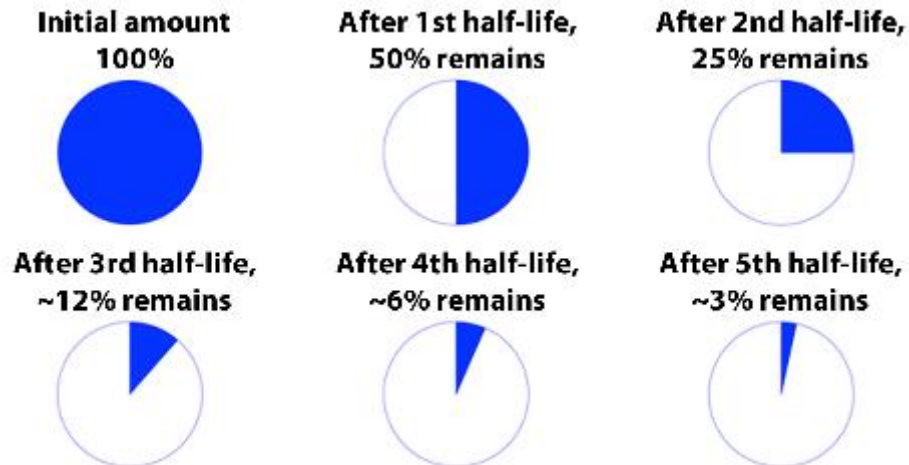
The accumulation of a substance, such as a toxic chemical, in various tissues of a living organism. Bioaccumulation takes place within an organism when the rate of intake of a substance is greater than the rate of excretion or metabolic transformation of that substance.

Biomagnification of Contaminants



# Half Life In Humans

- PFOA 3 to 4 years
- PFOS 5 to 6 years
- PFHxS 8 to 9 years

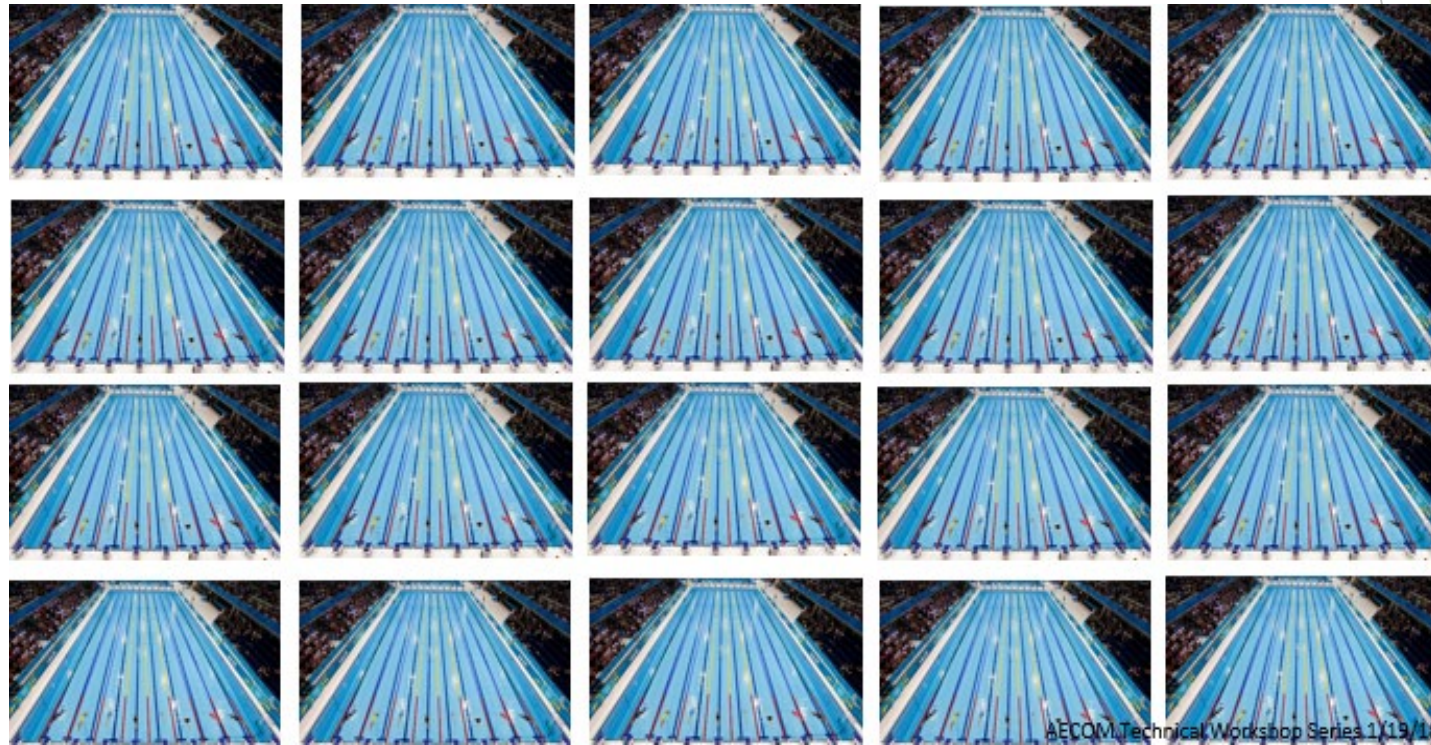


Data from Li, et. al., 2018

Figure: McGraw Hill Ryerson 2007

# Health Effects Can Occur At PPT Levels

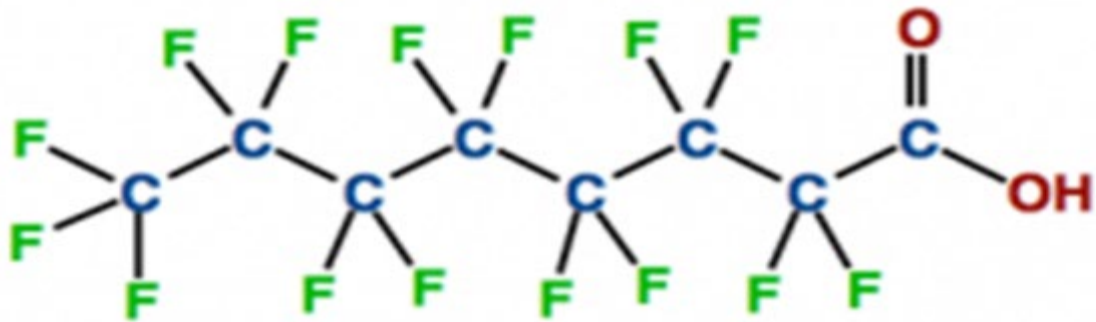
1 PPT = 1 DROP (0.05ML)  
IN 20 OLYMPIC  
SWIMMING POOLS



20 OLYMPIC POOLS = 13,200,000 GALLONS

# PFAS Are Extremely Persistent

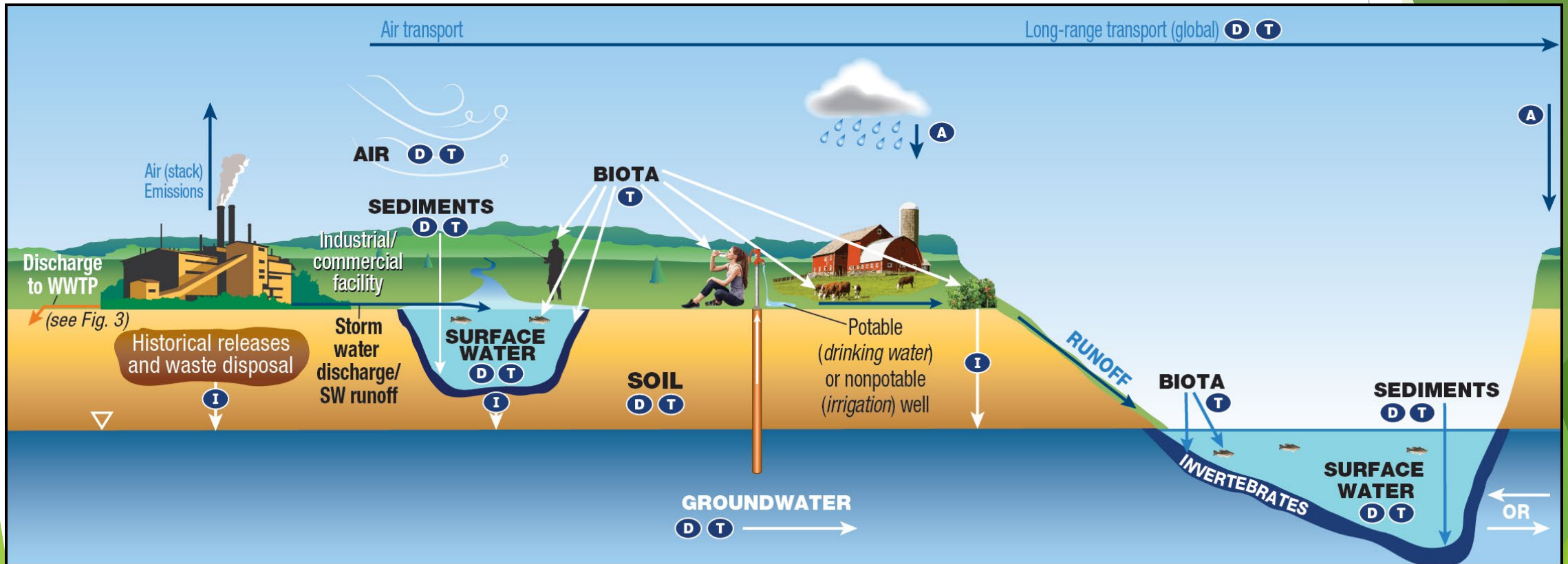
- The carbon-fluorine bond is the strongest in nature
- High temperature (in excess of 2,000° F) is required to break these bonds
- No biological mechanisms known to degrade PFAS
- Chemical mechanisms require intensive energy and controlled conditions.



**PFOA** - perfluorooctanoic acid



# Environmental Fate and Transport



KEY **A** Atmospheric Deposition **D** Diffusion/Dispersion/Advection **I** Infiltration **T** Transformation of precursors (abiotic/biotic)

# Environmental Transport Occurs Within and Between:

- Air
- Soil
- Surface Water
- Groundwater

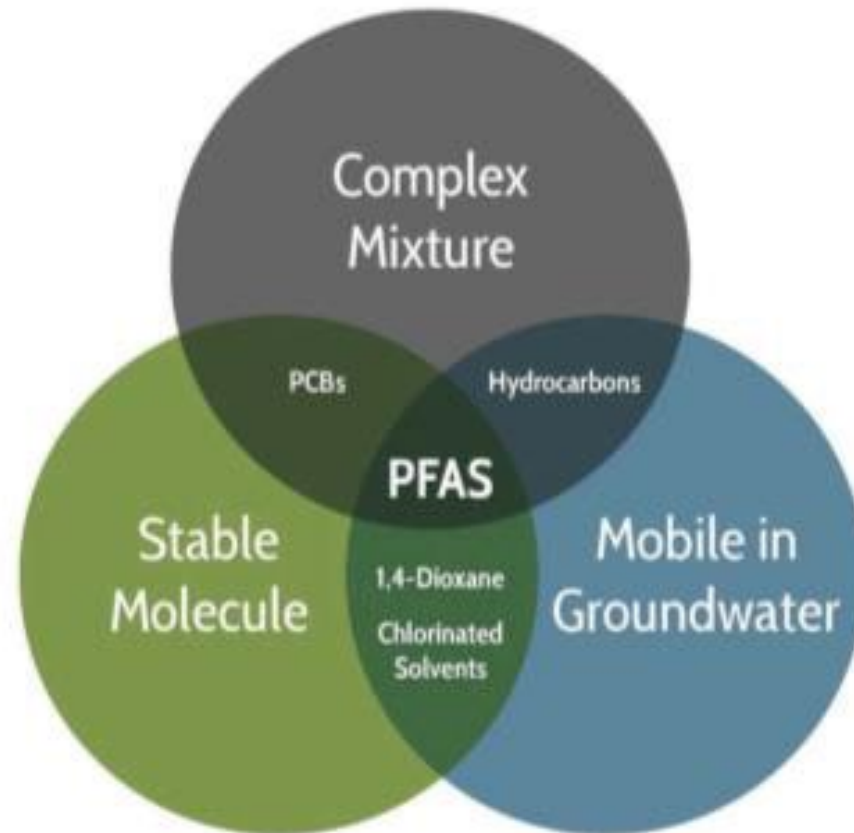




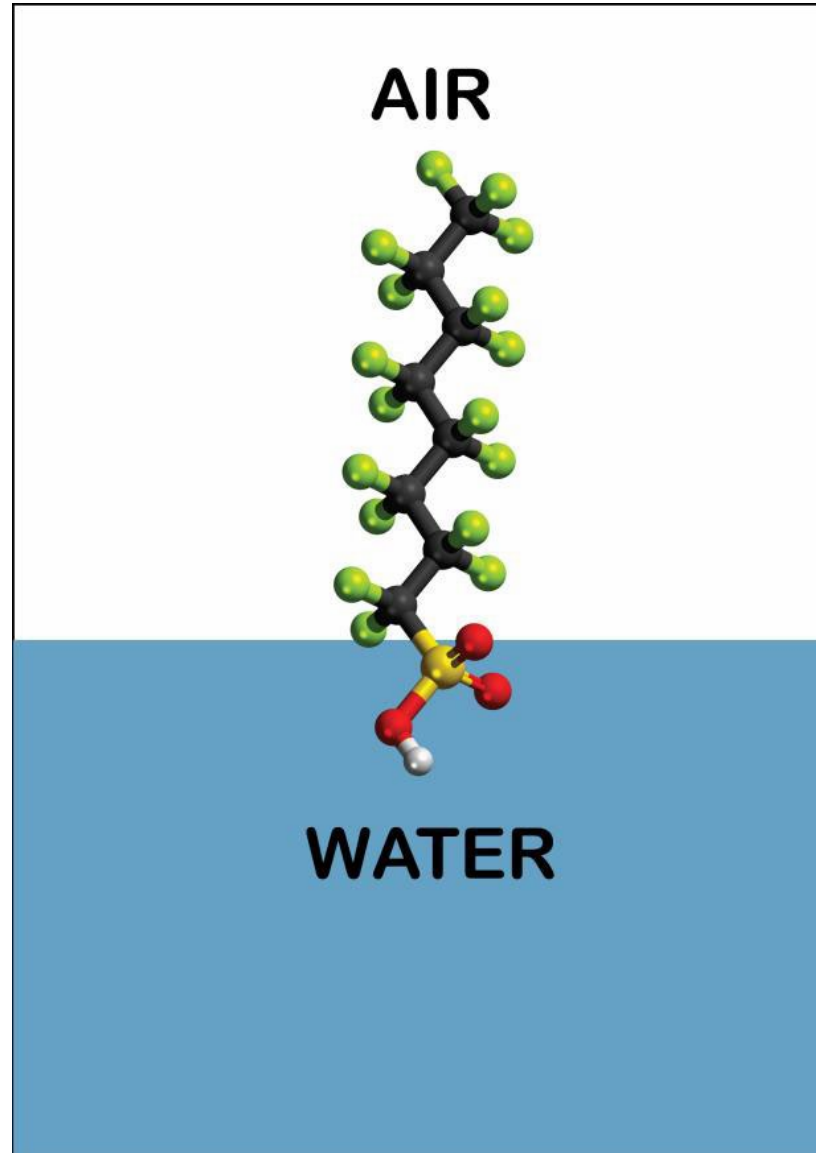
# **We Will Focus On Surface Water and Groundwater Because Primary Environmental Exposure to PFAS Is Through Drinking Water.**

Note: This does NOT mean that your only exposure is through drinking water!!

# So Why Is This Stuff Such A Problem in Water?



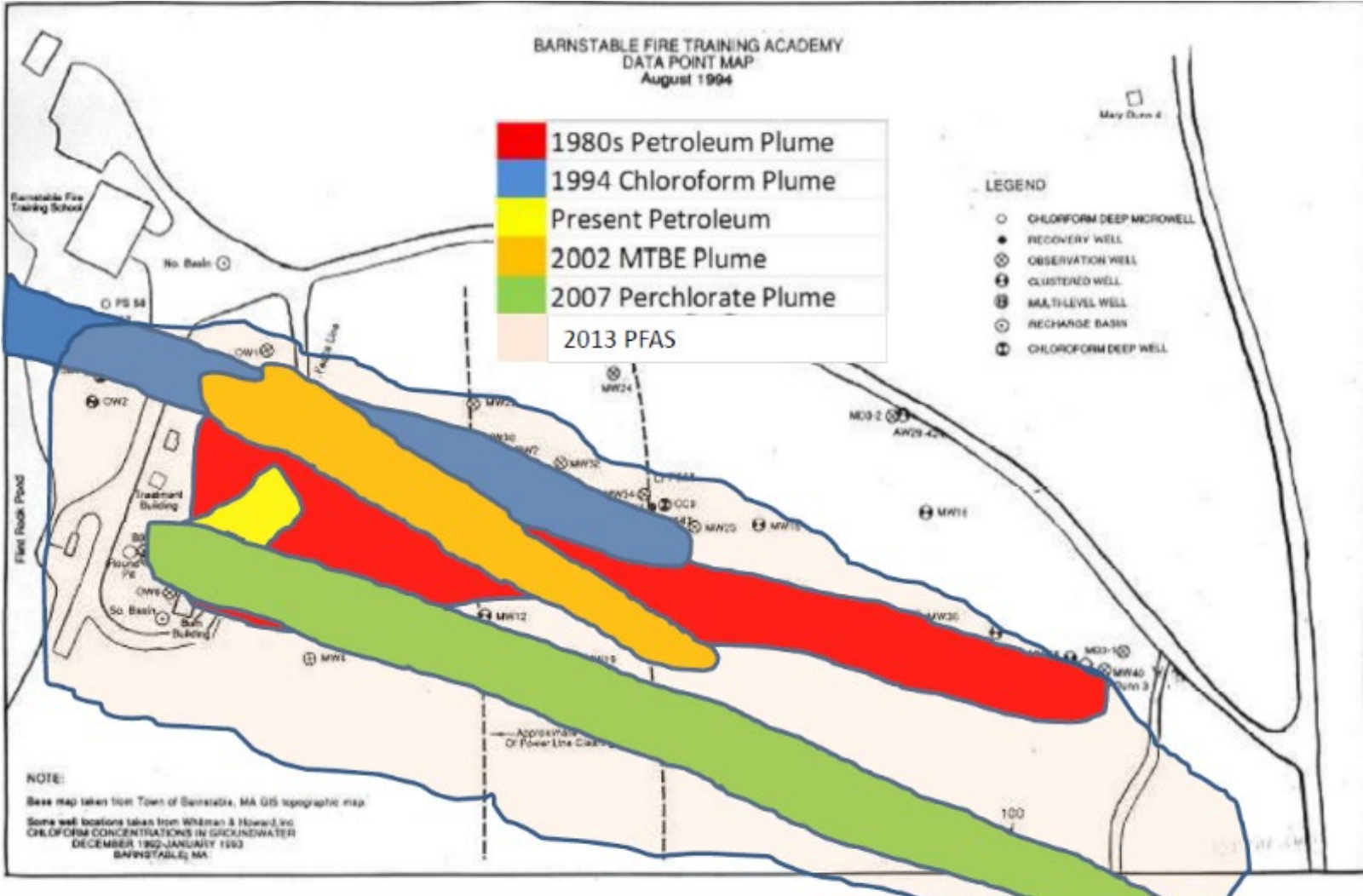
# PFAS Are Surfactants



# PFAS Are Slippery



# PFAS Plumes Tend To Be Longer and Wider Than Other Contaminants

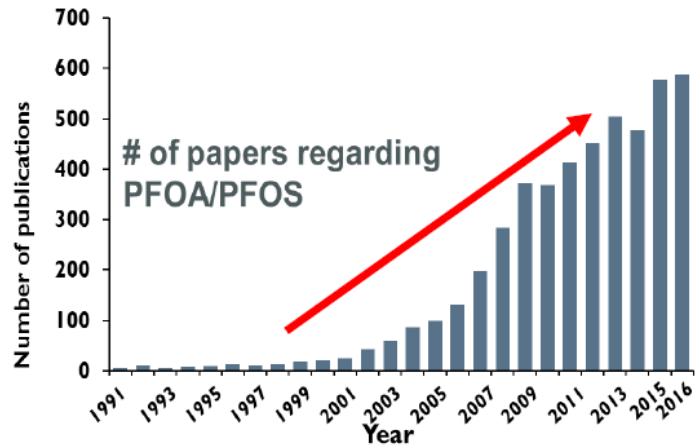
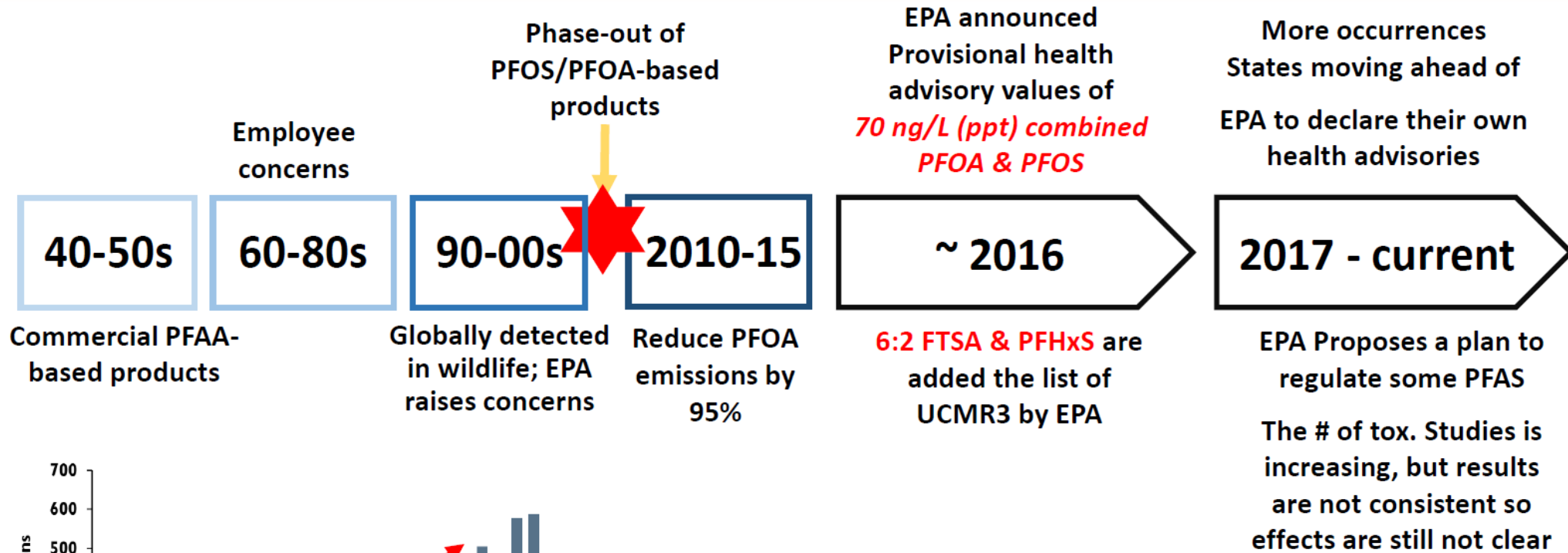


# PFAS Regulatory Landscape

The slide features a white background with a decorative graphic on the right side. This graphic consists of several overlapping, semi-transparent green shapes in various shades, ranging from light lime green to dark forest green. These shapes are primarily triangular and polygonal, creating a layered, abstract effect that resembles a stylized landscape or a modern architectural design.



# History & Regulations of Perfluoroalkyl Acids (PFAAs)



# Global Manufacture and Use of PFAS



# Michigan PFAS Action Response Team (MPART)

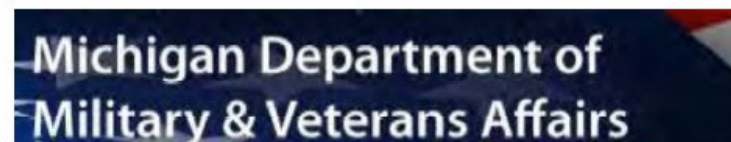
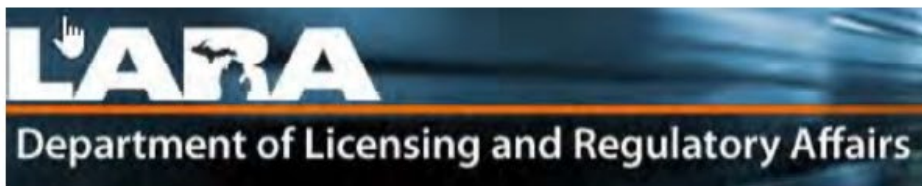
- ▶ Executive Order 2019-3
- ▶ Continues unique multi-agency approach
- ▶ Leads coordination and cooperation among all levels of government
- ▶ Directs implementation of state's action strategy



# MPART



MICHIGAN DEPARTMENT OF  
ENVIRONMENT, GREAT LAKES, AND ENERGY



Statewide cooperation and collaboration to strategically and proactively address this emerging contaminant.

**More Details on MPART at**

**<https://www.michigan.gov/PFAsresponse>**

# MI Standards

## Surface water quality

- ✓ 11/12 ppt PFOS
- ✓ 420/12,000 ppt PFOA

## Groundwater cleanup

- ✓ 70 ppt PFOA/PFOS
- ✓ GSI per surface water quality standards

## Drinking water

- ✓ 70 ppt PFOA/PFOS lifetime health advisory recommendation
- MCLs



# Michigan has begun the process of developing an MCL to apply to drinking water sources (details).

Governor Whitmer Press Release Quotes March 26, 2019

“All Michiganders deserve to know that we are prioritizing their health and are working every day to protect the water that is coming out of their taps.”

“Today I'm directing the Michigan PFAS Action Response Team to form a science advisory workgroup to review both existing and proposed health-based drinking water standards from around the nation to inform the rulemaking process for appropriate Maximum Contaminant Levels (MCL) for Michigan by no later than July 1, 2019.”

Placeholder Slide to update with  
most current regulatory  
information as of 5/5/19



# **PFAS in Composting, Biosolids and Recycling**

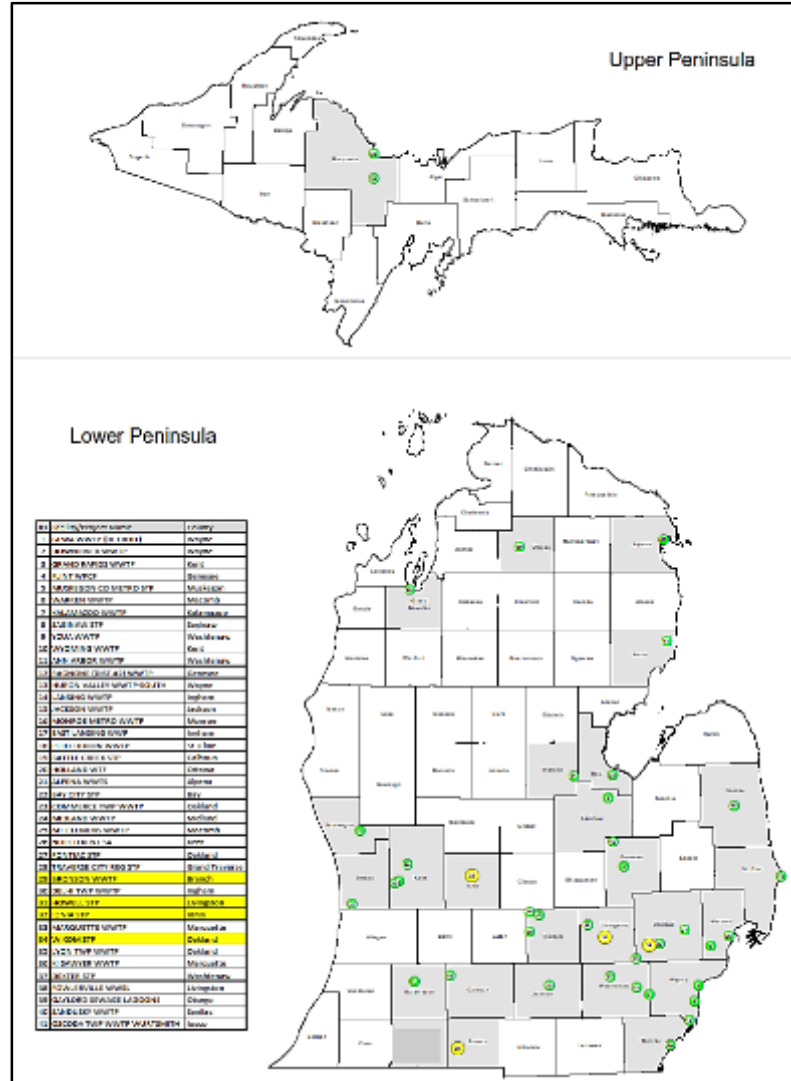


# **Biosolids and Biosolids Compost**



# Statewide Biosolids Study

- Sample Effluent, Influent, & Biosolids from 41 WWTPs
- Sample select fields from WWTPs with high conc. of PFOS in biosolids
  - ▶ Wixom, Ionia and Bronson
  - ▶ Revisit City owned field in Lapeer (complete)
- Sample fields from WWTPs with “typical” PFOS concentrations in biosolids
- Identify data gaps
- In lieu of criteria, develop guidance to assist with biosolids management decisions



**Legend**

- WWTP Sample Location
- WWTP + Biosolids Field Sample Location
- ▭ Planned Sampling

# Statewide WWTP Biosolids Study

October –  
November 2018



**41 WWTPs Evaluated**

Influent, Effluent,  
Sludge/Biosolids



**Selection Criteria:**

20 Largest

3.0 – 9.0 MGD ( 8 WWTPs)

0.5 – 3.0 MGD ( 8 WWTPs)

0.2 – 0.4 MGD ( 5 WWTPs)

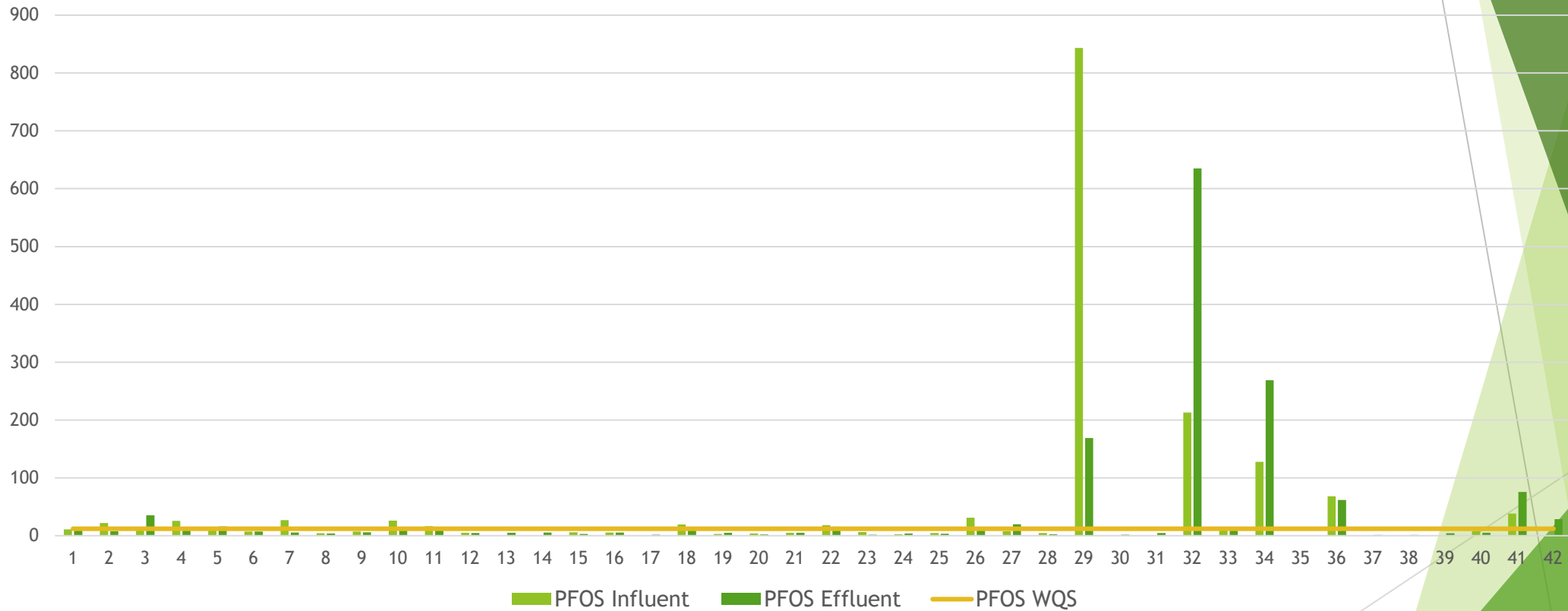


**Selected WWTP  
included:**

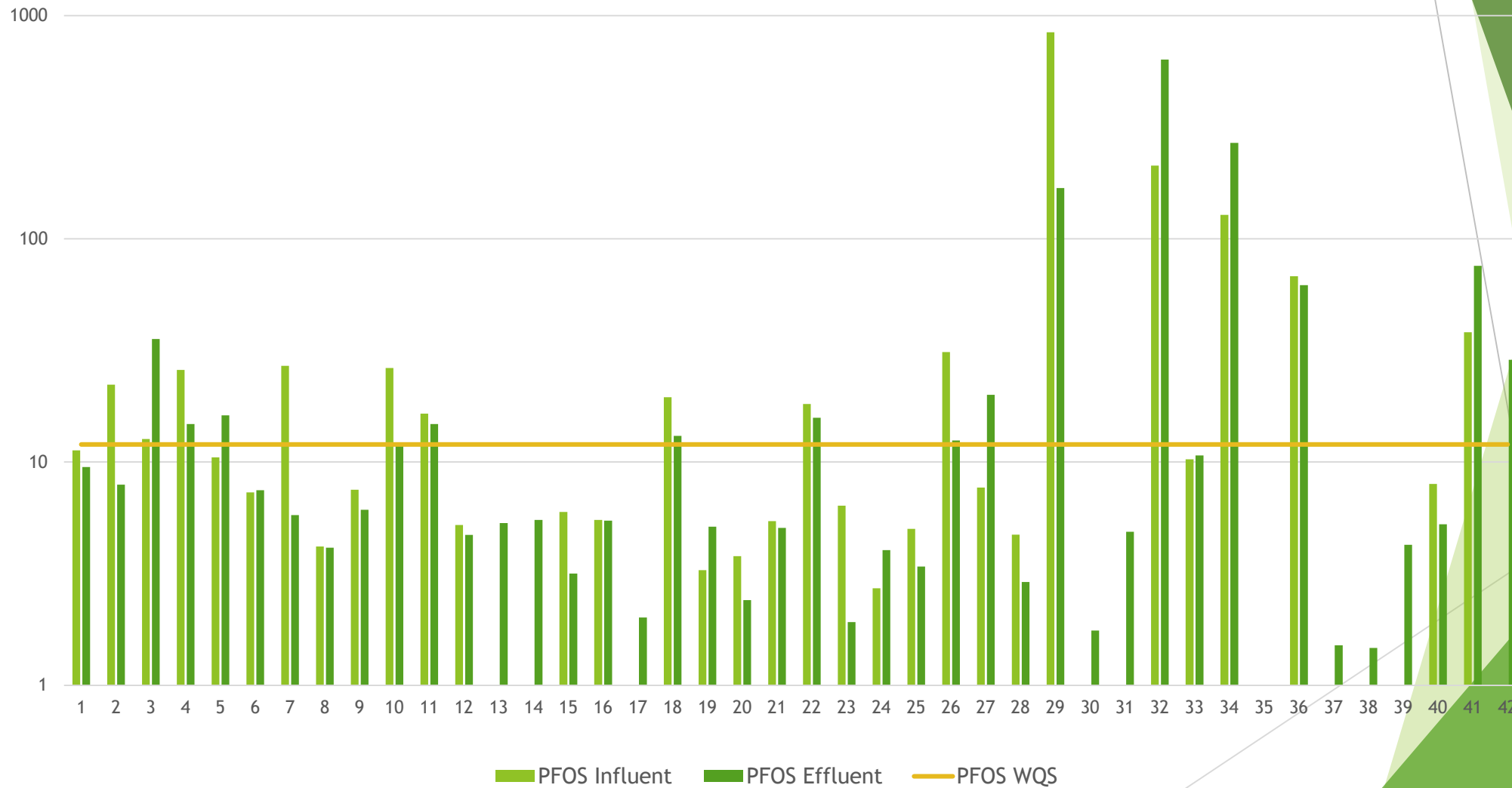
Various treatment processes

No industrial users

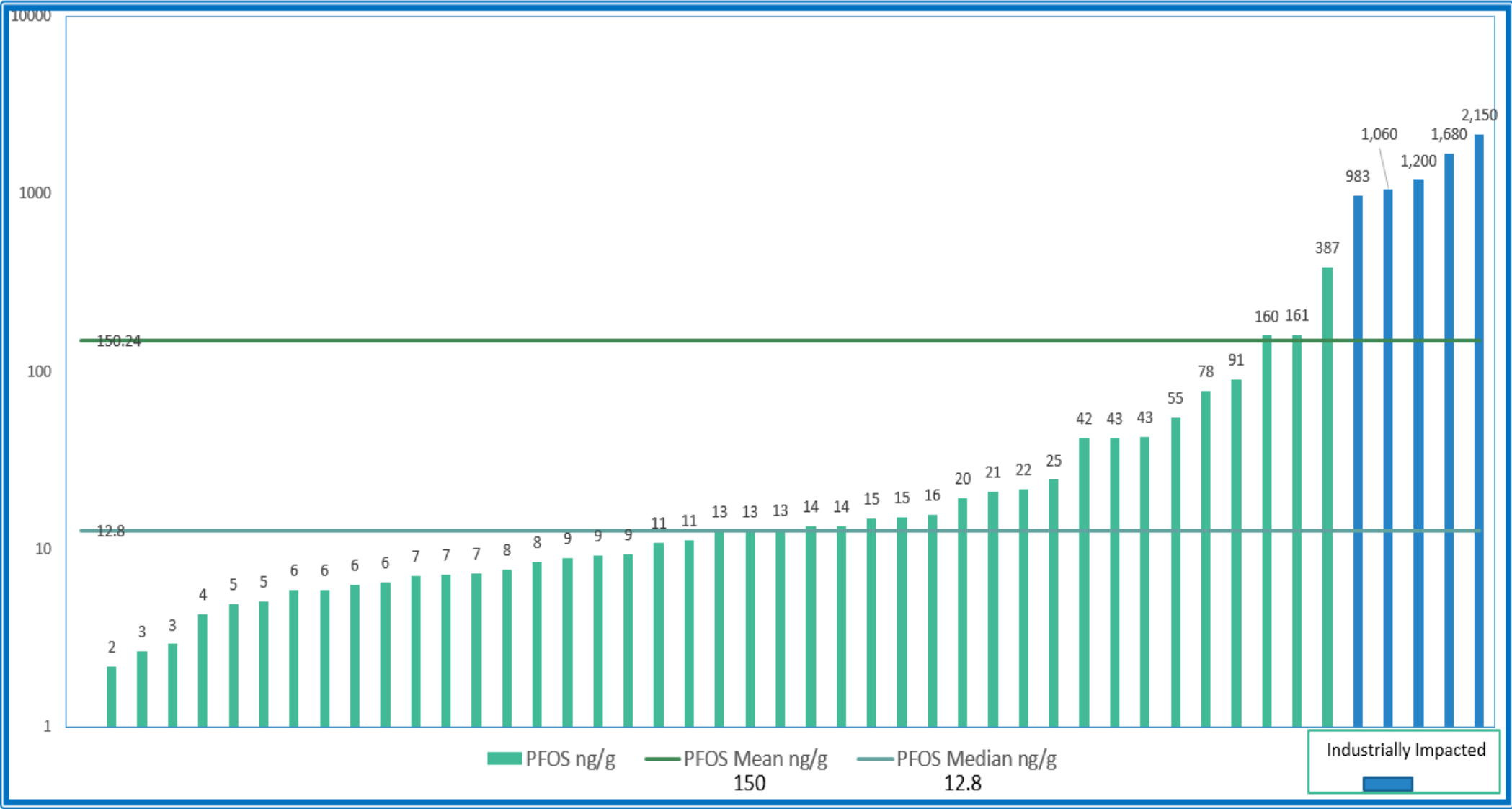
# WWTP Influent and Effluent Data



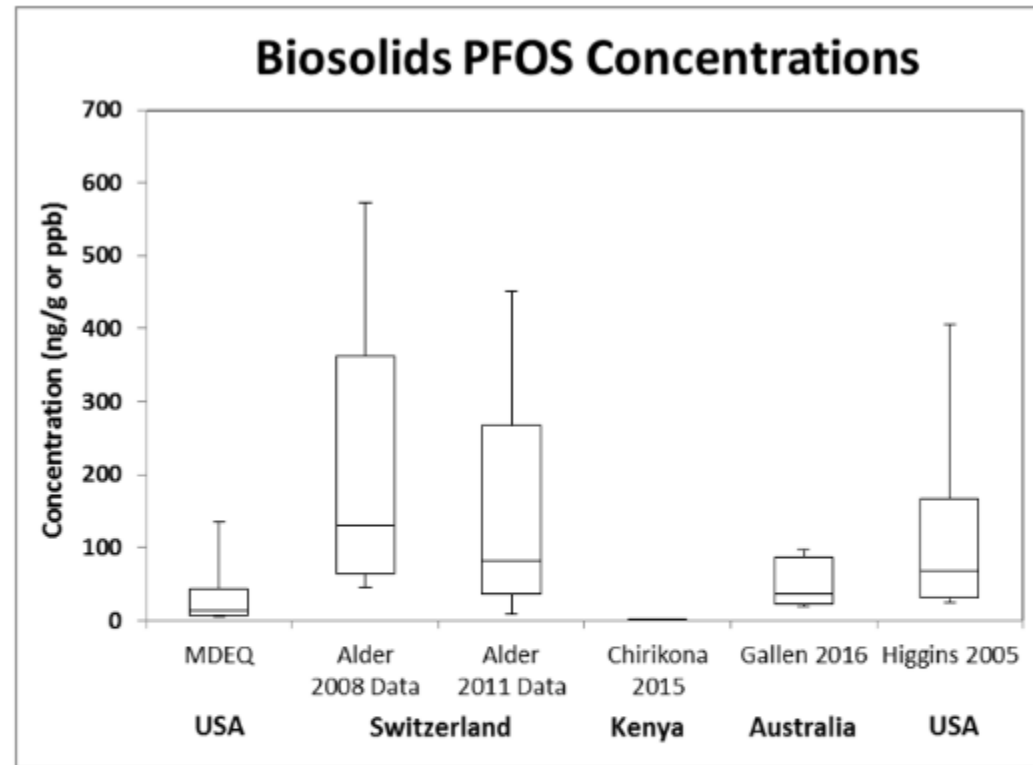
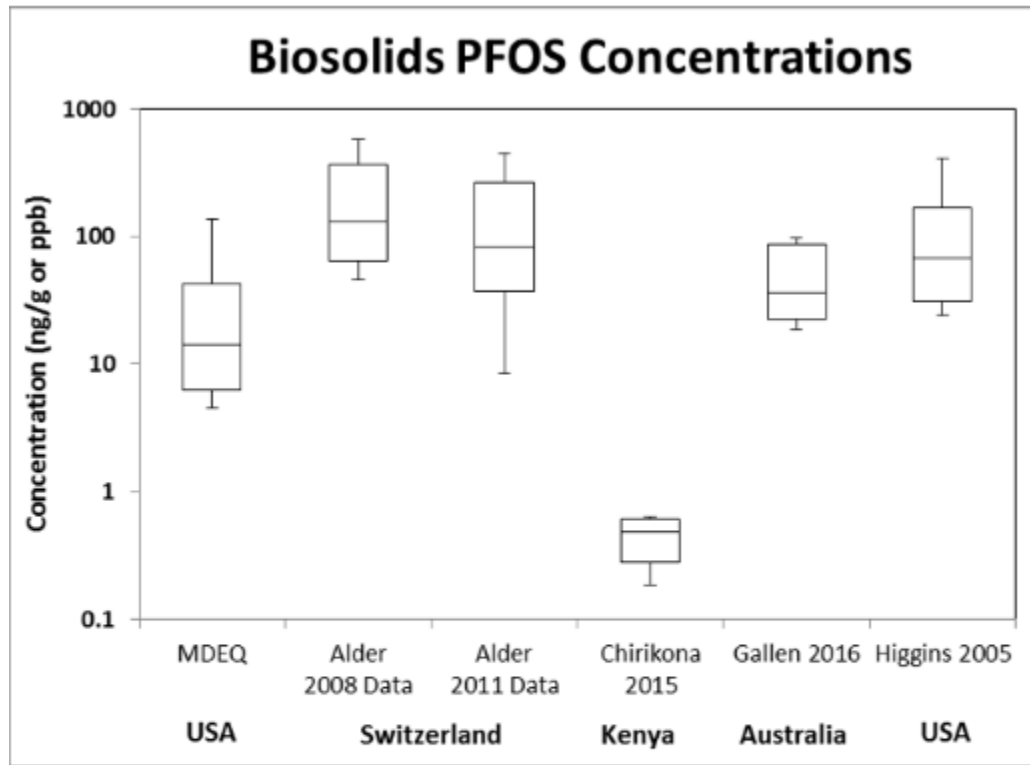
# WWTP Influent and Effluent Data



# Statewide Study - WWTP Stabilized Sludge/Biosolids PFOS Results



# PFOS In Biosolids Internationally



\*Excludes industrially impacted solids that are no longer being land applied



# Land Application Site Screening

- Field Selection Procedure to prioritize fields for screening
- April 2019 – Field Screening
  - Land App sites used by WWTPs with high PFOS concentrations
    - Wixom, Ionia, Bronson
    - Revisit City owned field in Lapeer (complete)
    - Soils, drain tiles, surface waters
  - Land app sites used by WWTPs with low/avg. PFOS concentrations ranges
    - 1 - <5 ng/g
    - 3 - 6 – 25 ng/g
    - 1 - 26 – 60 ng/g



# Biosolids - *Next steps*

- ▶ Compile / Analyze results from IPP initiative and the statewide WWTP biosolids sampling
- ▶ Continue Biosolids MPART / stakeholder group meetings
- ▶ Land Application Site investigations, compile /analyze results
- ▶ Develop Guidance for land application of biosolids based on study results

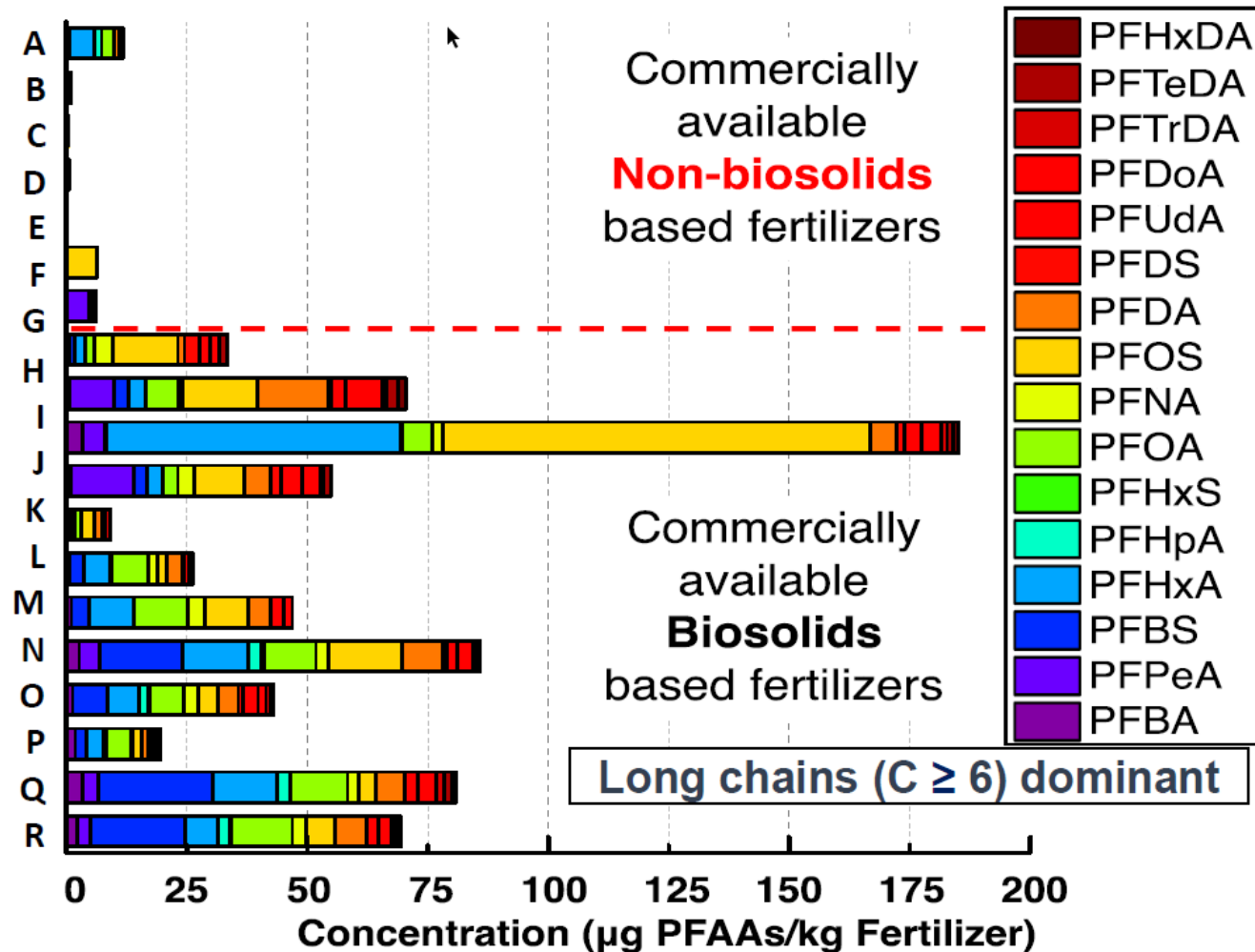


# Data From Purdue University Study

## PFAA Levels in Composts and Biosolids Products

- **17 PFAAs**
  - 13 PFCAs (C4 to C18):  $\text{CF}_3(\text{CF}_2)_n\text{COOH}$
  - 4 PFSAAs (C4, C6, C8 and C10):  $\text{CF}_3(\text{CF}_2)_n\text{SO}_3^-$
- **18 Commercially Available Fertilizers**
  - 11 biosolids-based (<2 mm fraction evaluated except for granular biosolids)
  - 7 non-biosolids-based (< 2 mm fraction evaluated)
  - Obtained in 2014, except for Milorganite (2014, 2016 & 2018)
  - Freeze-dried
- **10 Municipal Solid Waste (MSW) Composts**
  - Obtained in 2017 via Zero-Waste Washington

# Result: PFAAs in 2014 Commercial Fertilizers

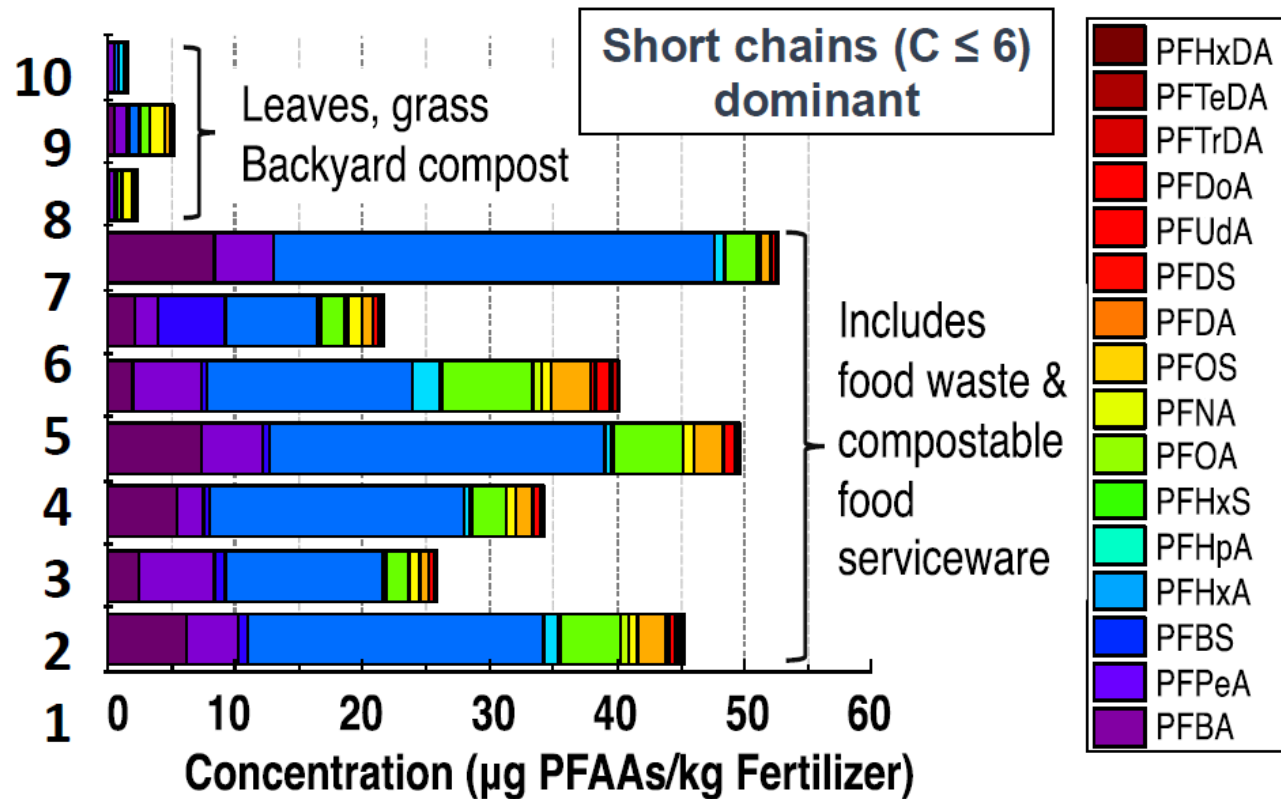


Fertilizer	Description
A	Food and yard compost
B	Compost with untreated wood products
C	Manure compost
D	Manure and peat compost
E	Mushroom compost
F	Mushroom compost
G	Peat/compost based growing mix
H	Heat-dried granular biosolids
I	Heat-dried granular biosolids
J	Heat-dried granular biosolids
K	Heat-dried granular biosolids
L	Heat-dried granular biosolids
M	Biosolids blended with maple sawdust and aged bark
N	Composted biosolids with woodchips
O	Composted biosolids with woodchips
P	Composted biosolids with municipal solid waste
Q	Composted biosolids with residential yard trimmings
R	Composted biosolids with plant materials

\*PFAA concentration in < 2mm fraction (36-80%) normalized to total mass (assumes PFAA is negligible in the fraction > 2 mm)

Kim Lazcano et al., Manuscript in preparation

# Result: What about PFAAs in Municipal Waste Composts (2017)



	Description
1	Municipal solid waste
2	Municipal solid waste and wood products
3	Residential and commercial food and yard waste, compostable food serviceware products
4	Residential and commercial food and year waste, compostable items
5	Mixed food waste (residential, local grocers, restaurants, and commercial food handling facilities) and yard waste
6	Residential food and yard waste, & compostable food serviceware
7	Food waste, horse manure, wood shavings, coffee grounds and lobster shells, & compostable food serviceware
8	Leaves and grass waste from municipalities
9	Residential back yard compost bin
10	Leaves

\*PFAA concentration in < 2mm fraction (30-69%) normalized to total mass (assumes PFAA concentrations is negligible in the fraction > 2 mm)

- Higher PFAA concentrations in municipal waste comp with food waste + food serviceware or packaging

Choi et al., Manuscript in preparation; Zero Waste Washington was provided the samples.

# PFAS Issues Specific To Recycling

- Not much is currently known about environmental impacts of recycling PFAS containing items
- Largest concerns likely to be with construction/demolition scrap and industrial items
- PFAS coated (glossy) paper may be a concern



# Recommendations For Recyclers

What to do with contaminated systems.

- Drain the system components to the maximum extent practical and containerize and manage these fluids as high concentration material.
- If the scrapped system is to be recycled, triple rinse the components and containerize the rinsate for management, as described above. Testing of rinsate would need to be conducted to provide the WWTP with information for them to determine if rinsate may be safely accepted or if pretreatment is necessary. Prior approval of the WWTP is required before any PFAS-contaminated discharge, and WWTPs may decide not to accept these wastewaters in any case.



# Recommendations for Recyclers (cont.)

- **Mixed and glossy paper: try to store under cover**
- **Recycled paper mills: occasionally sample process water and sludges to determine if they need special management**