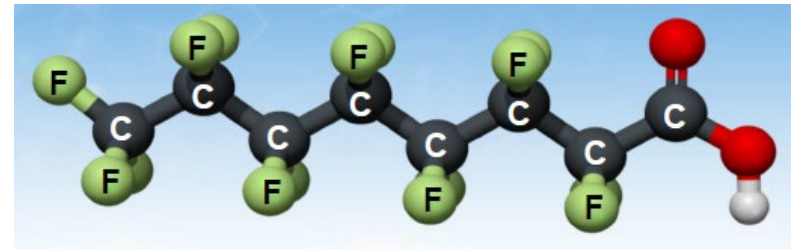


Groundwater Protection from PFAS Contaminants

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Outline

- PFAS Sources
- Chemistry
- PFAS Lawsuits
- PFAS Regulations
- Treatment Options
- Summary

PFAS is Everywhere



CARPETS



CARPET CLEANING PRODUCTS



FOOD PACKAGING



FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM

Source: Green Science Policy Institute

PFAS in the Environment

- PFAS has been found in:
- Groundwater,
- Surface water
- Bottle water,
- Rainwater,
- Wastewater,
- Biosolids,
- Soil,
- Ash,
- Air,
- Animal tissue,
- Plant tissue.



PFAS Infiltrated our Food Supply



FDA tested a dairy farm near a US Air Force Base in New Mexico



PFAS Related Health Effects

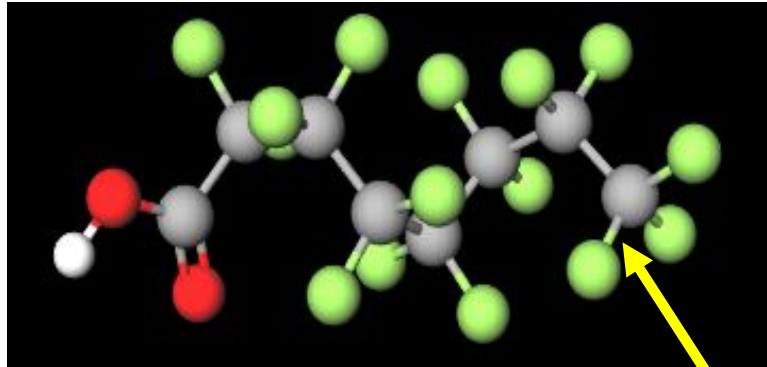
Studies have shown:

- Increased Cancer risk:
 - Colon
 - Kidney
 - Pancreatic
- Affect the immune system
- Increase cholesterol

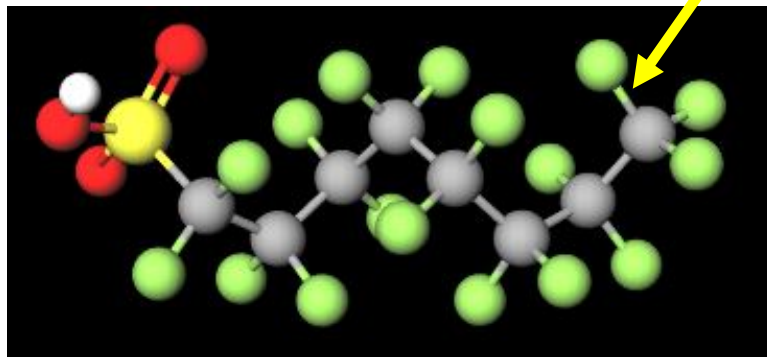


PFAS Structure

PFOA



PFOS



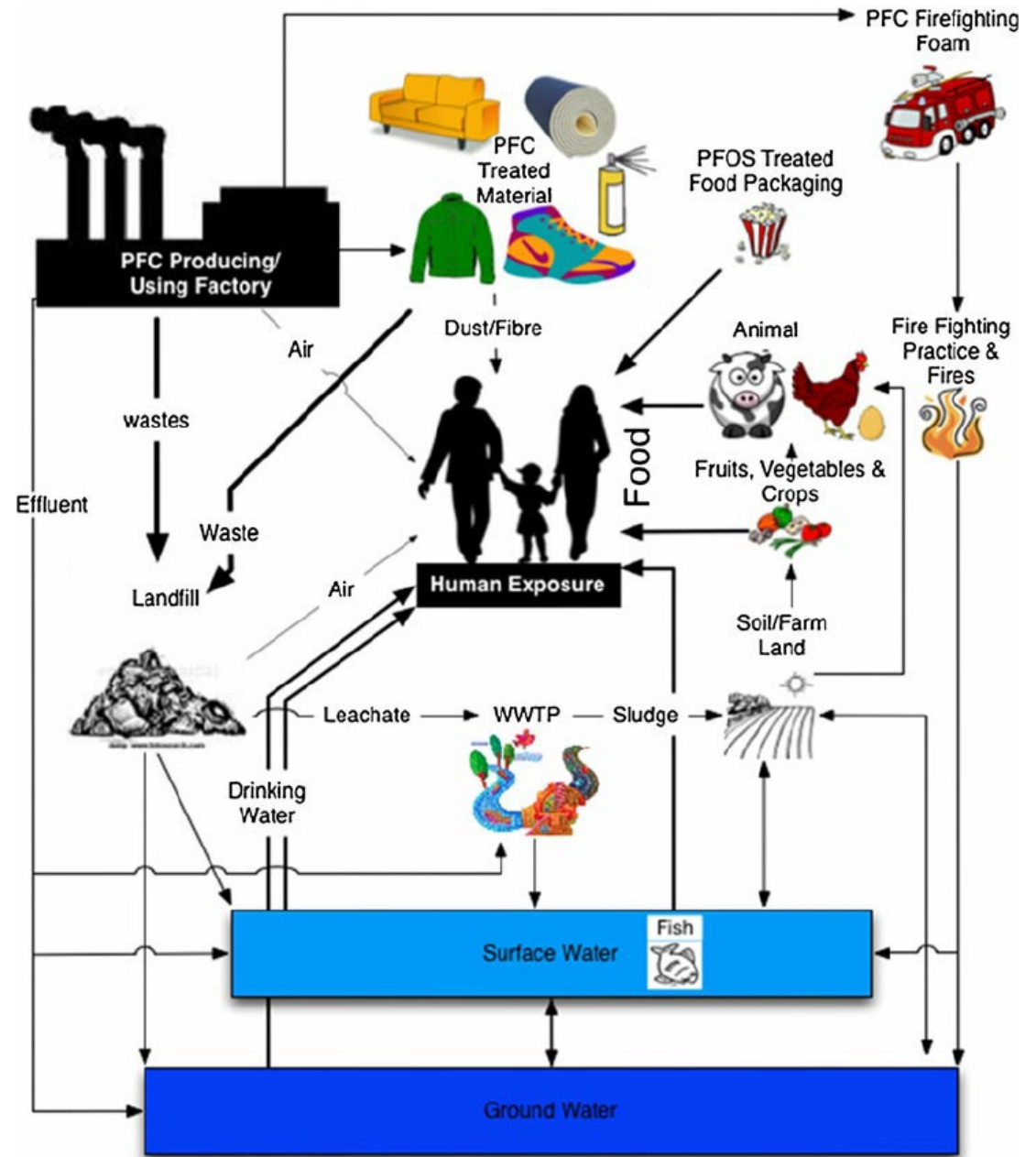
Strong
C-F bonds

	kJ/mol of bonds
C-F	485
C-H	436
C-C	346
C-Cl	339
C-N	305
C-Br	285
C-S	272

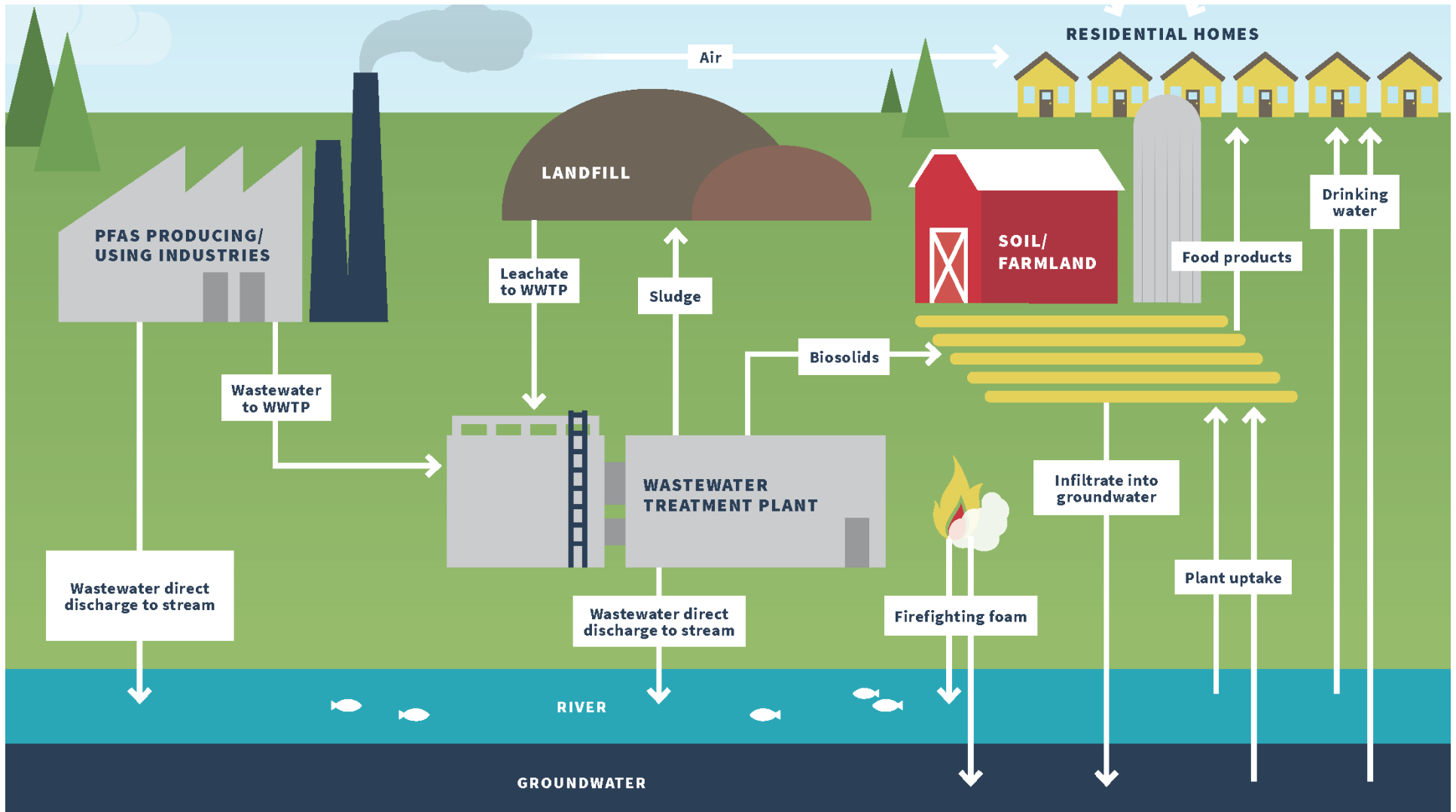
Sometimes you may hear **C8** Chemicals-
That's PFAS.

PFAS Exposure Pathways:

- Bioaccumulation
 - food chain
- Inhalation
 - Indoor Dust
 - Airborne particulates
- Oral
 - Food
 - Drinking water



PFAS Transport Pathways to Groundwater



Source: MI DEQ (2019)

PFAS Class-Action Lawsuits

- Alabama –\$35M West Morgan-East Lawrence Water Authority's (WMEL) settled with 3M in 2019
- Minnesota –\$850M settlement with 3M in 2018
- West Virginia -\$671M settlement with DuPont/Chemours in 2017
- North Carolina -\$13M settlement with Chemours in 2019
- Law Suits pending in Colorado, Michigan, New York, Pennsylvania, New Hampshire, Vermont, and New Jersey, and Nationwide (US)

Lawsuits-Environmental Contamination,
Health impacts, & Remediation



Gretchen Brown/WPR

Johnson Controls To Use \$140M For PFAS Cleanup

Limited Analytical Methods

EPA 537

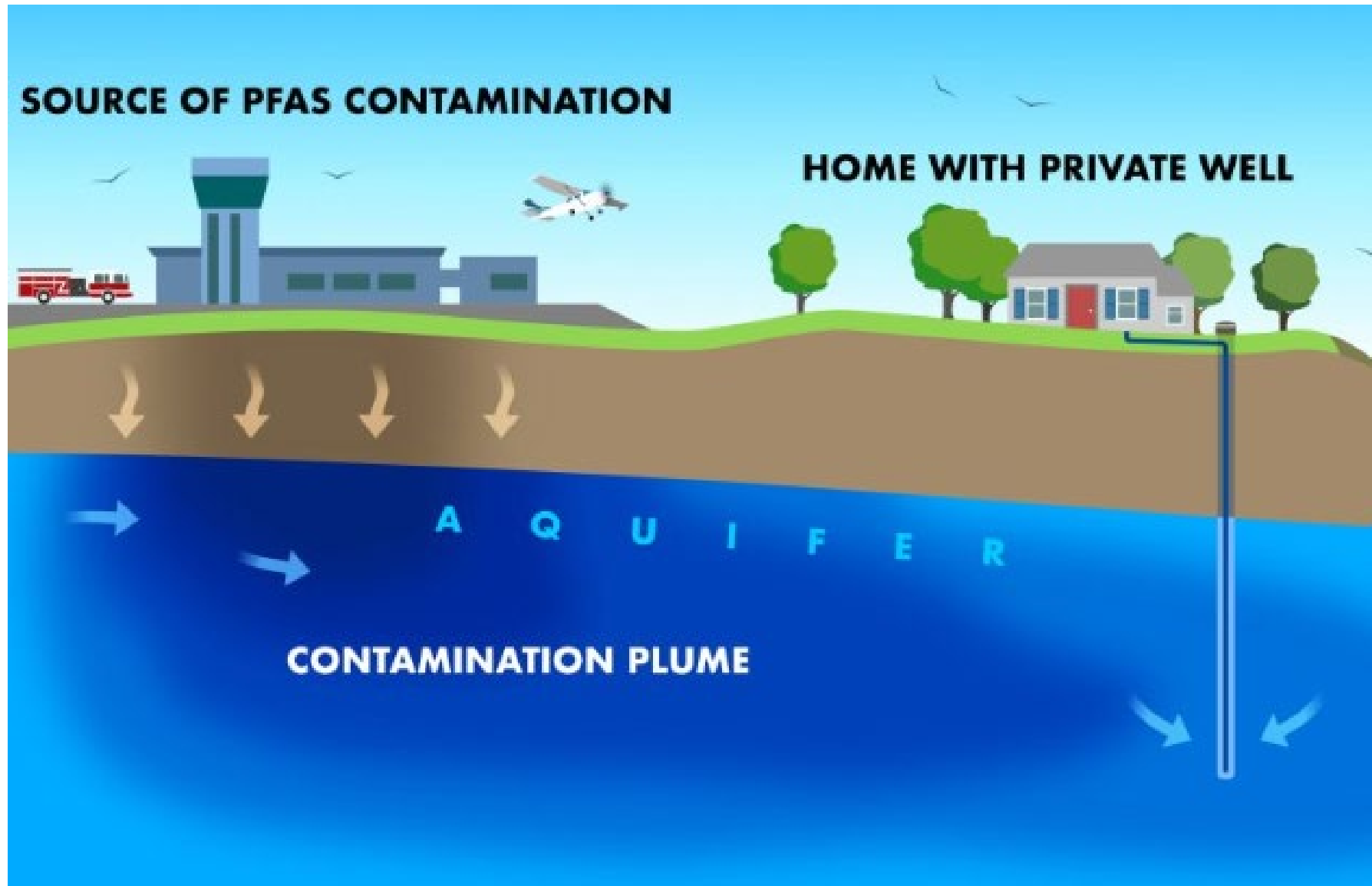
- SPE LC-MS/MS
- 18-33 Compounds
- For drinking water
- Holding time: 14 days for extraction
- Typical RL: 5 - 25 ppt
- ~ \$250-400/sample
- Approximate 40 laboratories

Sample collection:

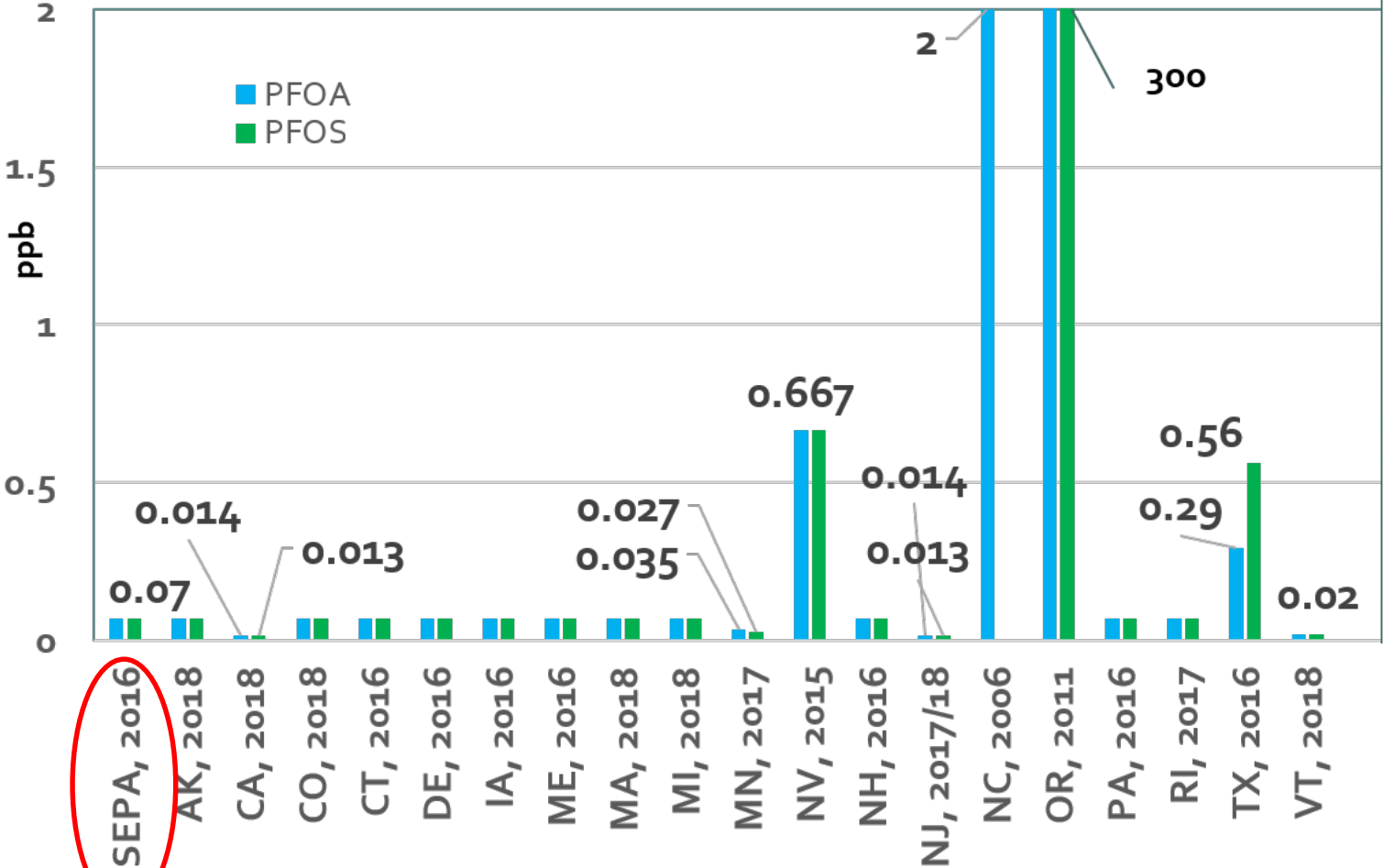
- Cross contamination



Groundwater Contamination



PFAS Regulations



Water

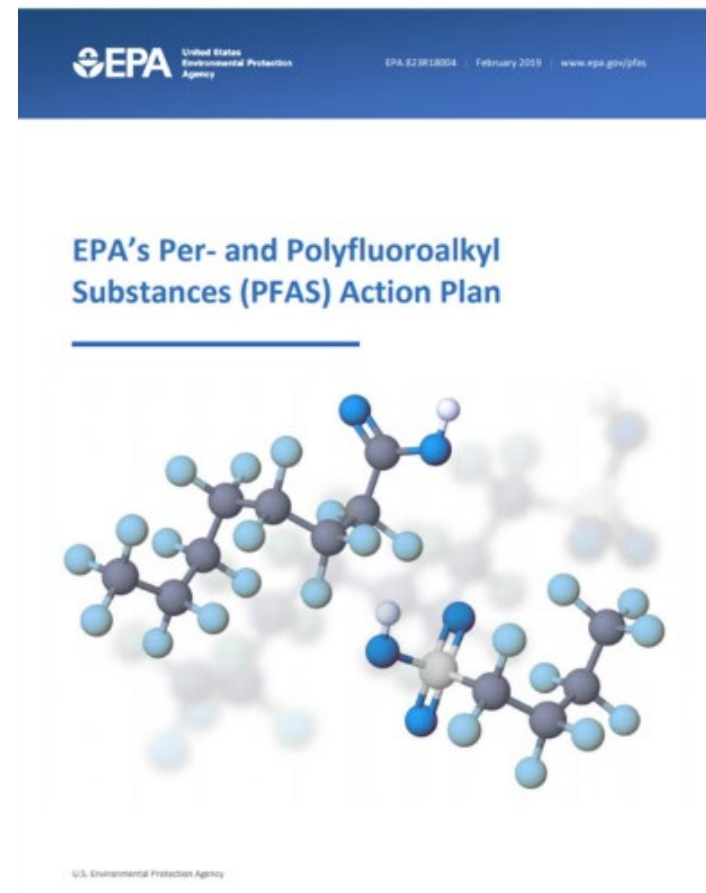
PFAS: State Level Directives

MI, NY, NH, ME, CA, WI

- Sampling of Groundwater around active and closed landfills
- Addition of PFAS to existing pre-treatment permits
- Directive for WWTP to sample influent, effluent, biosolids
- Directive for WWTP to identify and sample point-source contributors

PFAS Regulations

- 2016 EPA issued Health Advisory for PFOA and PFOS limit of 70 ppt
- 2019 EPA has developed PFAS Action Plan to begin developing a Drinking Water Standard for PFAS
- Several States have established PFAS drinking water limits / advisories



PFAS Treatment (Pump and Treat)

- GAC (Granular Activated Carbon)
- IX (Ion Exchange)
- RO (Reverse Osmosis)
- Concentrate/Waste Management

Typical GAC Process

- Influent/Second GAC vessels

- “Lead” & “Lag”

- Monitoring

- Influent
- Mid-point
- Effluent

- Carbon Change Out

- Lead to reactivation
- Lag to lead
- New to lag

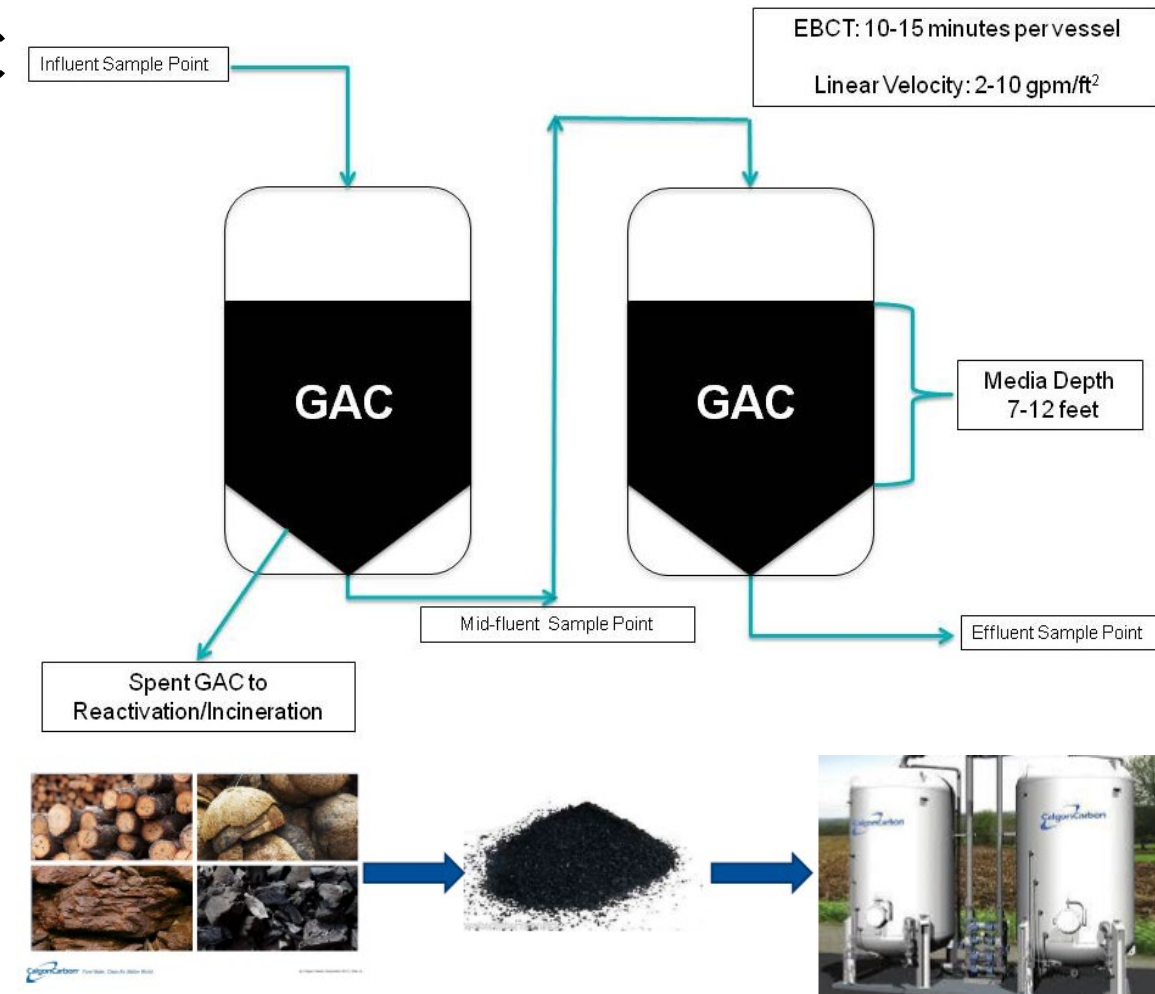


Diagram courtesy of Calgon Carbon

PFAS Treatment: GAC

- May require pretreatment
- Effectiveness depends on:
 - pH
 - Temperature
 - contact time
 - NOM
 - Chlorine
- Better for long-chain PFAS
- No brine and chemicals
- GAC may be cost-effective



Oakdale, MN



Oscoda, MI

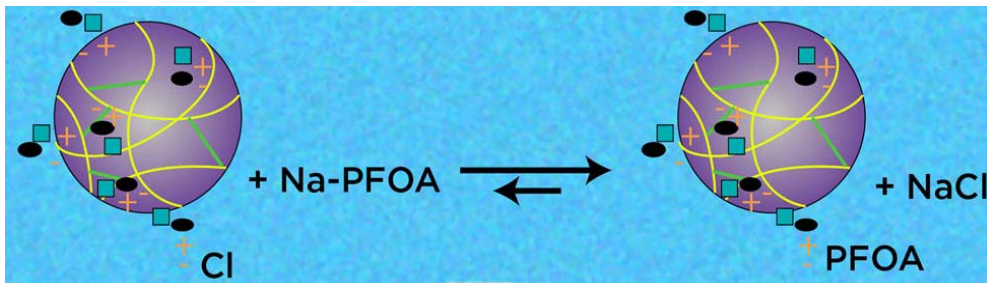
PFAS Treatment: Ion Exchange (IX)



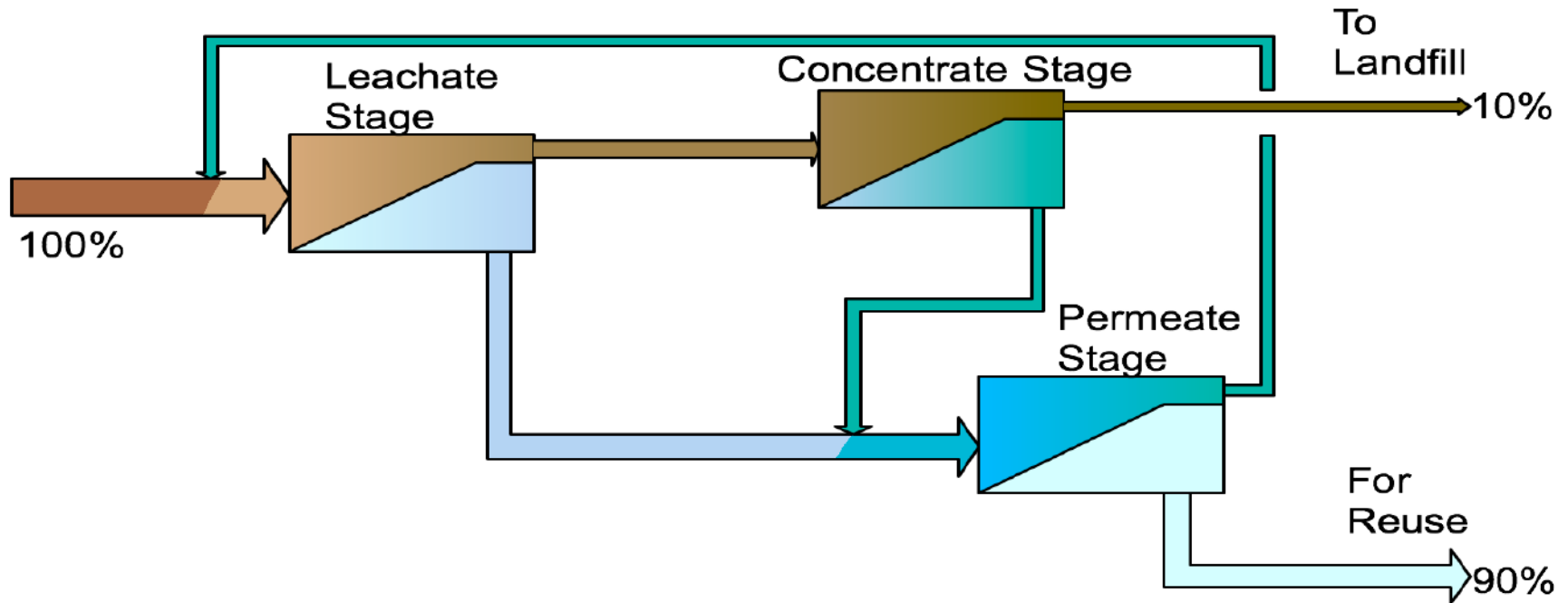
Illustrations courtesy of Puro-lite, Inc.

PFAS Treatment: Ion Exchange (IX)

- PFAS are anions - IX can remove
- Longer PFAS chains preferred over shorter chains
- Resins disposed offsite (incineration)



PFAS Treatment: Reverse Osmosis (RO)



PFAS Treatment: Reverse Osmosis (RO)

- Effective for PFAS
 - High pressure membrane
 - High energy usage
 - Reject water disposal
- Removes a wide range of constituents:
 - Hardness
 - Dissolved solids
 - PFAS
 - Organics
 - Ammonia-N



PFAS Treatment Efficiencies

Treatment Method	PFOA	PFOS	Considerations
Granular Activated Carbon	48-90%	89-98%	Requires regeneration or replacement and disposal. May release PFAS into the atmosphere
Ion Exchange	51-90%	90-99%	Resins need to be regenerated or replaced
Reverse Osmosis	90%	93-99%	Waste stream contains salts, and filtrate require disposal.

Incineration (PFAS Concentrate/Waste)

- Thermal Method
- High Energy Cost
- Air Emissions
- Limited Availability
- Ash Disposal



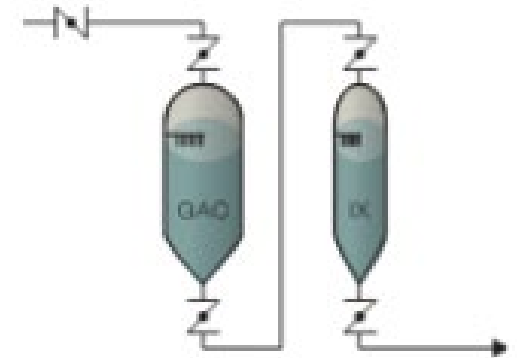
Deep Well Injection

- Inject far below drinking water sources
- Construction is Costly ~\$4-6 M/Well
- Clogging well during injection may be an issue
- 3rd Party accepting 0.18-0.25/Cents Gallon

SUMMARY - PFAS Treatment

- Treatment is site specific (pilot testing)
- PFAS removal may be Influenced by:
 - pH, water temperature, contact time, Organics and Chlorine compounds
- Polishing Step may be required
- Land applied Biosolids is a potential source of PFAS impacts Surface water and groundwater

GAC → IX



QUESTIONS?

Groundwater Protection from PFAS Contaminants

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