Introduction to Emerging PFAS Treatment Approaches and Technologies

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NEWMOA Events

CDM Smith

AGENDA

Proven Separation Technologies

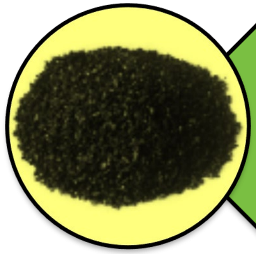
Breaking Down PFAS Cycle

Emerging Technology Development

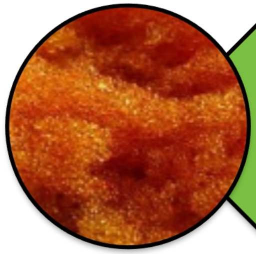
Summary

Proven PFAS Treatment Technologies

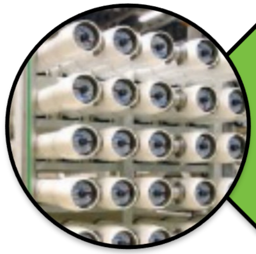
- GAC, AER and RO are proven and demonstrated for drinking water and groundwater treatment
- Additional considerations needed for wastewater and landfill leachate treatment
  - Some may contain high PFAS
  - Water quality and co-contaminants can reduce GAC, AER and RO treatment effectiveness



Granular Activated Carbon (GAC)

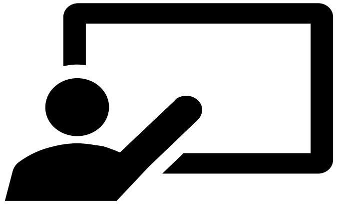


Anion Exchange Resin (AER)

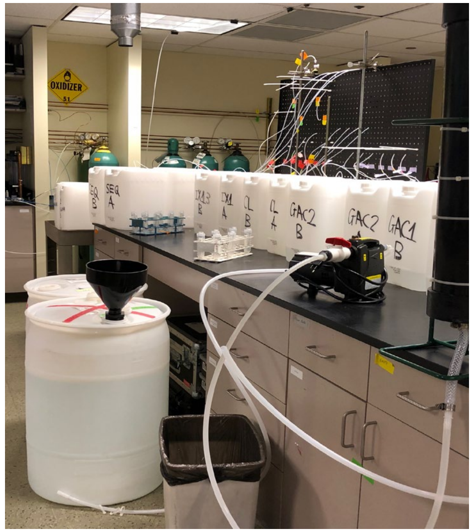


Membrane

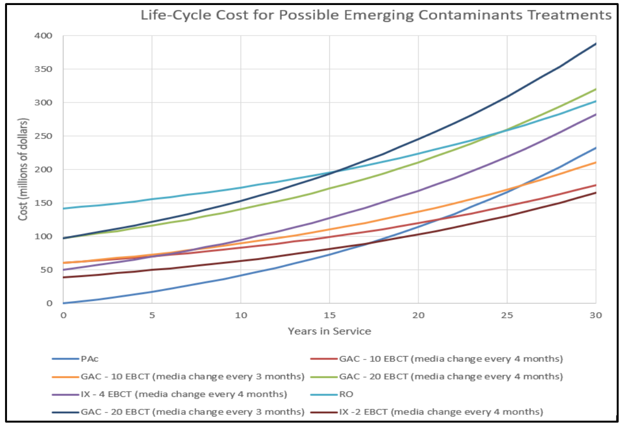
Drinking Water Treatment Solutions from Bench to Full-Scale



Engineering evaluation
- System upgrades
- New system to remove PFAS



Check on PFAS treatability and compatibility with other existing treatment processes



Pilot testing and life cycle assessment

System design, permitting, construction, operation, maintenance, monitoring
→ Life cycle success

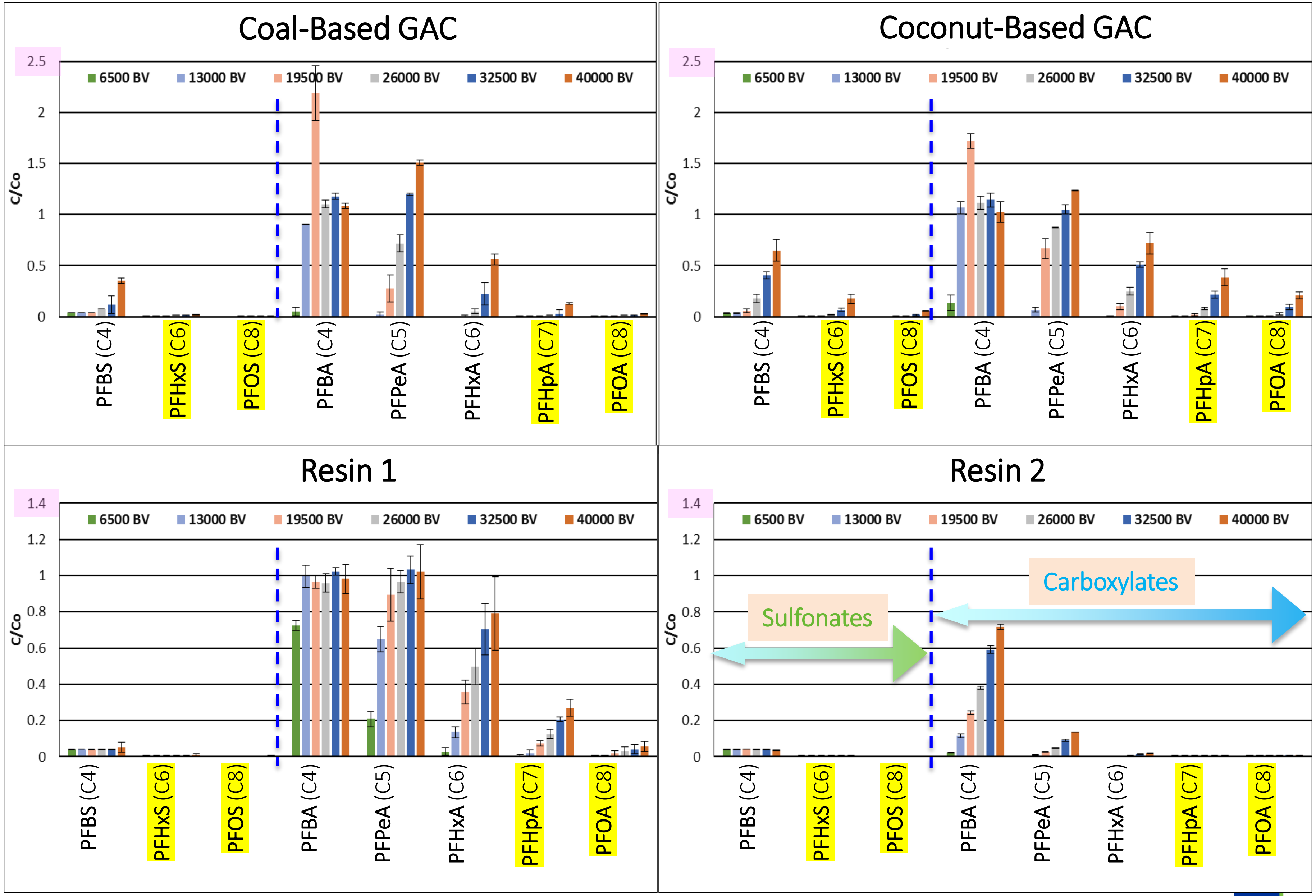
GAC vs Single-Use AER for Drinking Water Treatment

GAC	Single Use AER
7 to 20 minute EBCT	**2 to 3 minute EBCT**
Larger infrastructure footprint	Smaller infrastructure footprint
Typical bed life: 50,000-120,000 bed volumes	Typical bed life: 250,000-300,000 bed volumes
Less effective for short chain PFAS	Effective for a wider range of PFAS
Backwash is available	Backwash not recommended
GAC media is less expensive (~$2/lb)	AER media is more expensive (~$6.5/lb)
Well established technology	Not as extensively practiced as GAC

- Life cycle costs for GAC and IX-R can be comparable but should be confirmed
- **Both generate spent media requiring off-site waste management**
- Pretreatment may be needed for both technologies to increase media life span

GAC vs. AIX

- Selection of GAC and AER is site-specific
- Both AER & GAC treated the target PFAS effectively, but differences in performance among the media products observed.
- AER chosen as the treatment technology for removing a wider range of PFAS, including shorter chain compounds

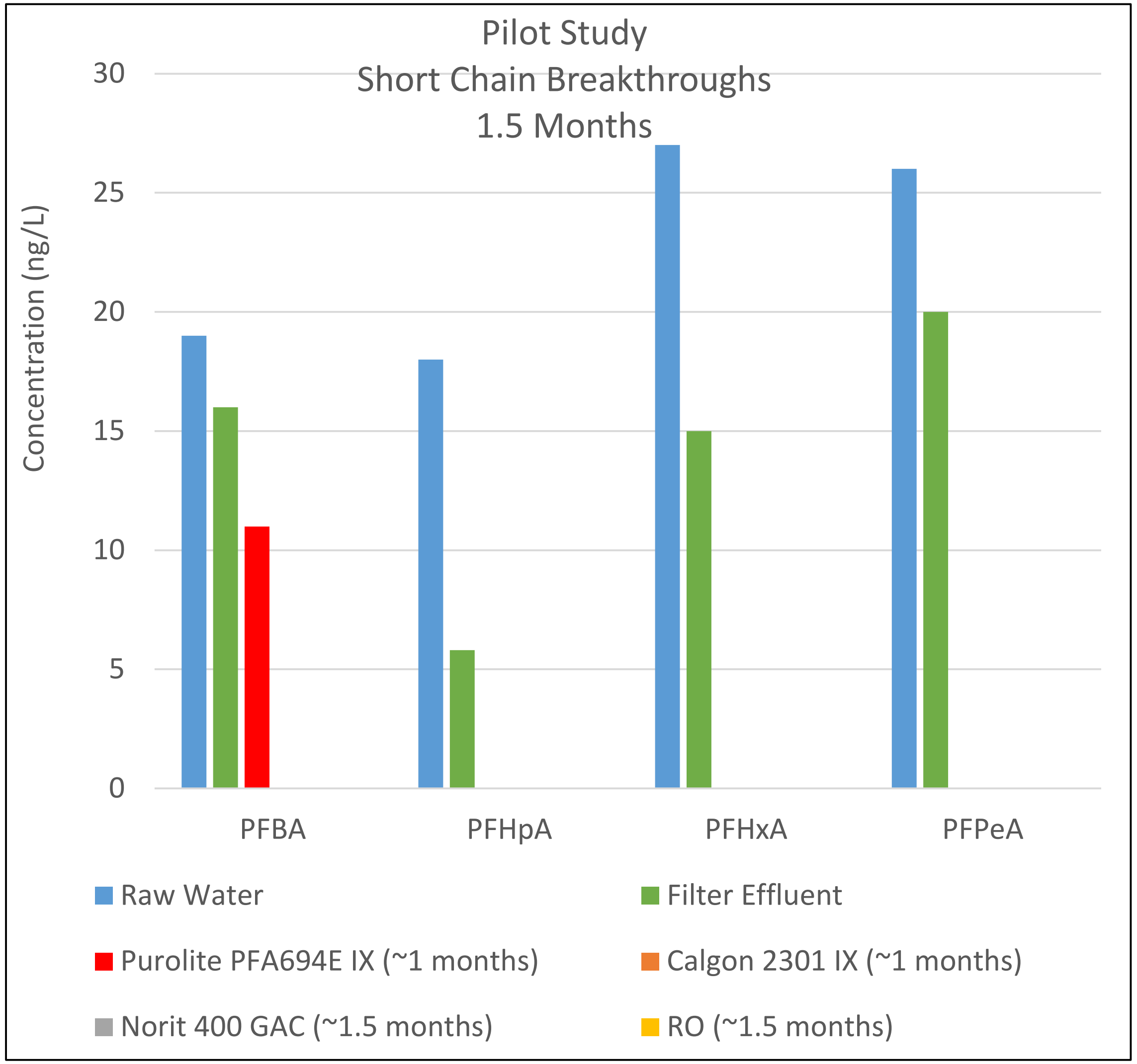


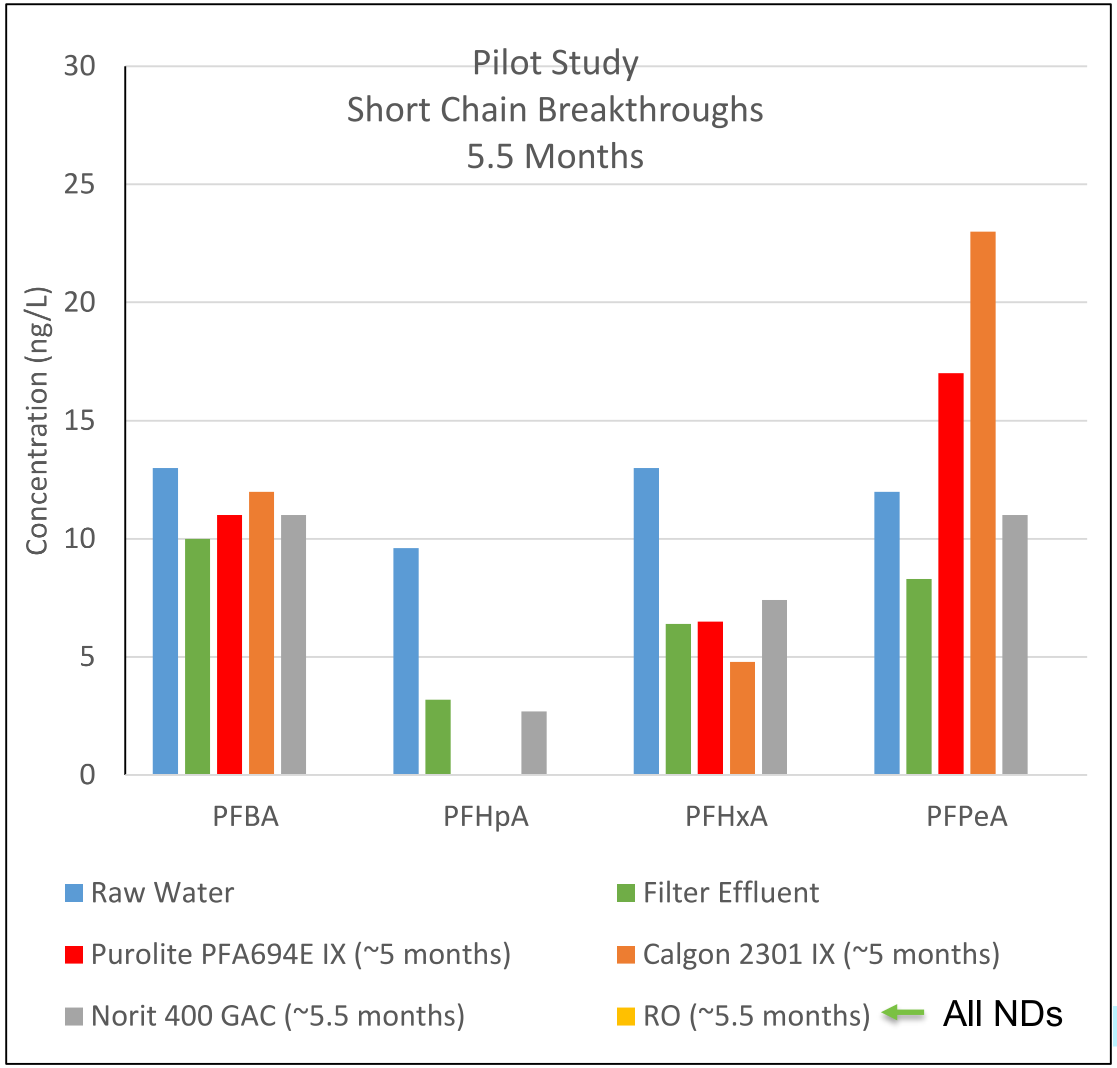
Grove Pond PFAS Treatment Facilities

The $3.1M AER facility construction

Pilot Study Comparing GAC, AER and RO

(Short Chain Data Only)



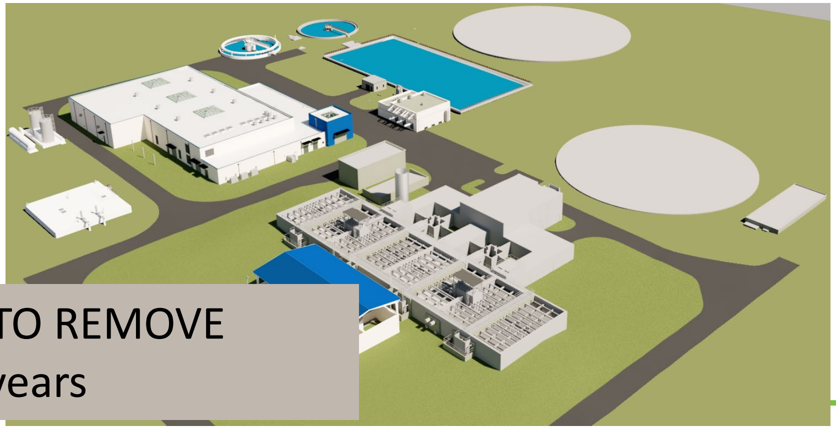


For all cases, RO is proven to remove short to long chain PFAS

Reverse Osmosis for PFAS, GenX and Other Emerging Contaminants

- Primary Target Contaminants
  - Per-and Poly-fluoroalkyl Substances (PFAS)
  - **GenX**
  - PFMOAA, PFMOPrA, PFMOBA, PFO2HxA, etc.
  - Other identified PFAS compounds
  - Additional unidentified PFAS

- Secondary Target Contaminants
  - 1,4-Dioxane
  - Pharmaceuticals and Personal Care Products (PPCPs)
  - Endocrine Disrupting Compounds (EDCs)
  - Pesticides and Herbicides
  - NDMA, Brominated DBPs
  - Other identified compounds
  - Additional compounds not yet identified

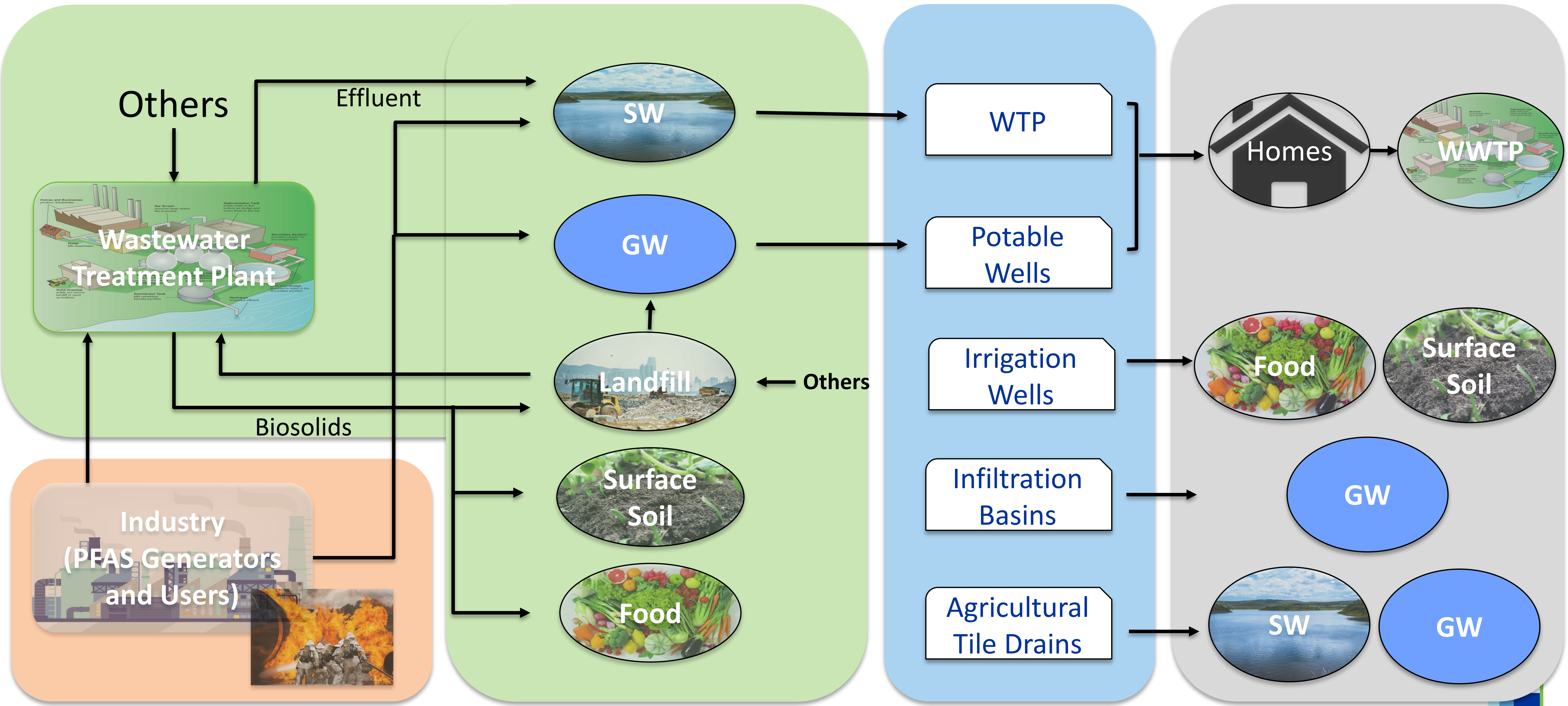


BRUNSWICK COUNTY 41-MGD LPRO FACILITY TO REMOVE PFAS – Construction to be complete in next 3 years

Waste Stream Management

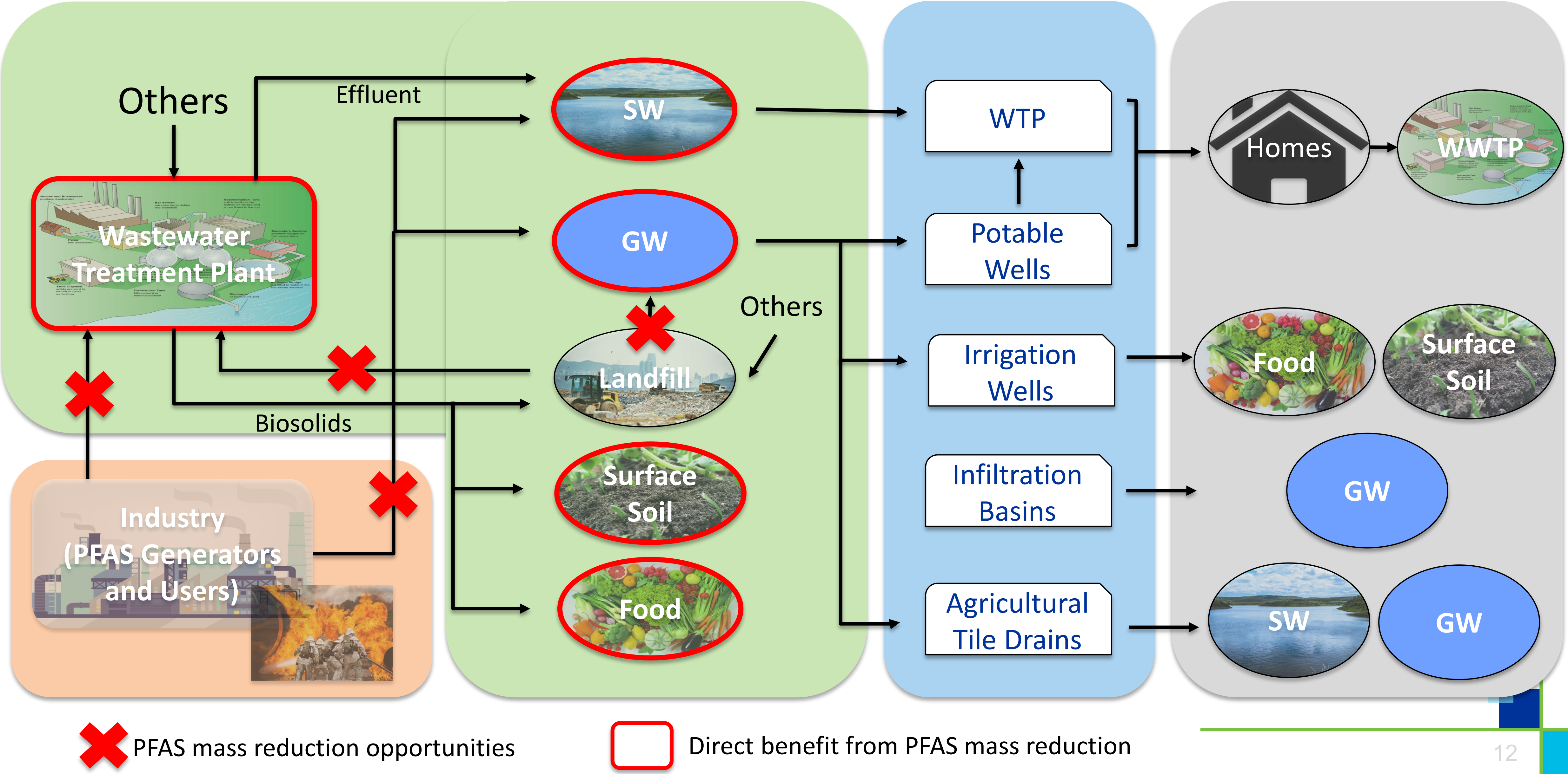
- Spent GAC→ Reactivation (some PFAS destruction + off gas collection)→ Reuse
  - Spent GAC regeneration is not recommended
- Single use IX-R→ High temperature incineration
- Regenerable IX-R→ Chemical regeneration → IX-R reuse→ High-temperature incineration of regenerant waste
- (Innovation) Regenerable IX-R→ On-site chemical regeneration → IX-R reuse→ On-site destruction of regenerant waste
- RO rejected concentration → Diffuse into non-drinkable waters

PFAS Cycle

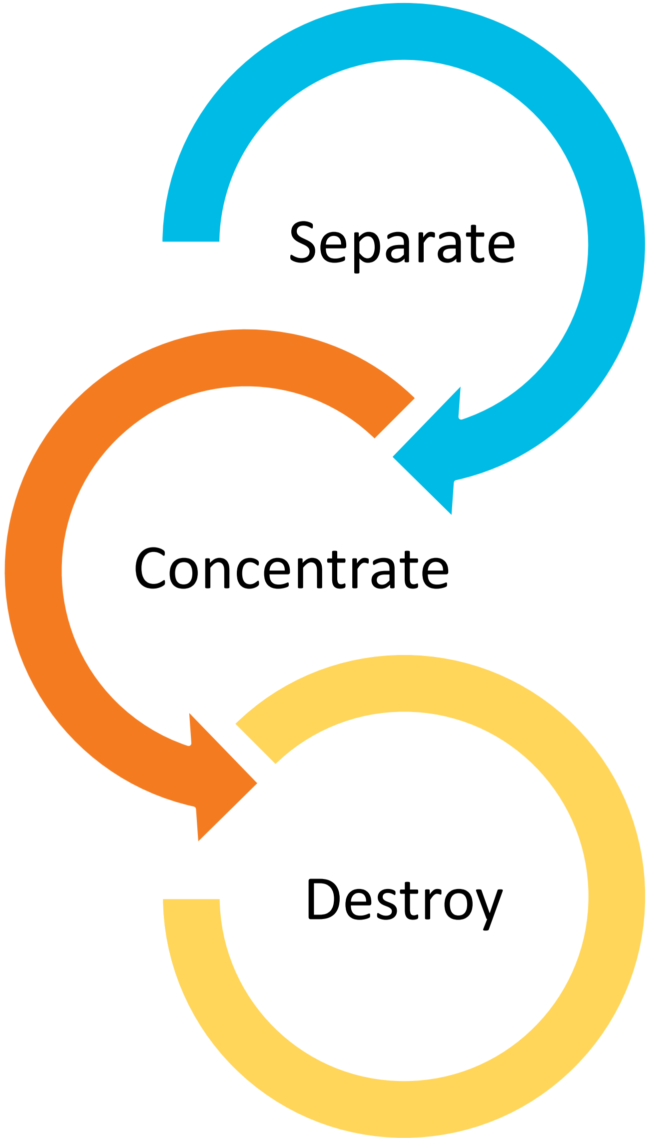


Others
Effluent
SW
GW
Wastewater Treatment Plant
Landfill
Others
Biosolids
Surface Soil
Food
Industry (PFAS Generators and Users)
WTP
Potable Wells
Irrigation Wells
Infiltration Basins
Agricultural Tile Drains
Homes
WWTP
Food
Surface Soil
GW
SW
GW

Breaking PFAS Cycle



Treatment Train for Comprehensive PFAS Solution

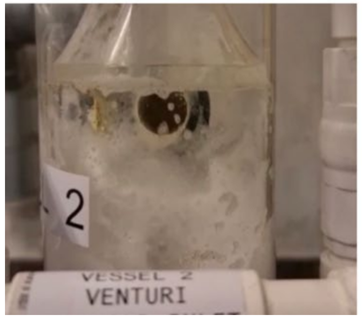


Remove PFAS to trace ppt levels
(current demonstrations for DW treatment)

Reduce PFAS waste streams and generate low-volume **PFAS concentrates**

Destroy PFAS in **PFAS concentrates**

Foam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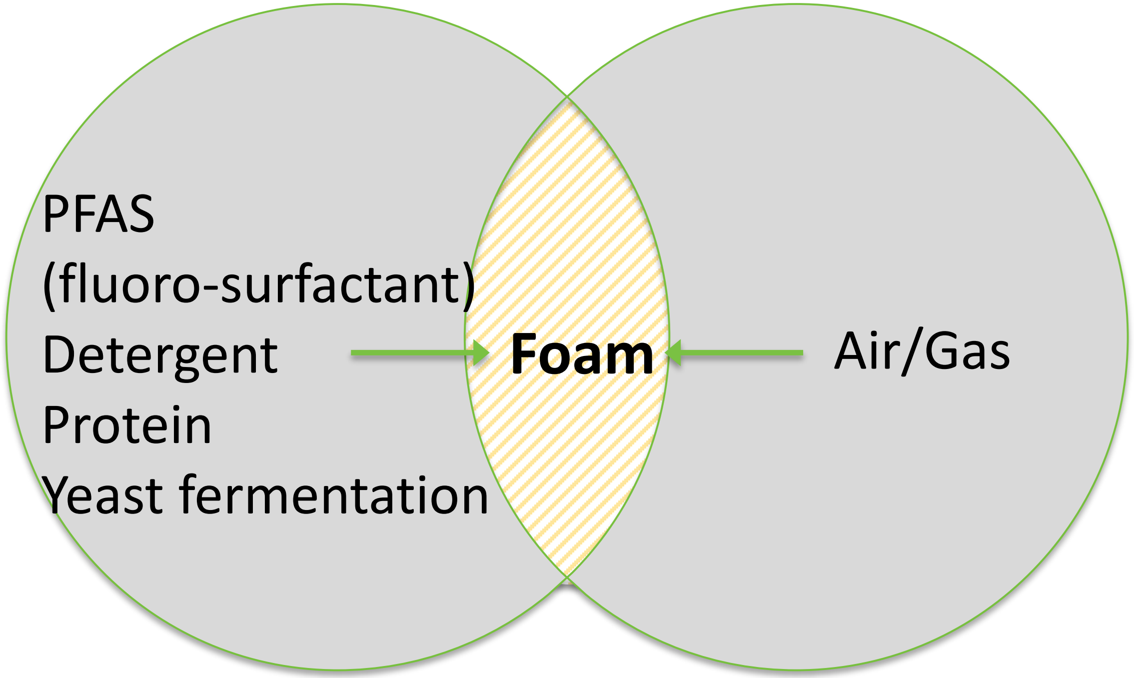
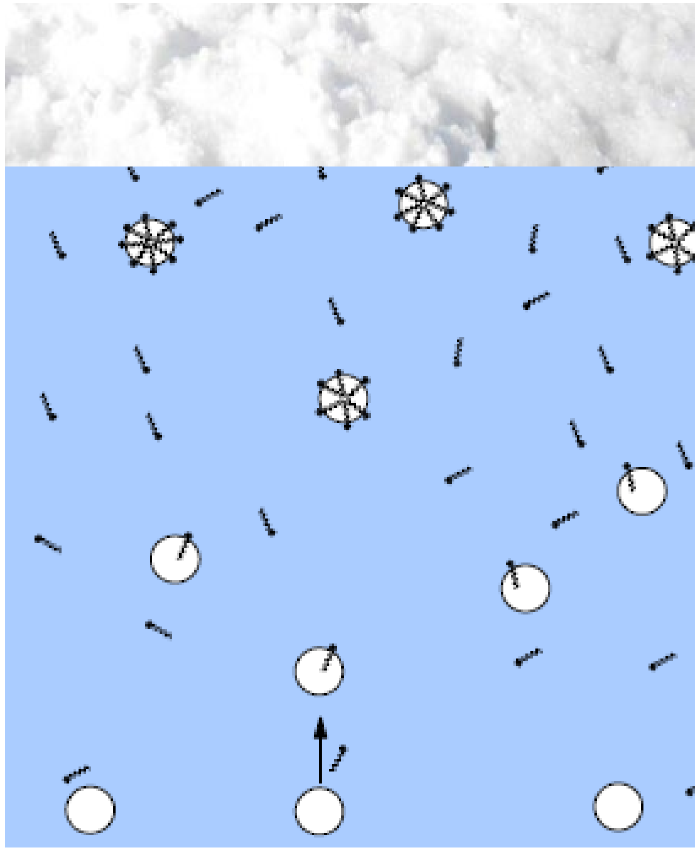

PFAS
(fluoro-surfactant)
Detergent
Protein
Yeast fermentation
Foam
Air/Gas

Foam is nothing new to surface water and WWTP

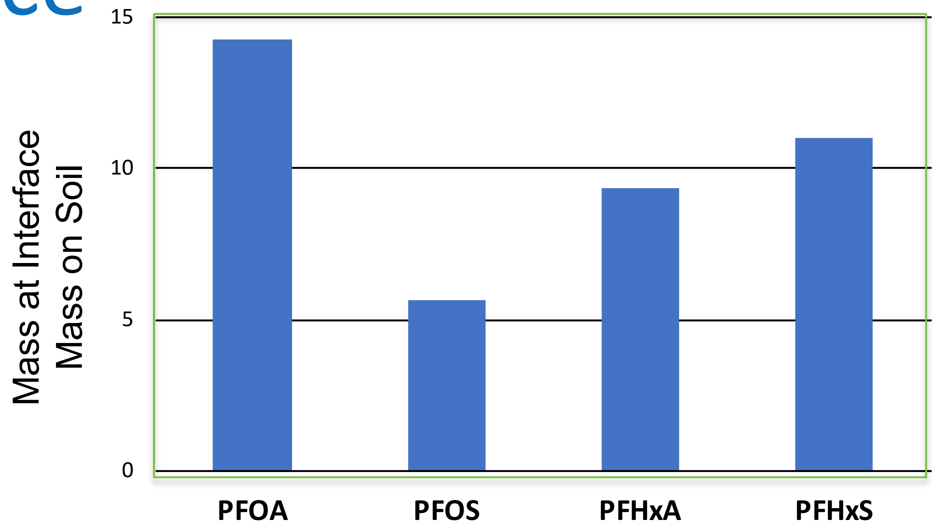
PFAS Sticks Into Air-Water Interface

PFAS in Air-Water

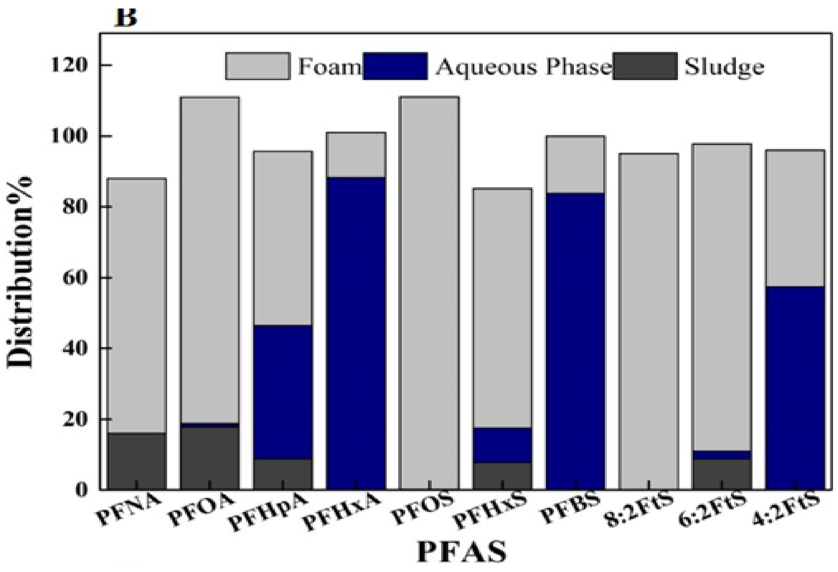


(Manuscripts under preparation)

PFAS in Air-Water, Soil System



PFAS in Water, Sludge, Foam System



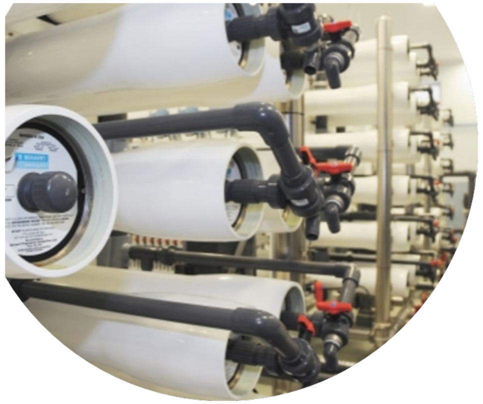
Engineering PFAS Characteristics Into Treatment Solution

Foam Fractionation

- PFAS separation using bubble-formation and PFAS accumulation at the air-water interface
- No sorbents needed
- PFAS foam concentrate layer removed and concentrated
  - Concentration factors can vary based on scale and operation conditions
- PFAS specific applications for groundwater, surface water, wastewater and leachate treatment

Summary – Drinking Water

- With the best practice, **PFOS and PFOA** treatment down to 70 ppt or lower is achievable
- PFAS treatment is a young practice: Do not generalize or assume
- GAC, IX-R and RO are effective for drinking water protection but all generate waste streams
- Be wary of citing other treatment results on other waters. Consider site specific water chemistry!
- Pre-design study can help
  - Select technology and media
  - Identify issues and pre-treatment need
  - Identify optimization approach and methods



Summary – Breaking PFAS Cycle

- High PFAS mass reduction opportunities
  - DW technologies may not be efficient or cost-effective
  - Need comprehensive solution - separate, concentrate, destroy
  - PFAS destruction is critical for breaking the cycle
  - More fate and transport understanding is needed
- PFAS destruction are undergone pilot testing
- Be specific which PFAS are successfully treated and which ones have limitation

Find more insights:
www.cdmsmith.com/pfas

Questions?

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