

Practical Solutions to PFAS:

Scalable Site Management Strategies

Practical Solutions to PFAS: Scalable Site Management Strategies

Moderator:

Ivy Harvey, Army Program Manager, EA Engineering, Science, and Technology Inc., PBC

Speakers:

- Mike Hertz, PG, VP, Director for Site Characterization and Remediation
- Mahsa Modiri, PhD, PE, Director of Emerging Science and Innovation

Contributor:

David Steckler, PG, Director for Navy Programs

**TRI - REGIONAL
JETS 2025**

Society of
SAE
American Military Engineers



Presenter

Michael Hertz_{PG, VP}

EA Engineering

Director SCR Service Line



- **Sports Teams: The Buckeyes**
- **Vacation Spots: Maine, OBX**
- **Did You Know: We foster dogs for fun?**
- **Coolest Project(s): Concurrent In-Situ Groundwater Remediation of 6 sites**



Presenter

Mahsa Modiri^{PhD, PE}

EA Engineering

Director Emerging Science and Innovation
Service Line



- **Sports Teams: World Cup**
- **Vacation Spots: Anywhere with good hiking trails**
- **Hobbies: Trail hikes, trying new sports/gyms, trying new brunch places on Sundays**
- **Coollest Project(s): WRF projects and working with utilities/Source Identification for RIs**

Learning Objectives

- Learn the about the evolving PFAS regulatory landscape and how that can affect IRP and MILCON projects
- Discuss how characterization and remediation are delayed by uncertainty in the end goals
- Discuss how remediation is delayed by uncertainty of treatment technologies and treatment goals
- Learn about a novel remediation technique to optimize GAC usage
- How to use these lessons learned for future consideration in your projects

Agenda

- Programmatic Considerations
- Considerations for Site Characterization and Remediation
- Novel remediation technologies focused on PFAS residuals management

**Useful for developing a scalable
framework for PFAS remediation projects**

Programmatic Considerations



What are the Hurdles?

Based on discussions with our clients, the following are key hurdles/concerns:

- The CERCLA process (including PFAS site identification) continues to evolve, and regulators are lukewarm about the DoW identification and action process
 - New sites keep getting added!
- How does the DoW handle MILCON soil near an identified environmental site
 - How to coordinate with the ERP?
 - Are background conditions considered? What is “clean” fill?
- The PFAS with actionable risk-based screening levels continues to grow
 - When and how do these get considered in the risk assessment process
 - What is the timeline for “all” PFAS toxicity assessments? Is there a total PFAS metric that could be considered?
- How do we move to remediation while all of the above are still considered when we pretty much have quantified the major releases areas in soil and groundwater.

Considerations for Site Characterization and Remediation





Why are PFAS RI/RAs different from legacy compounds?

- Changing regulatory risk-based screening levels (federal and state)
- Method 1633 – not a rapid analysis and does not promote EPA triad approach
- Other PFAS sources on base/installation not identified
- Source to groundwater for very unique contaminants
- Significant projected costs (~\$10B and growing for DoW) for remediation to part per trillion concentrations
- Whose PFAS is it?
 - Anthropogenic background?
 - Source Differentiation
- Precursors transformations/analytical limitations

“There are thousands of PFAS that remain unregulated and unlisted; the regulation of various individual PFAS and/or combinations of PFAS can make it difficult to reconcile the contrast between different media risk assessments, regulatory frameworks and state specific standards and guidelines,” ASTSWMO Open Letter

Typical Cleanup Phases (Regulatory Framework)

Field Investigation Phase

Generally phased investigation approach

Subject to ever-changing guidance and regulations

Risk Assessment

Background PFAS Concentration(s)
Development

HH - Unrestricted Use

HH – Current/Anticipated Land Use

Ecological Risk

Soil to Groundwater

Vapor Intrusion

Feasibility or Corrective Measures Study

Define Long-Term Remedial Goals and Assess Acceptable Remediation Timeframes

Soil/Sediment Current/Anticipated Receptors

Soil – Impact to Groundwater

- No GW MCL exceedances from soil
- No MCL exceedances at boundary

Surface Water

- No unacceptable HH/ecological receptor risk

Remediation/Corrective Action

Ex Situ Soil Treatment

In Situ Soil Stabilization

Ex Situ Groundwater Treatment

In Situ Groundwater Stabilization

Monitored Natural Retention/Recovery

Ex-Situ Surface Water Treatment

Interim Action

(Based on identification of connected pathway(s) and unacceptable risk)

Wellhead treatment

In Situ Sorption

Alternate Water Supply

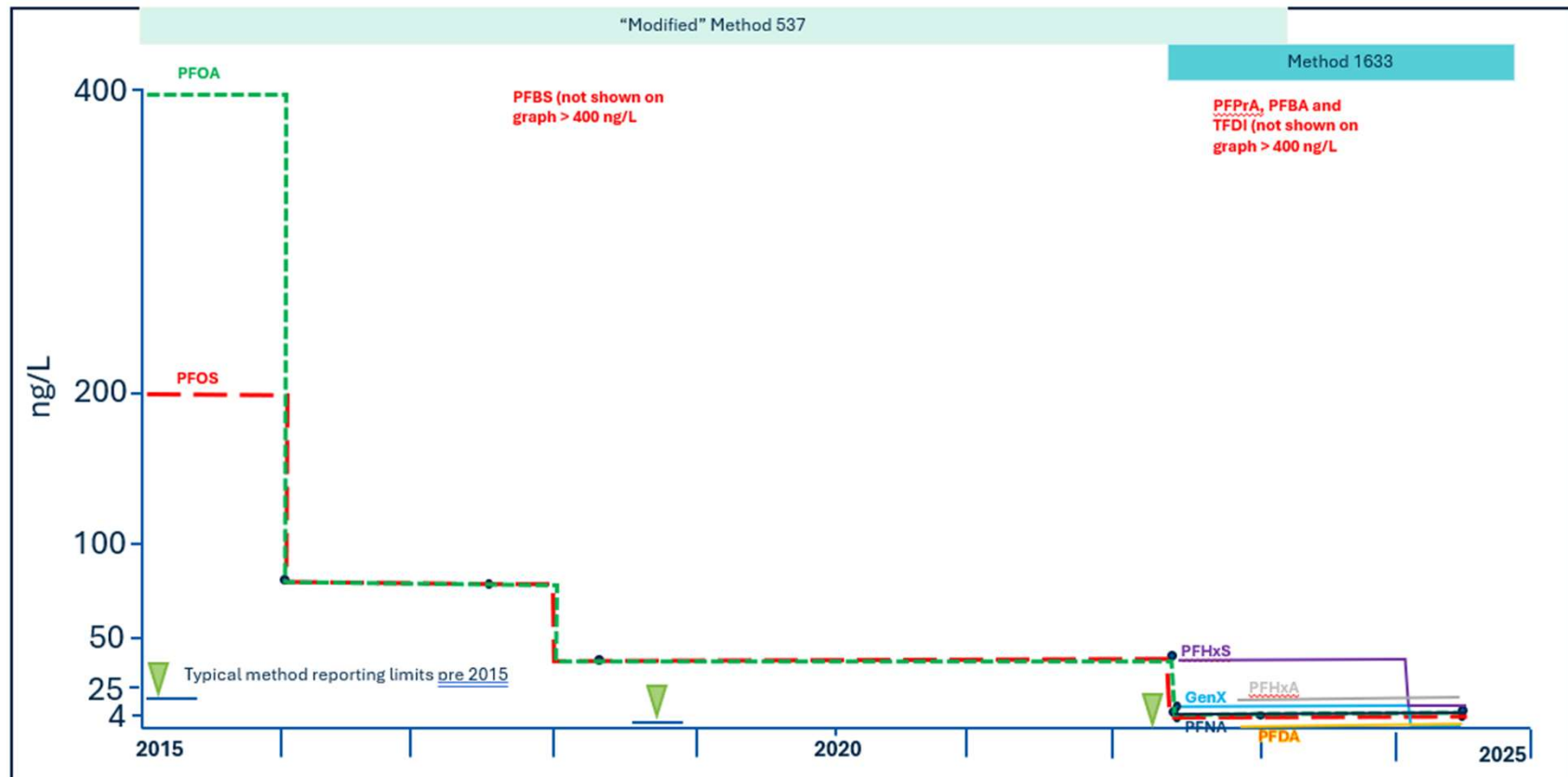
Groundwater Intercept (i.e. Pump and Treat)

Surface Water Treatment

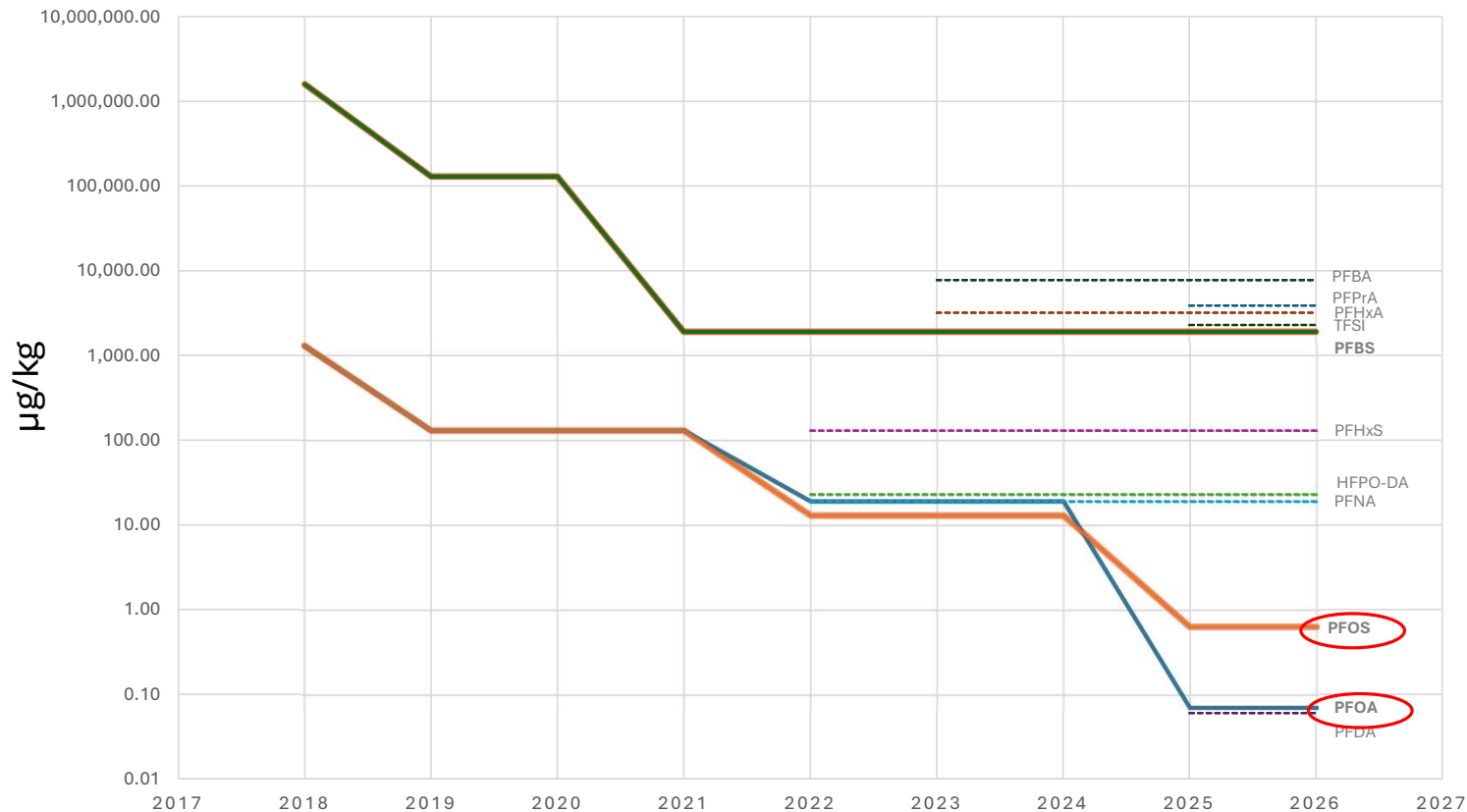
RI Screening Levels: Which Ones?

- Human Health (federal and state)
 - Residential
 - Commercial/Industrial
- Ecological Screening Levels
- Soil-to-Groundwater Assessments
- All concentration focused

HH Screening Levels: Groundwater over past 10 years



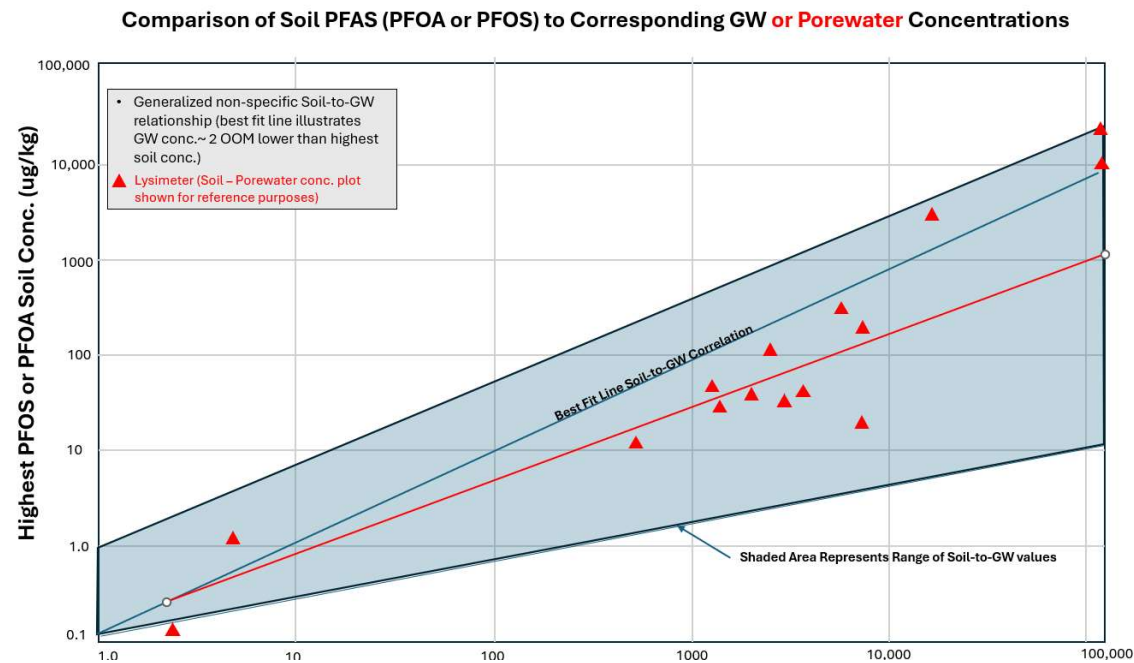
HH Screening Levels: Soil over past 10 years



Soil screening levels are generally based on DoW requirements, which used cancer slope factors or reference doses from EPA (i.e. RSL calculation methods).

PFAS Soil to Groundwater Pathway

- PFAS has unique properties that affect contaminant flux from soil to groundwater versus other organic compounds.
 - EPA generic SSLs (April 2025) do not account for PFAS characteristics
 - <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>
 - PFOS = 0.031 ug/kg
 - PFOA = 0.061 ug/kg
- Therefore, site-specific (AOPI-specific) porewater concentrations (i.e. lysimeters or SPLP) are often collected



PFAS Soil Concentration(s) to Impact GW Estimates



Are Regulatory PFAS Screening Levels Good Enough to Assess the Soil to Groundwater Pathway?

Prepared for:

International Symposium on Bioremediation and Sustainable Environmental Technologies - 2023

Prepared by:

50
YEARS

EA

EA Engineering,
Science, and
Technology, Inc., PBC

Michael Hertz, PG
Hannah Dennis
Jonathan Reeve, PG

11 May 2023

Conclusions – SPLP and SSL Comparisons

- Extrapolation of soil/groundwater ratios from site-specific
 - ◆ PFOS SSL = 18.5 ug/kg (EPA Look-up Value = 0.004 ug/kg)
 - ◆ PFOA SSL = 3.2 ug/kg (EPA Look-up Value = 0.092 ug/kg)

NJDEP PFAS Leachability Assessment

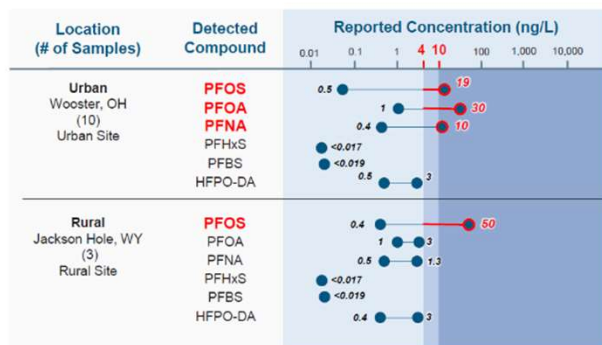
The soil concentration results and the SPLP leachate results were used to estimate the leaching potential for each sample.

The site-specific soil remediation standards for the migration to ground water exposure pathway (SRS-MGW) was based on GW standards of 13 ng/L (PFOS) and 14 ng/L (PFOA).

PFAS	SRS-MGW
PFOS	13 ug/kg
PFOA	2.9 ug/kg

PFAS Background

Example Summary of PFAS in Precipitation



EPA MCL:
PFOS, PFOA = 4 ng/L
PFHxS, PFNA, HFPO-DA = 10 ng/L
Red Font = Precipitation Exceeds MCL

Data from:
Pike et al. (2021)

HFPO-DA: hexafluoropropylene oxide
dimer acid
ND: nondetect

ng/L: nanograms per liter
PFOA: perfluorooctanoic acid
PFOS: perfluorooctanesulfonic acid

PFHxS: perfluorohexanesulfonic acid
PFNA: perfluorononanoic acid

Key Considerations for Assessing Background PFAS

Contextualizing PFAS Detections: Background and Forensics 39

Environ Monit Assess (2024) 196:229
<https://doi.org/10.1007/s10661-024-12400-z>

RESEARCH



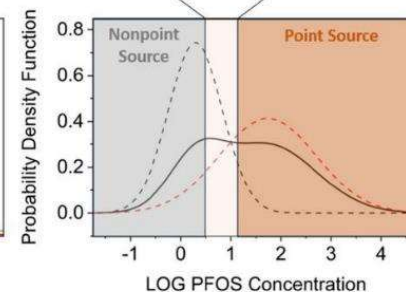
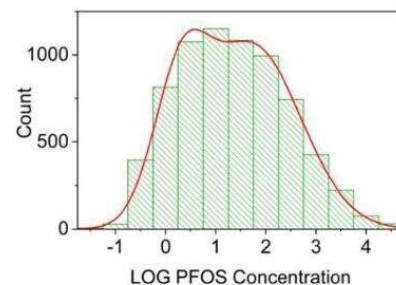
Application of Gaussian mixture models to quantify the upper background threshold for perfluorooctane sulfonate (PFOS) in U.S. surface soil

Richard Hunter Anderson · Mahsa Modiri

Gaussian Mixture Models

Nonpoint Source-Impacted : AFFF-Impacted

Background Threshold
1.9-13.8 µg/kg



Contextualizing PFAS Detections: Background and Forensics

Jeff Gamlin, PG, CHG, GSI Environmental Inc.

PFAS Background

Per- and Polyfluoroalkyl Substances in New Jersey Soils: A Statewide Investigation

Authors:

Jennifer Willemsen¹, Greg Toffoli¹, Alex Iannone¹, Lori Lester², Zahid Aziz², Sandra Goodrow¹,
Allan Motter¹, Nick Procopio², Erica Snyder¹, Joe Stefanoni¹

¹New Jersey Department of Environmental Protection, Contaminated Site Remediation and Redevelopment

²New Jersey Department of Environmental Protection, Division of Science and Research

New Jersey Department of Environmental Protection

September 2025

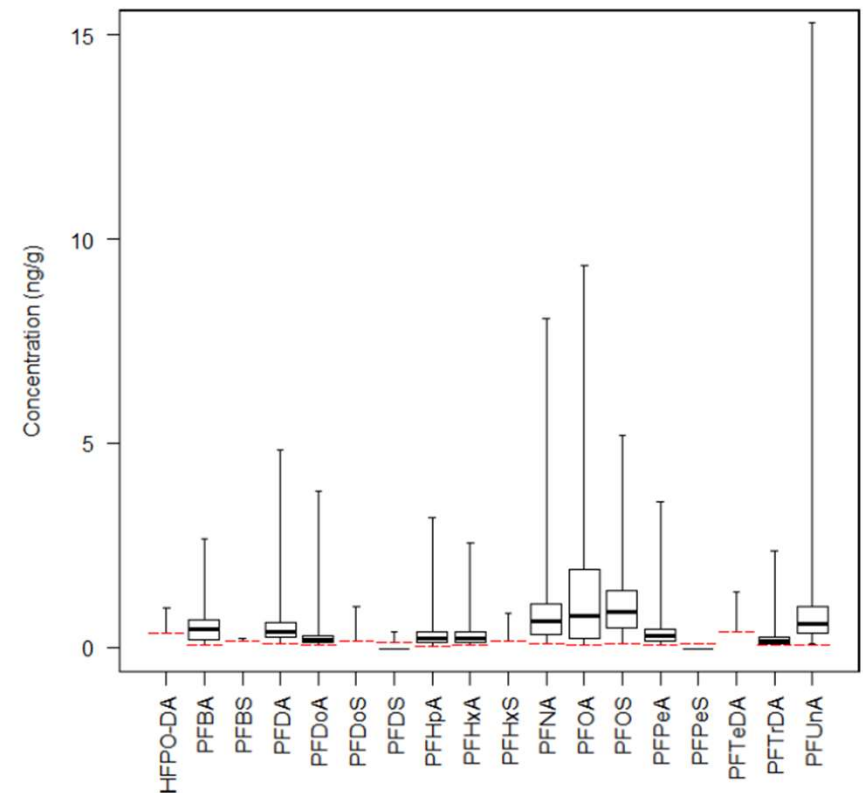
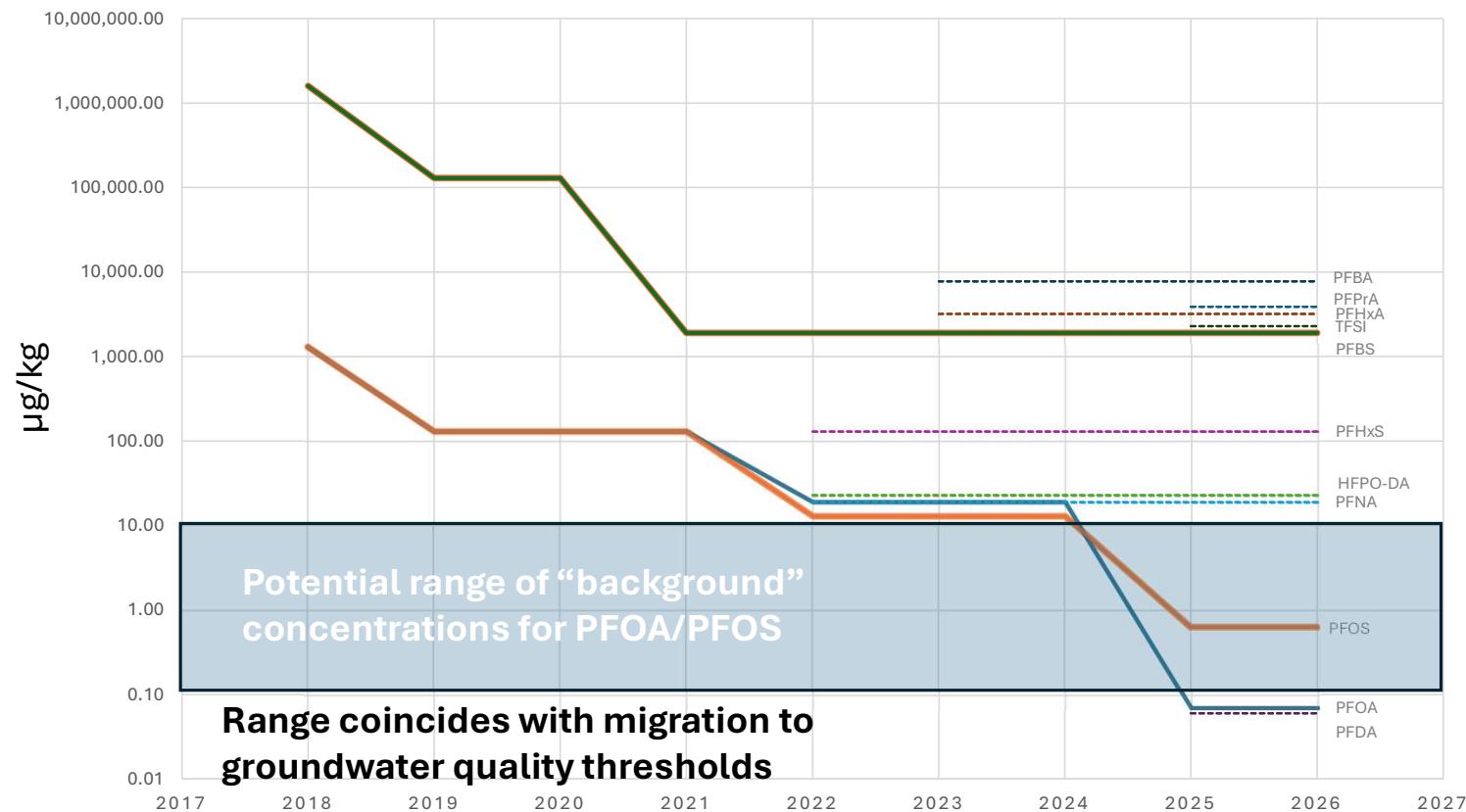


Figure 3: Summary percentiles of PFAS concentrations. The horizontal red dotted lines represent the highest detection limit for each PFAS (i.e., multiple detection levels were reported for each compound). Box plot: box, 25th-75th percentiles; center line, median; whiskers, minimum & maximum. Note: Only PFAS with sufficient detections (> 5) are displayed.

HH Screening Levels: Soil over past 10 years



Upper range for “background” concentrations for PFOA/PFOS are generalized

Lower range for “background” concentrations for PFOA/PFOS are current MDLs

PFAS CSM Refinement - Mass Discharge

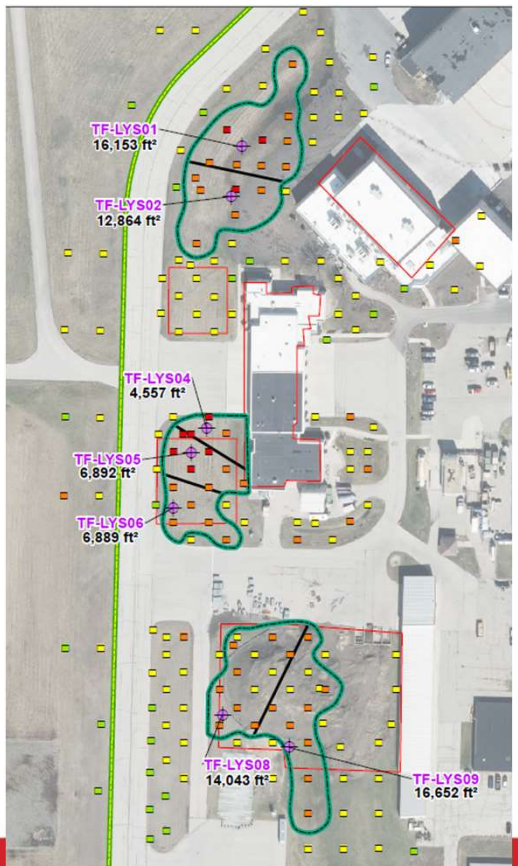
- Many guidance documents on source strength assessments. Example: AF Guidance for Soil to Groundwater (29 January 2025)
 - Provides suggested DQOs and methodologies for soil to groundwater assessments when lysimeters are used
 - Provides methods to assess source strength (i.e. vertical mass discharge in grams per year)
- Quantified Source Strength(s) can support mass flux assessments (soil and groundwater)
- Dissolved phase PFAS mass flux/discharge assessments can be performed to assess aquifer's attenuation/retention capacity
 - Can be used to help reveal additional potential sources to groundwater

ITRC's Enhanced Attenuation: Chlorinated Organics (ITRC 2008) defines a mass balance assessment as including a quantitative estimation of the source strength (i.e., source zone mass discharge) into a dissolved phase plume, which is then compared to the plume attenuation rate.



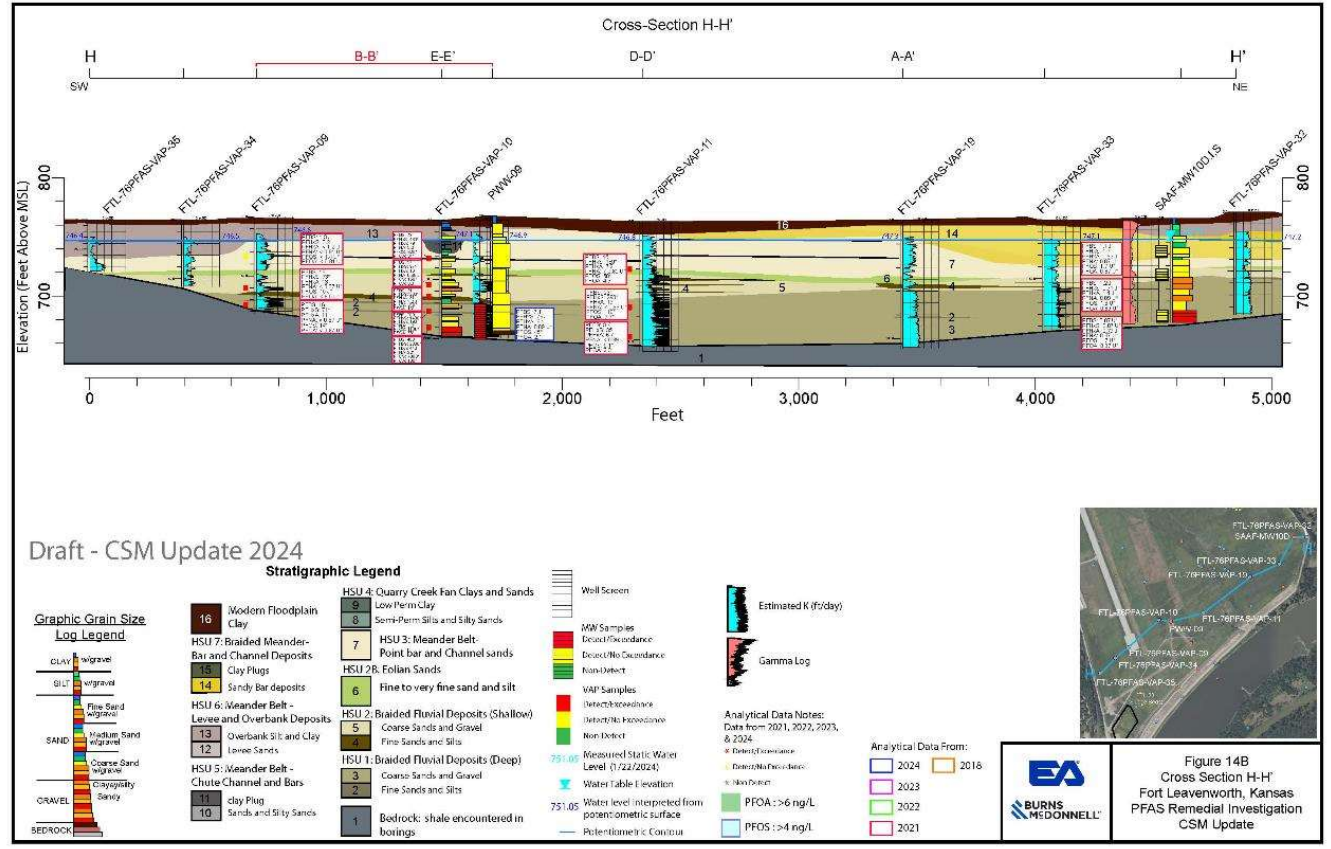
Mass Discharge Assessments

Vertical

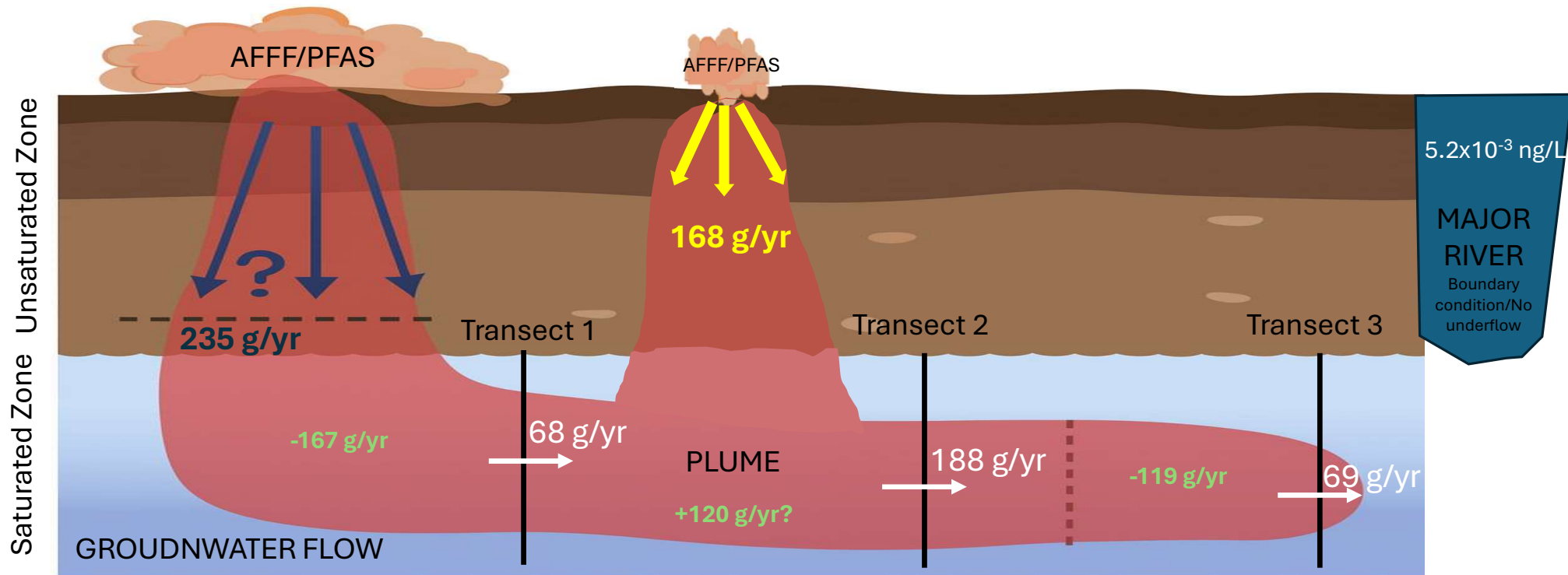


Vertical

Horizontal



Mass Discharge (Md) Example



Scenario 1: $M_d >$ the plume attenuation rate
dissolved plume will expand in length

Scenario 2: $M_d =$ plume attenuation rate
plume will be stable

Scenario 3: $M_d <$ plume attenuation rate
mass delivered by the plume will decrease

Where is the PFAS Mass in a Source Area?

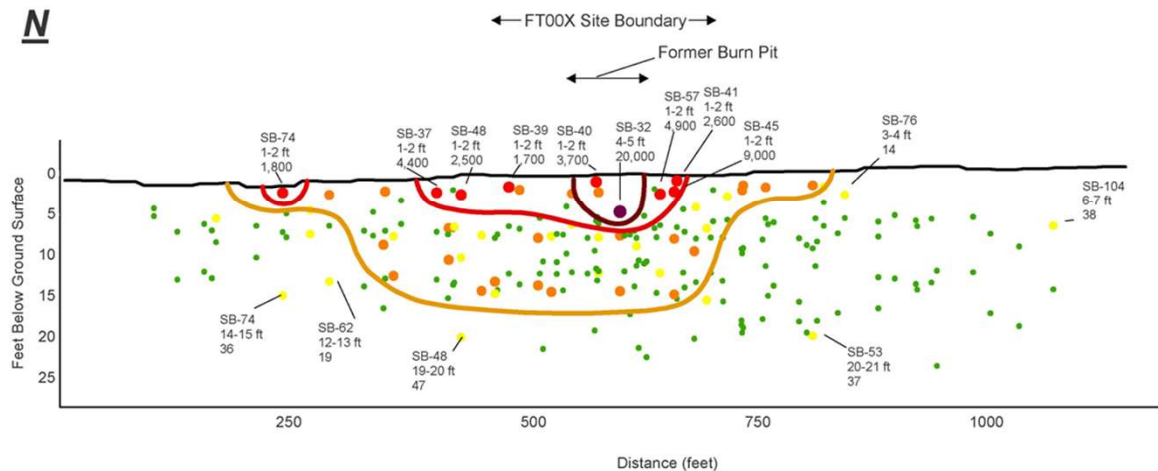
ENVIRONMENTAL
Science & Technology

pubs.acs.org/est

Article

High-Resolution Depth-Discrete Analysis of PFAS Distribution and Leaching for a Vadose-Zone Source at an AFFF-Impacted Site

Matthew C. Bigler, Mark L. Brusseau,* Bo Guo, Sara L. Jones, J. Conrad Pritchard, Christopher P. Higgins, and James Hatton



S

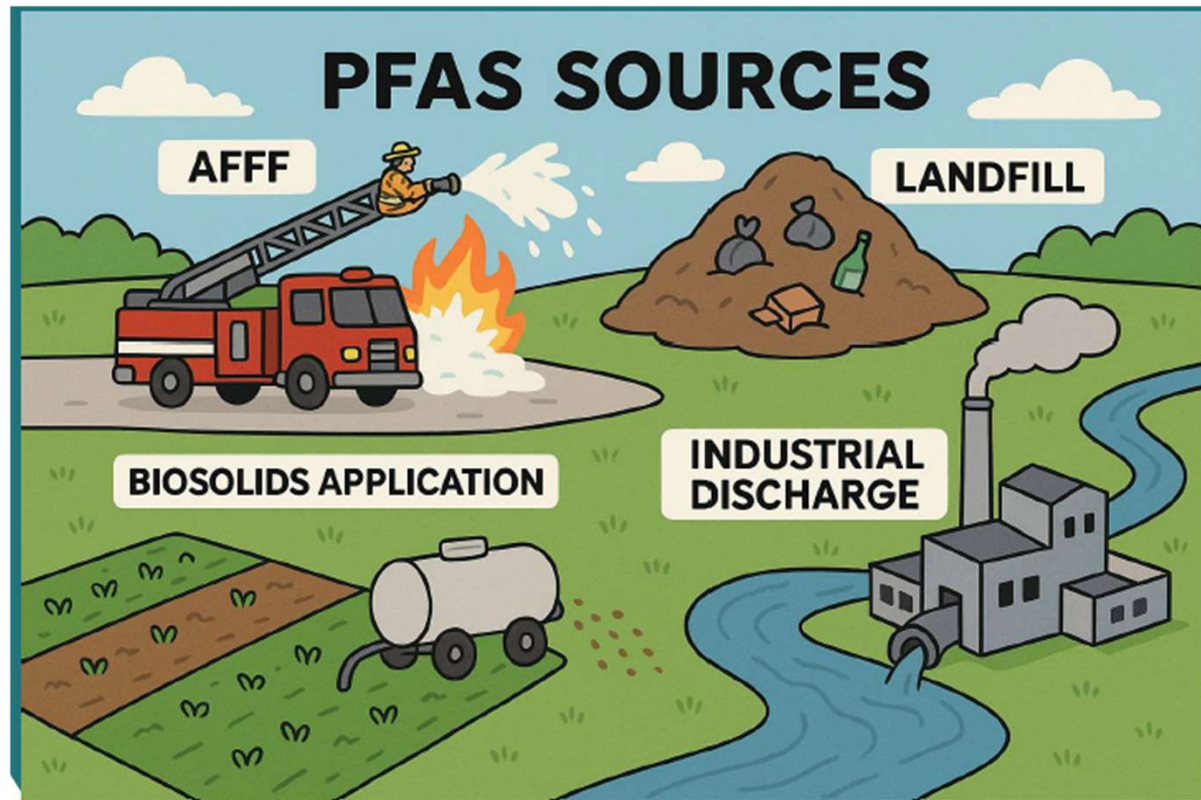
- 99% of PFAS mass within 3 meters (Bigler *et al*)
- 181 soil samples in the example site (to left)
- 1 ft sampling intervals (biased to surface)
- 66% of PFAS mass within 2 ft of surface
- 95% of PFAS mass within 5 ft of surface
- Will assist with soil remediation design

Prioritizing Remediation

- Validated destructive technologies are limited – more to come
- Groundwater plumes are large and are often co-mingled with other PFAS sources
- PFAS Monitored Retention (PMR) proposal/consideration for groundwater plumes as part of risk management decision making process
 - Mass discharge metrics can support remediation prioritization
- Sources discharge that exceed aquifer attenuation capacity with connected receptors should be prioritized
- Strategic source removal (i.e. scalable reduction in mass discharge) to support PMR as an alternative. Can be used to ensure exposure mitigation for groundwater, which will optimize resource allocations.
- Sources discharge that are less than the aquifer attenuation capacity and no connected receptors could be strong candidates for PMR assessments and risk management as interim and potentially final remedy.

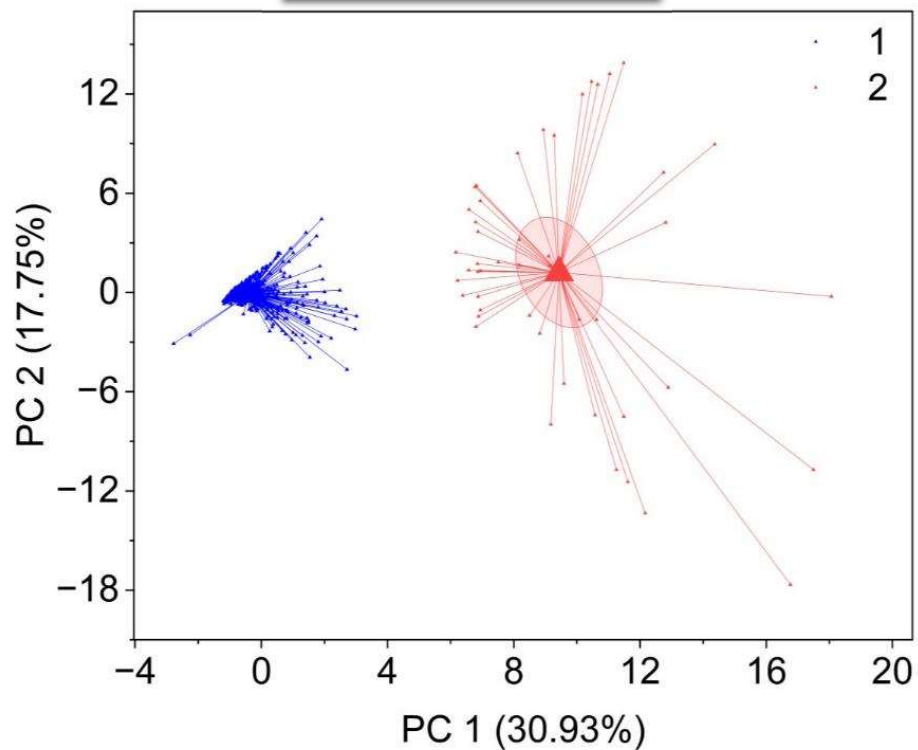
PFAS Forensics

- Why is it important/When does it happen in an RI
- Method 1633 – not a rapid analysis and does not promote EPA triad approach
- Other PFAS sources on base/installation not identified
- Whose PFAS is it?
Anthropogenic background?
- Source to groundwater for very unique contaminants

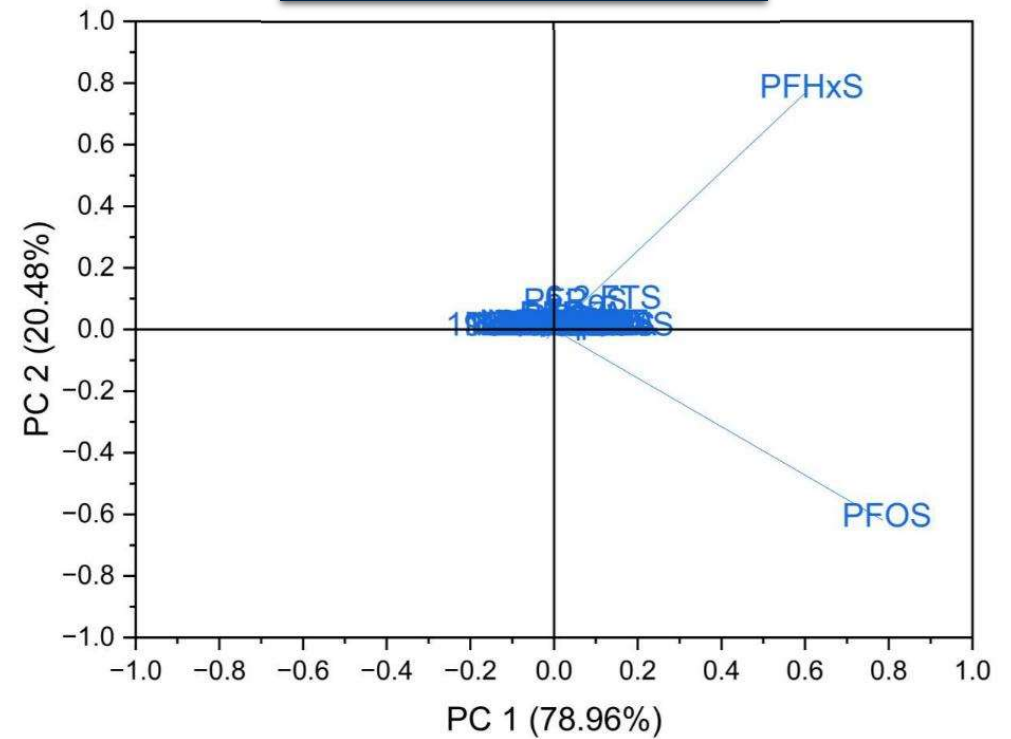


Leveraging ML Techniques

K-Means Clustering



Biplot Visualization of PCA



REMEDIATION

THE JOURNAL OF ENVIRONMENTAL CLEANUP COSTS, TECHNOLOGIES, & TECHNIQUES

RESEARCH ARTICLE

Strategic Delineation at Per- and Polyfluoroalkyl Substance (PFAS)–Contaminated Sites: A Framework Combining Source Identification, Background Assessment, and Plume Migration Insights for Remedial Investigations

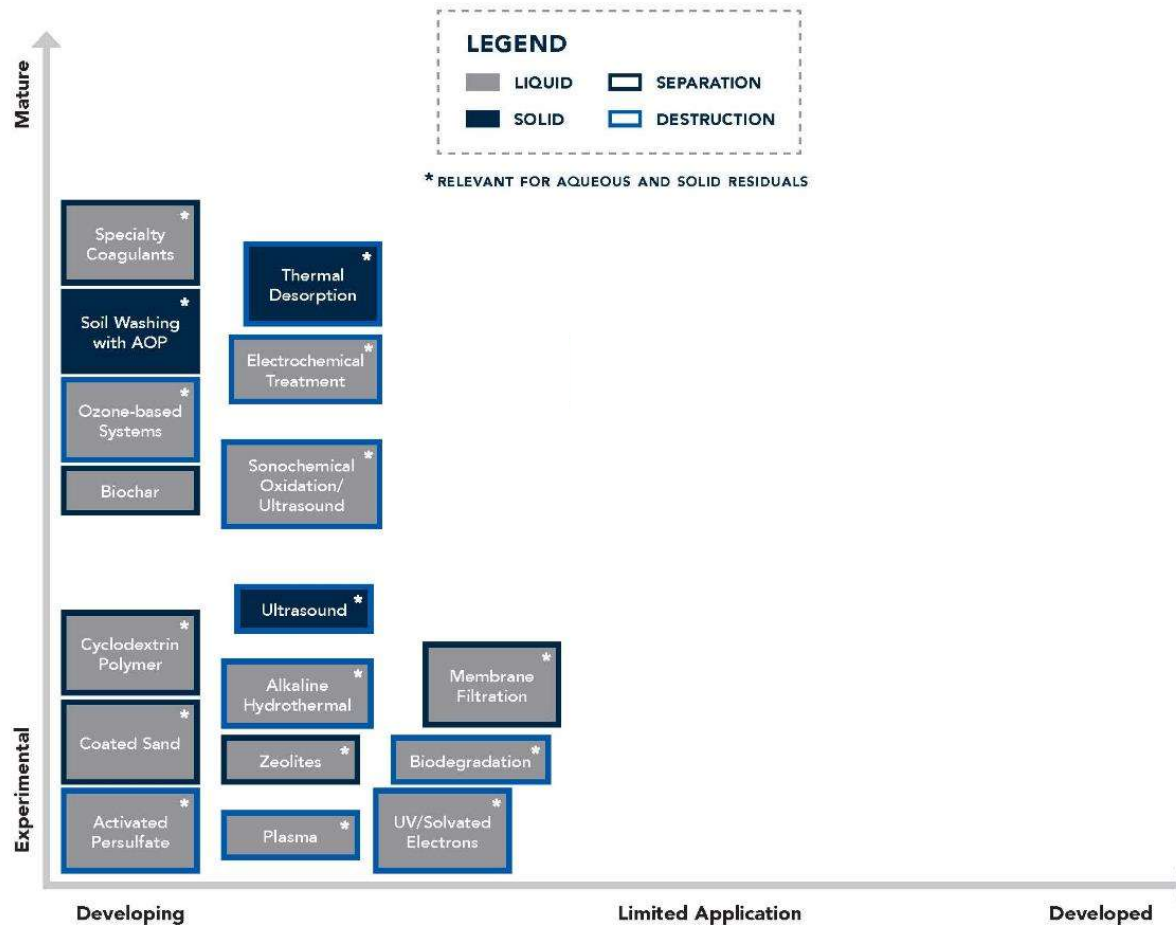
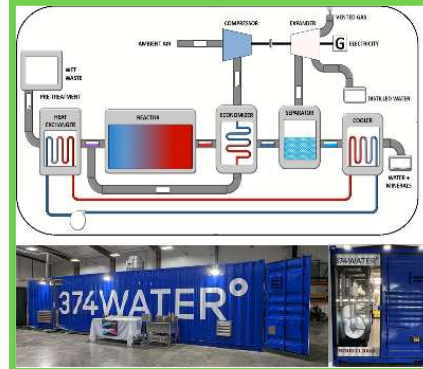
Mahsa Modiri, Faran Torres, Luke Flores, Richard H. Anderson ✉

First published: 16 October 2025 | <https://doi.org/10.1002/rem.70040>

Remediation



Emerging Technologies for Solids



PFAS Res Managem

■ PRIMARY TREATMENT TECHNOLOGIES ■ RESULTING RESIDUALS ■ DESTRUCTION TECHNOLOGIES
■ OTHER DESTRUCTION TECHNOLOGIES ■ ANCILLARY RESIDUALS ■ END OF LIFECYCLE

Granular
Activated
Carbon (GAC)

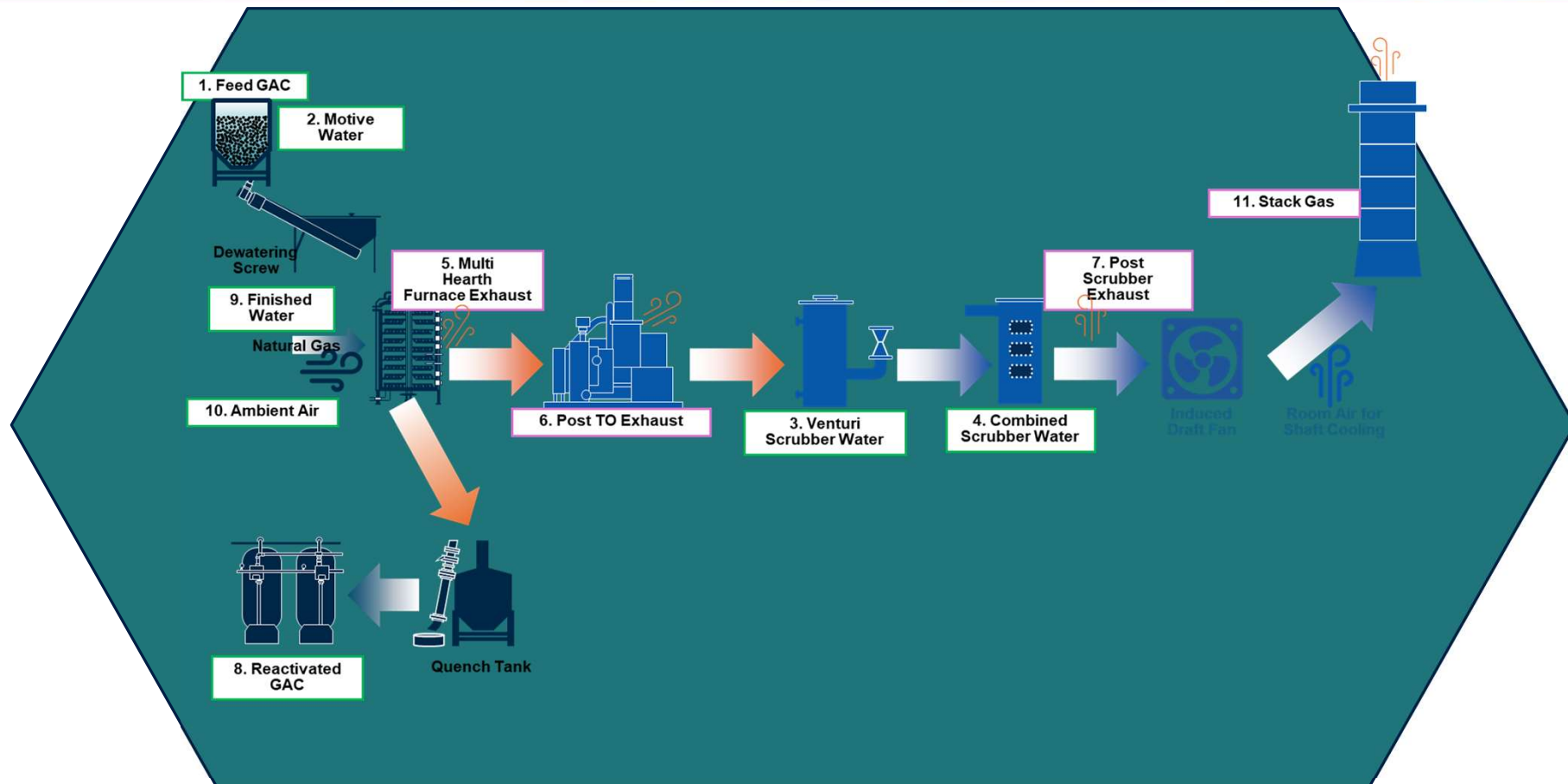
Anion
Exchange
Resins (IX)

Membrane
Filtration

Foam
Fractionation

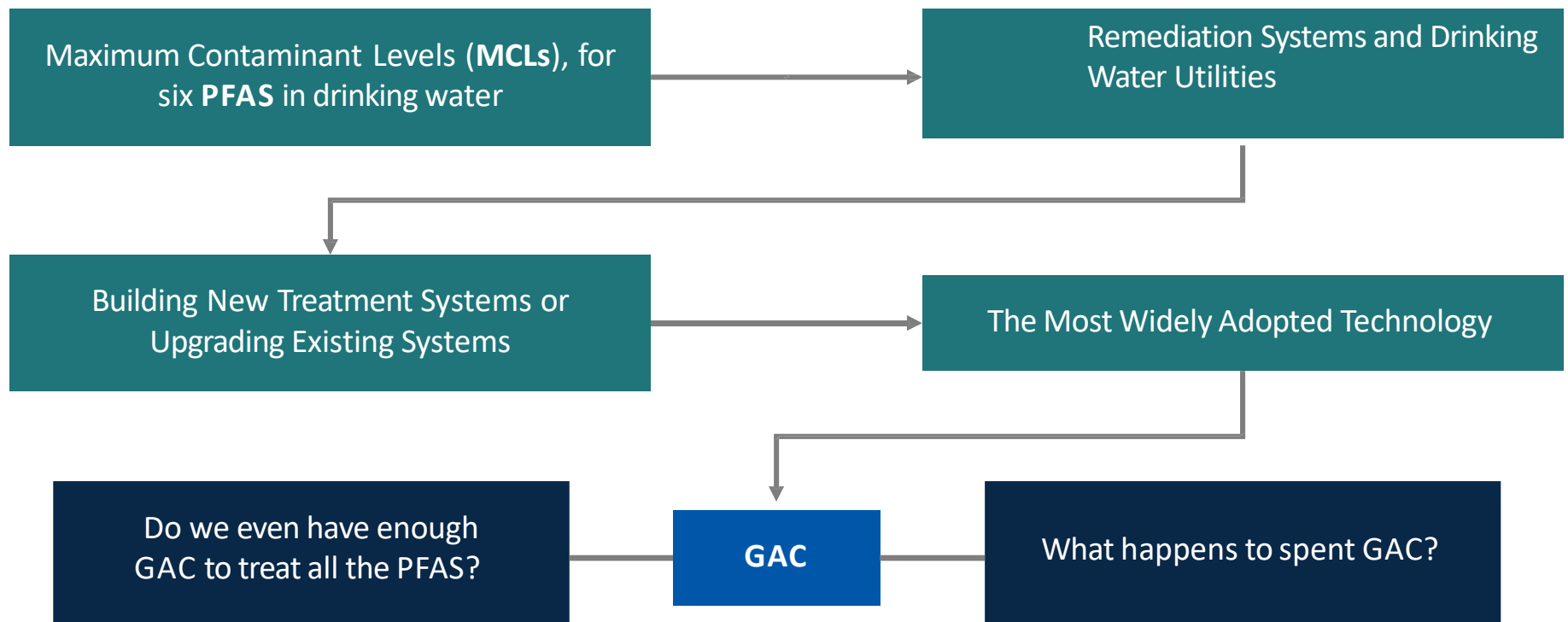
Wastewater
Treatment Plant
Operations



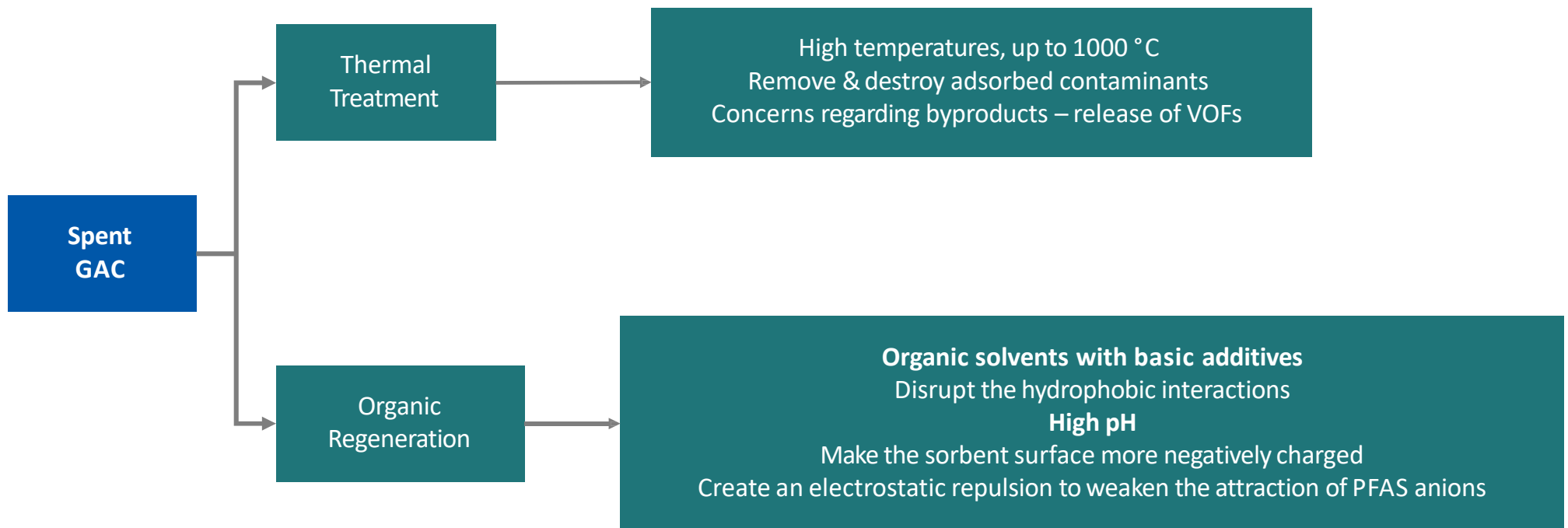


PFAS Fate During Thermal Reactivation???

Granular Activated Carbon



Current Strategies for Spent GAC



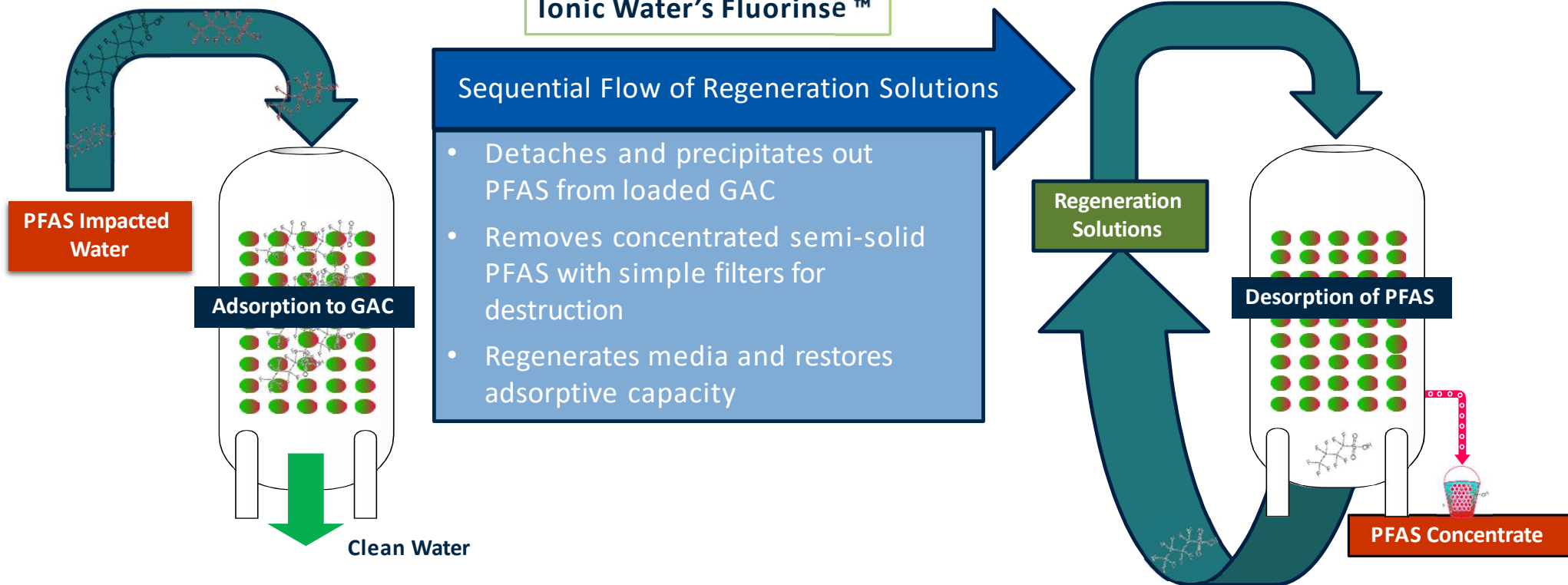
A technology that can be used on-site and does not require solvent or high temperature!

Novel Non-Organic Regeneration – Fluorinse™

Ionic Water's Fluorinse™

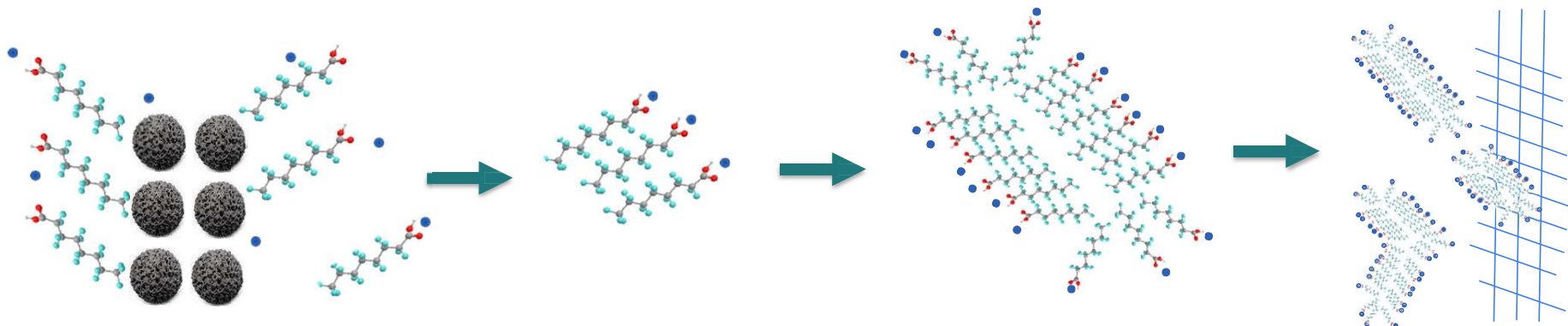
Sequential Flow of Regeneration Solutions

- Detaches and precipitates out PFAS from loaded GAC
- Removes concentrated semi-solid PFAS with simple filters for destruction
- Regenerates media and restores adsorptive capacity



Patent No: US 11958763. Issued April 2023

Chemistry Behind Fluorinse™ Method



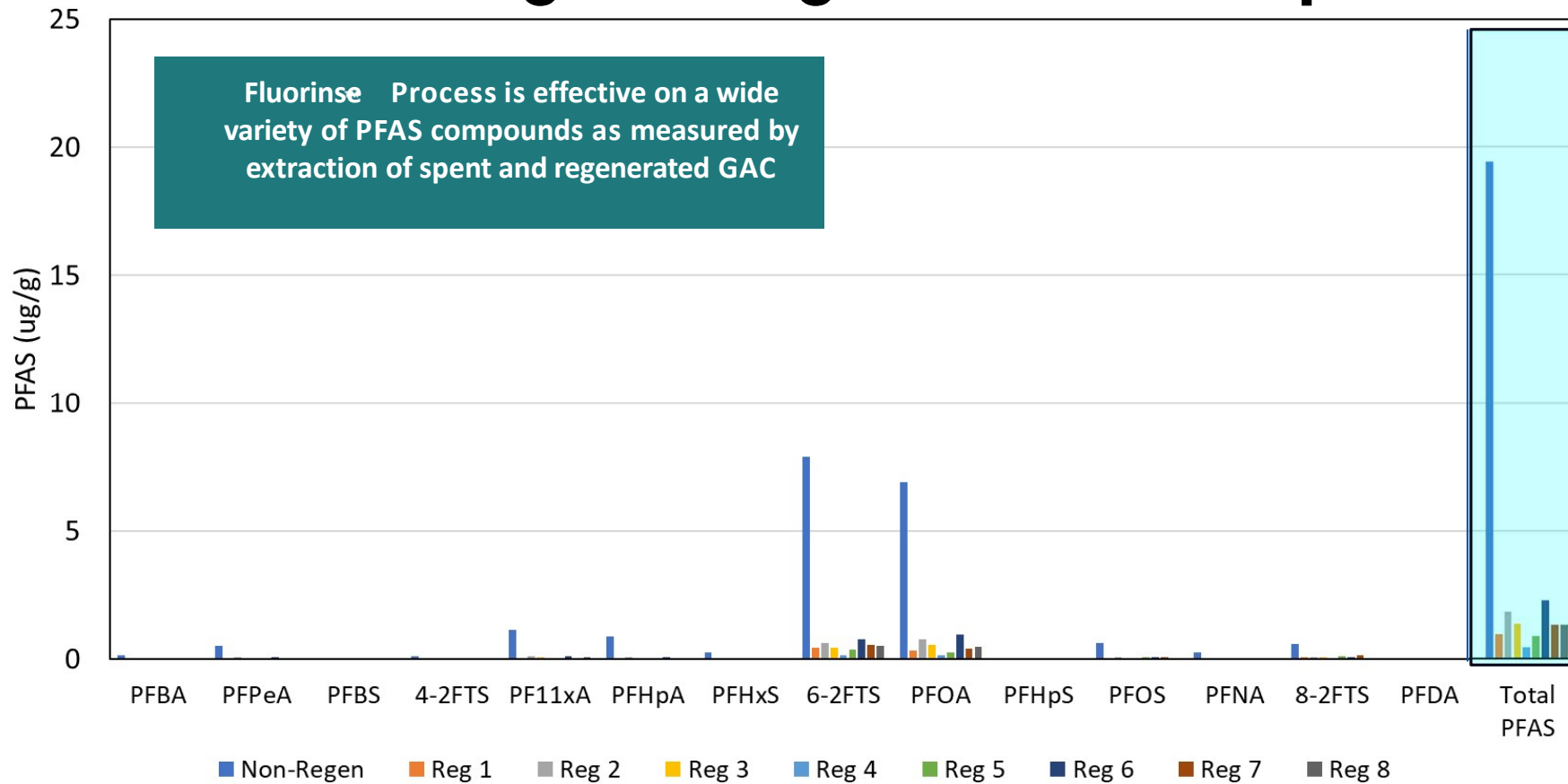
1. Cations in Fluorinse™ have higher affinity for PFAS than GAC => **PFAS desorbs**

2. Desorbed PFAS are flushed from column and agglomerate to reduce polar interactions with water

3. Outside of column, PFAS forms larger agglomerates and ripens

4. Agglomerates are filtered with standard pore size bag filter from regeneration fluid before recirculation

Different Non-Organic Regeneration Recipes



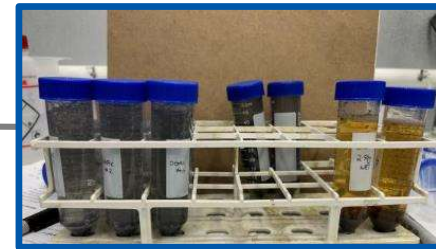
Analytical Challenges



**GAC
Extraction**

Low Surrogate
Recoveries

Underestimation of PFAS
Concentrations in Spent
GAC

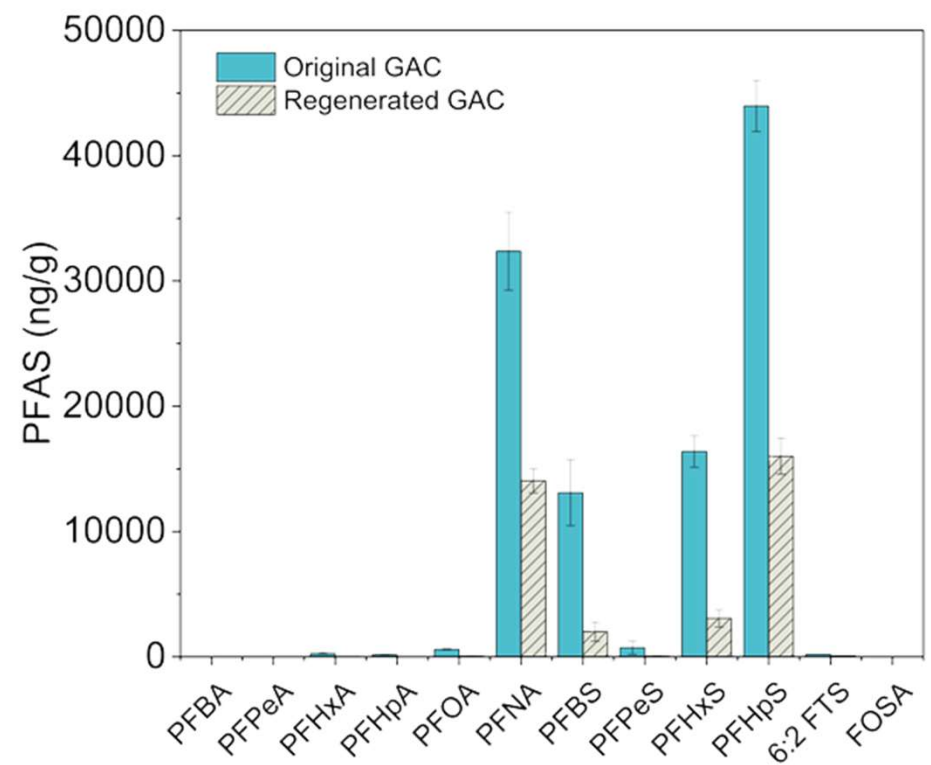
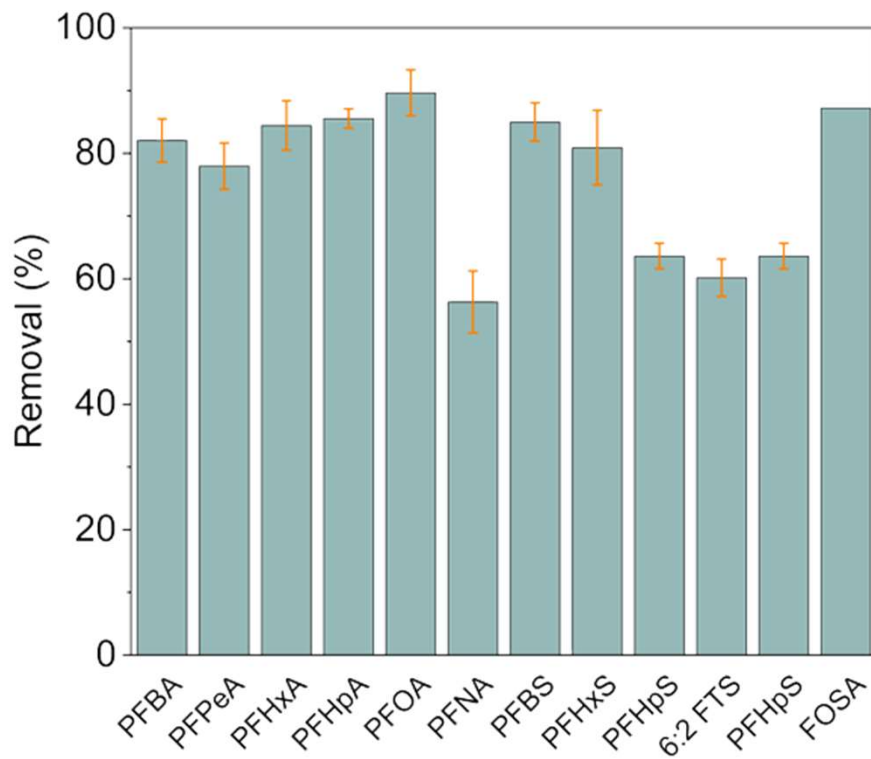


**Regeneration
Solutions**

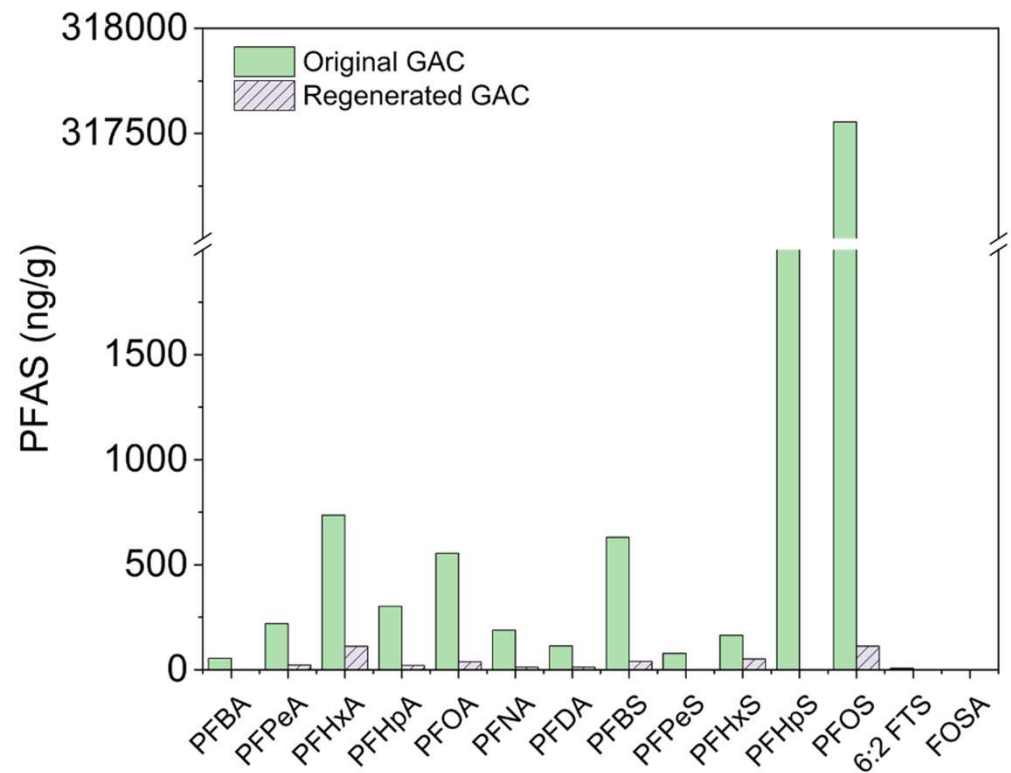
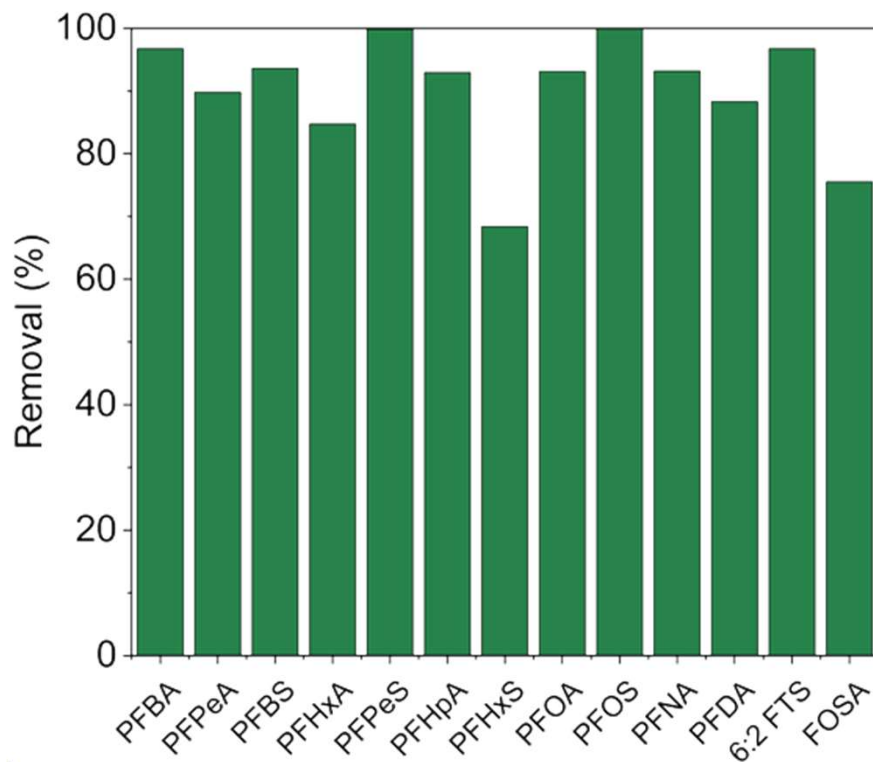
High pH

Ionization Problem
with Direct Injection/
Solid Phase Extraction

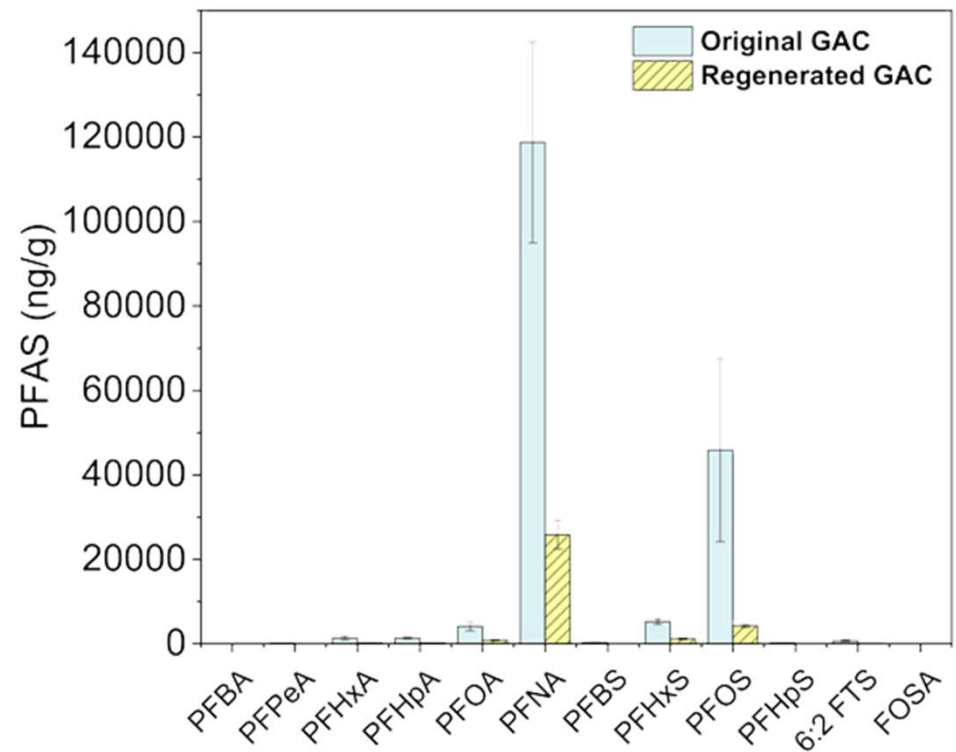
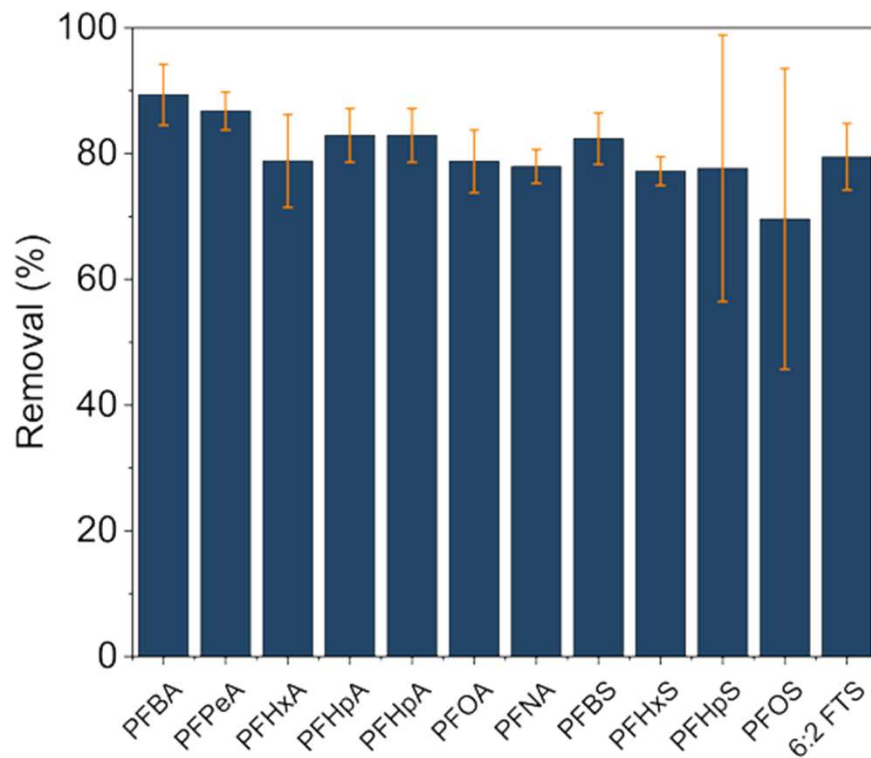
Virgin GAC with Spiked PFAS



Spent GAC from a Public Drinking Water Facility

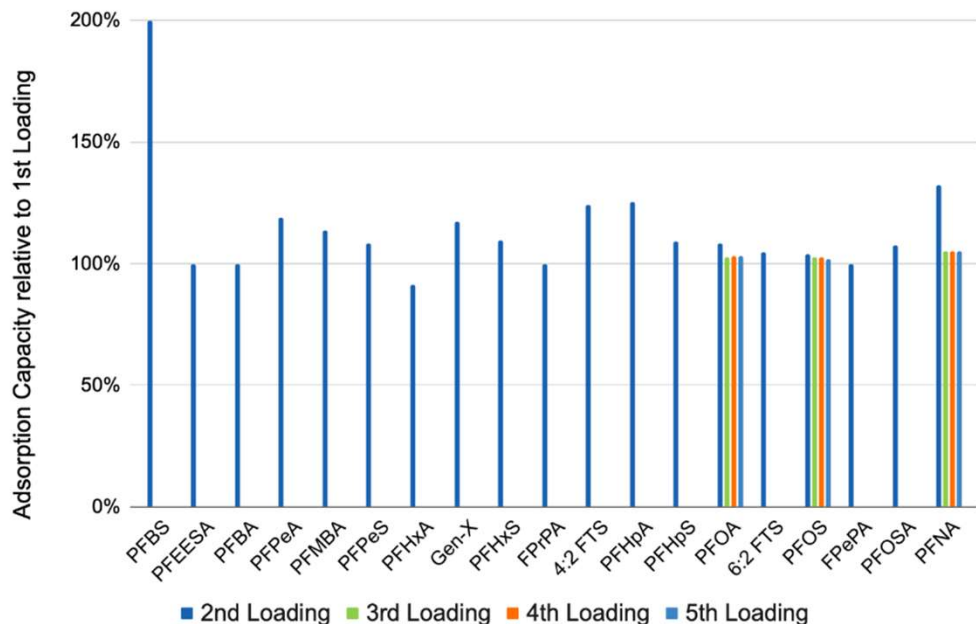


AFFF-Impacted GAC from DoW Sites

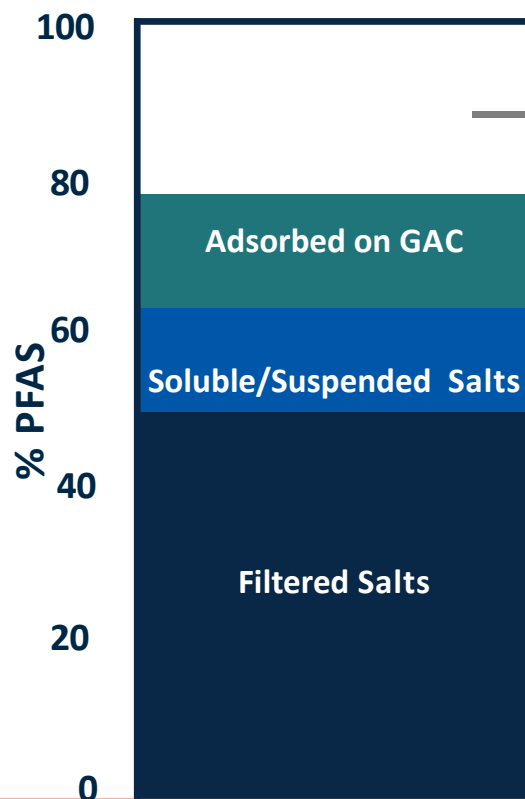


Total PFAS = ~15 mg/kg

Adsorption Capacity after Regeneration



Preliminary Mass Balance Beaker Study



Potential Sources:

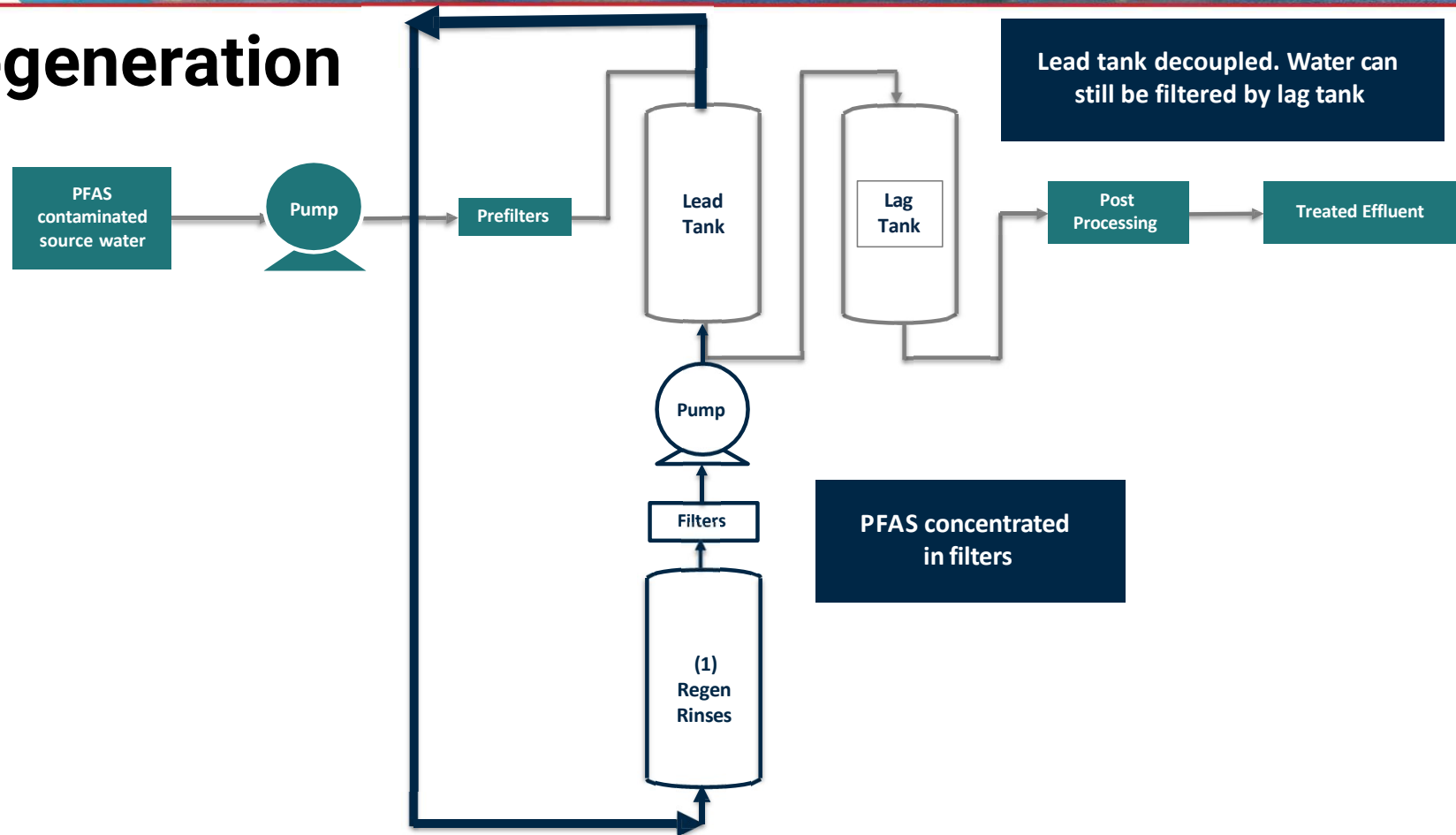
- Unfiltered precipitates
- PFAS adhering to glassware
- Analytical method artifacts

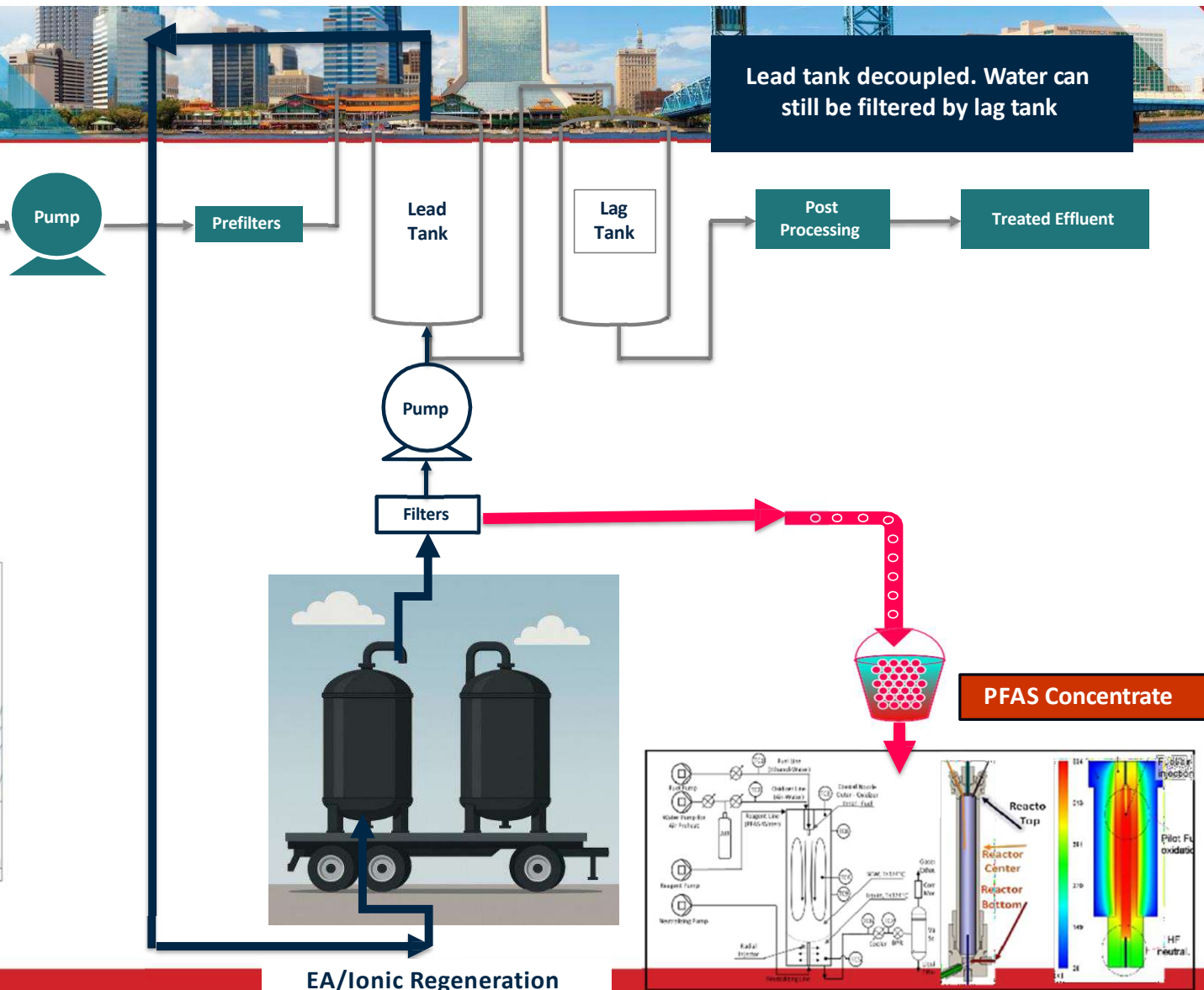
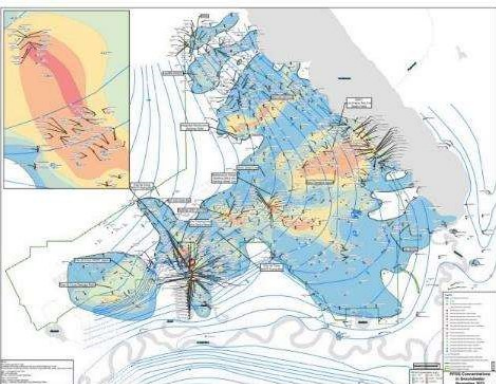
Optimizing analytical methods will serve in better understanding the PFAS mass in each phase.

EA/Ionic Mobile Unit



On-Site Regeneration





Take-Home Messages

- **PFAS site management must integrate forensics, meta-analysis, and treatment selection**
- **Full life-cycle assessment is the key**
- **Solids and spent residuals should be managed strategically**
 - Still concerns associated with in-situ adsorbative technologies and longevity of media
- **Spent GAC management is a critical bottleneck.**
- **Non-organic regeneration (Fluorinse™) offers a viable path forward**
- **Next step: bridge research to practice**
 - by piloting regeneration processes, closing PFAS mass balances, and integrating destruction of concentrates.

Q&A / Discussion





Contact Us



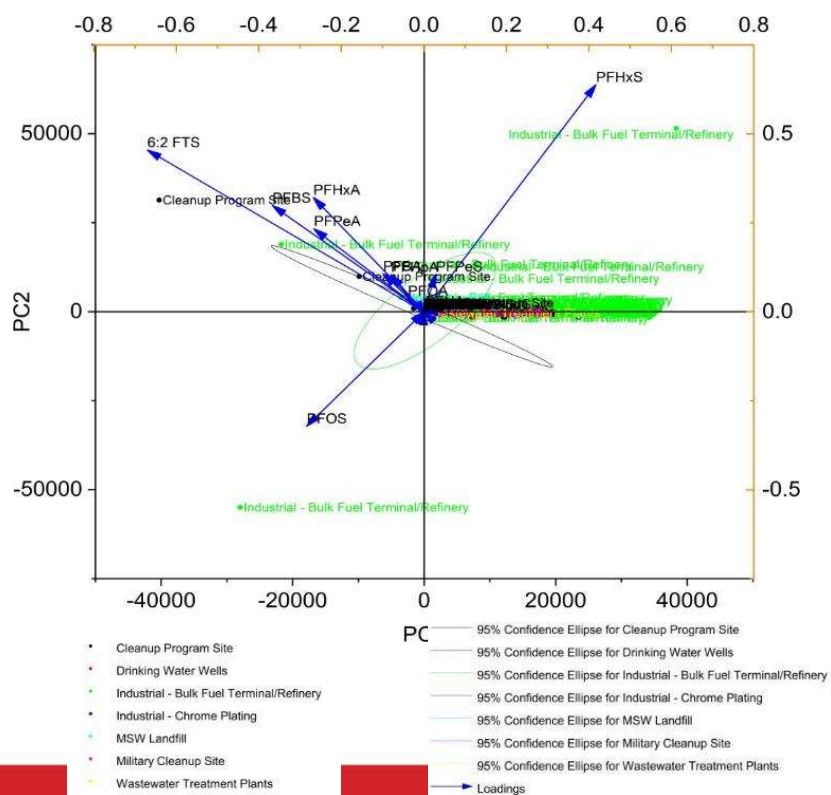
Mahsa Modiri PhD, PE
mmodirig@eaest.com



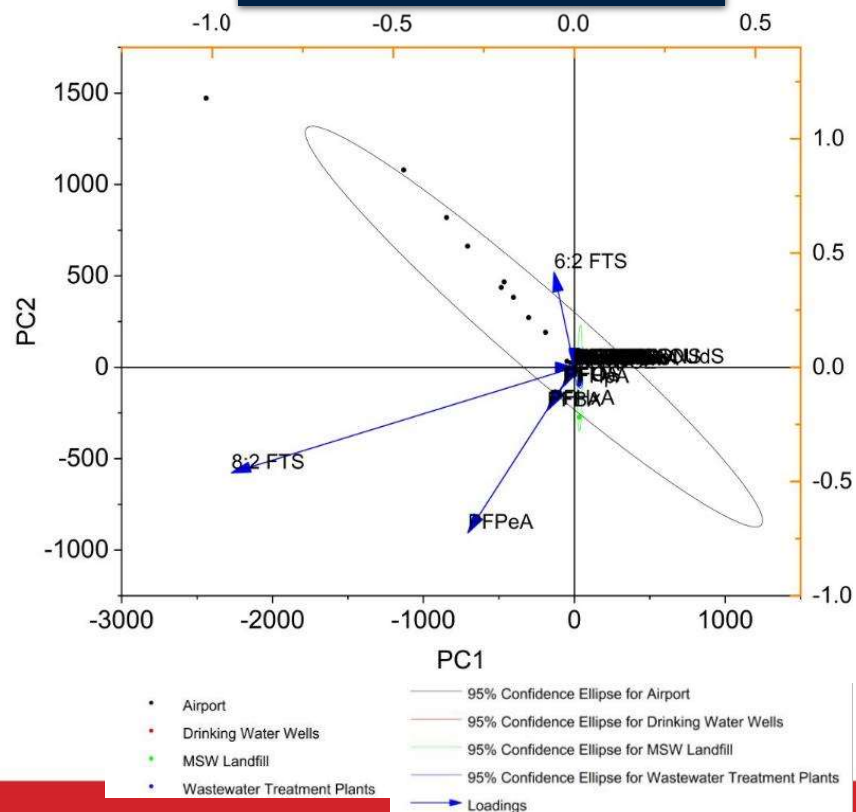
Michael Hertz, PG
mhertz@eaest.com

Leveraging ML Techniques

Sparce PCA all
Sources



Sparce PCA Impacted
Watershed



Visualization of Analytical Results

