



**REMEDICATION &  
RISK MANAGEMENT**

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**DEWATERING &  
WATER TREATMENT**

## **Case Studies: Real World PFAS Remediation Work Completed in Alberta**

ESAA PFAS Symposium - Calgary  
December 4, 2025

Bruce Tunncliffe, M.A.Sc., P.Eng.  
VEI Contracting Inc.



## Presenter



**Bruce Tunncliffe, M.A.Sc.,  
P.Eng.  
Environmental Engineer,  
President of VEI**

# Agenda

- **Background: VEI and PFAS**
- **Case Study 1: In-Situ Permeable Reactive Barrier**
- **Case Study 2: Ex-Situ Lagoon Treatment**
- **Closing and Questions**



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# Company Overview

# VEI Contracting Inc.

- Specialty Remediation Contractor est. 2003
- Offering a variety of contracting services



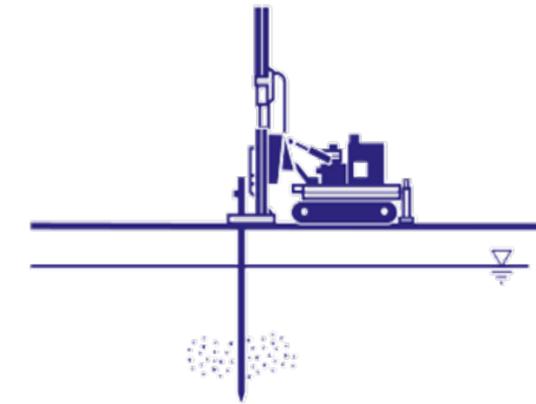
In-Situ Remediation



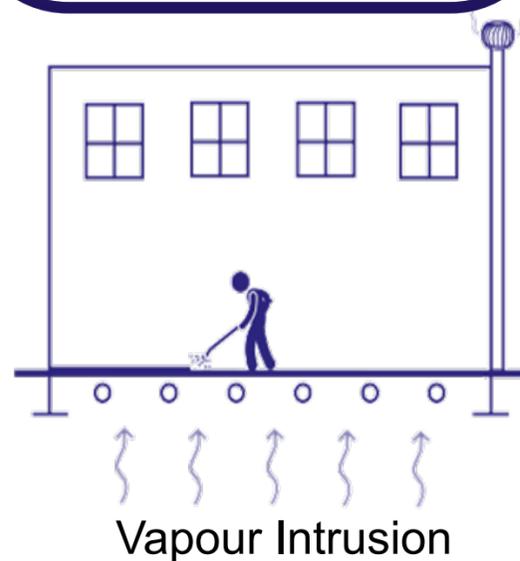
Water Treatment Systems  
& Dewatering



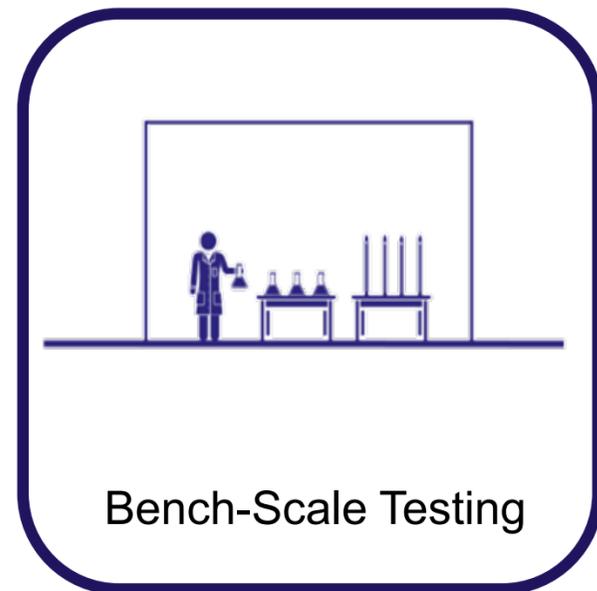
Ex-Situ Remediation



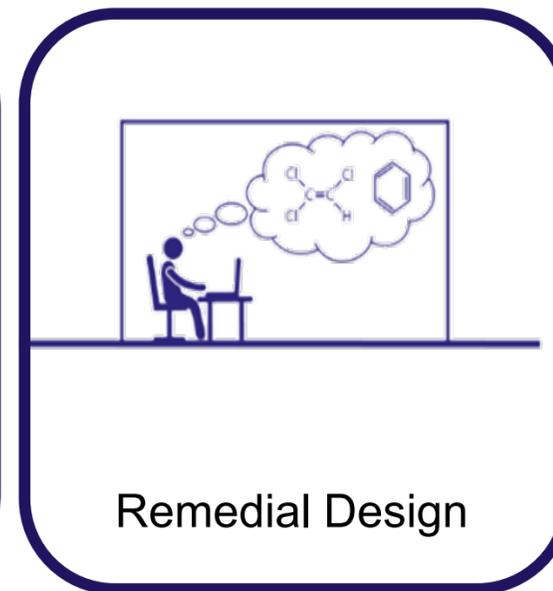
High Resolution Site Characterization  
& Remedial Design Characterization



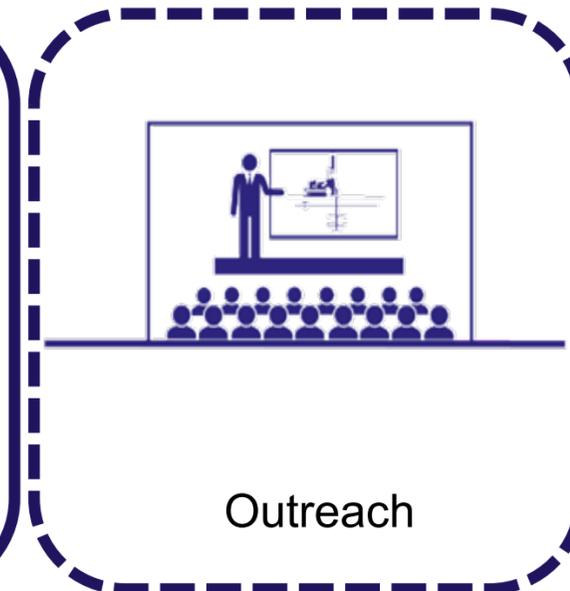
Vapour Intrusion



Bench-Scale Testing



Remedial Design



Outreach



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Below the Surface | Beyond the Science

# SMART *Remediation*

*Smart Methods in Advanced Remediation Technologies*

REGISTER

**VANCOUVER**

January 20, 2026

**CALGARY**

January 22, 2026

**TORONTO**

January 29, 2026

**OTTAWA**

February 12, 2026



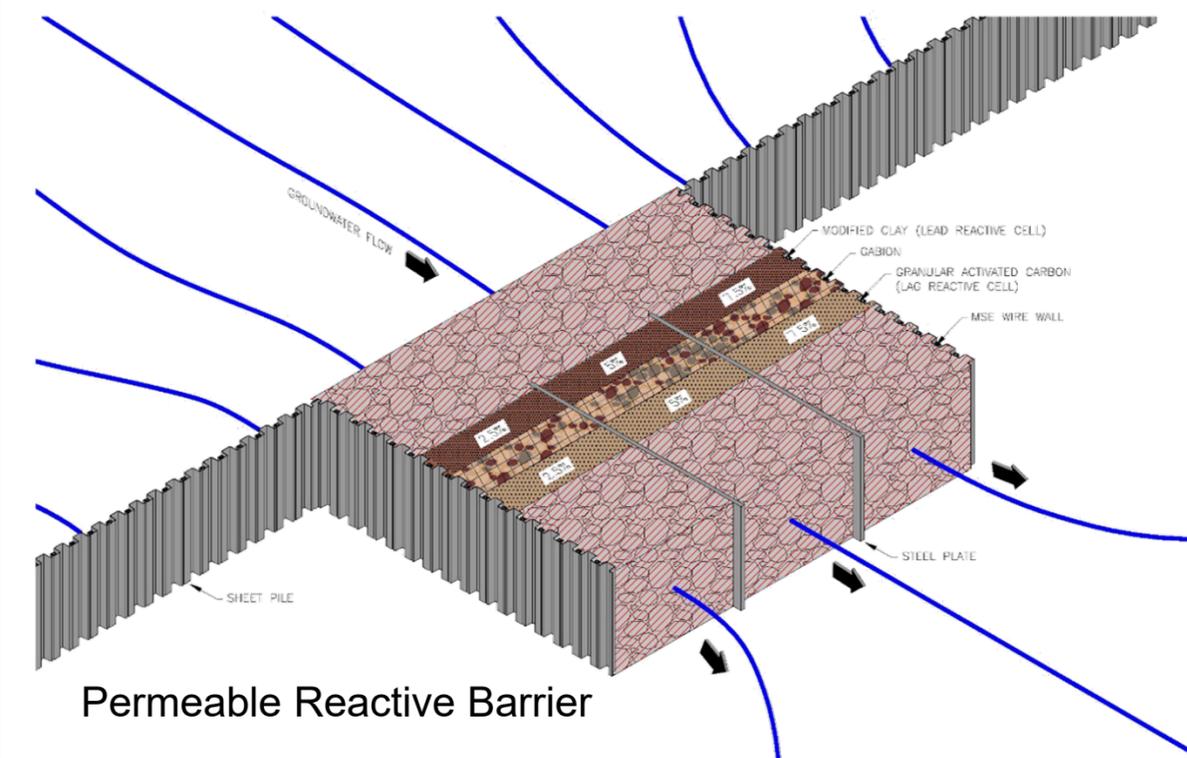
# VEI and PFAS Work

## Examples of PFAS Projects

- Numerous Bench-Scale Studies
  - First bench one was 2015: 10 years ago
- Pilot-scale groundwater treatment
  - First was in 2018: 7 years ago
- Two Permeable Reactive Barriers
- Large lagoon with complex water
- Water treatment system design and build
- Major research grant re: PFAS Destruction



Water Treatment System





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# Information on PFAS

# PFAS in Contracting – The State of Treatment

ITRC (Interstate Technology Regulatory Council) in the USA:

- Treatment technologies for PFAS in environmental media are **still evolving** and it is prudent to use caution
- At some sites, it might be reasonable to **take short-term site actions** that address impacted or threatened receptors
- ...with the intent of applying more robust and cost-effective technologies **as these are developed.**
- Prioritize **water** treatment
  - Don't drink PFAS
  - Don't let PFAS migrate into sensitive areas



Treatment Technologies and Methods for Per- and Polyfluoroalkyl Substances (PFAS)



# Bench Testing Laboratory

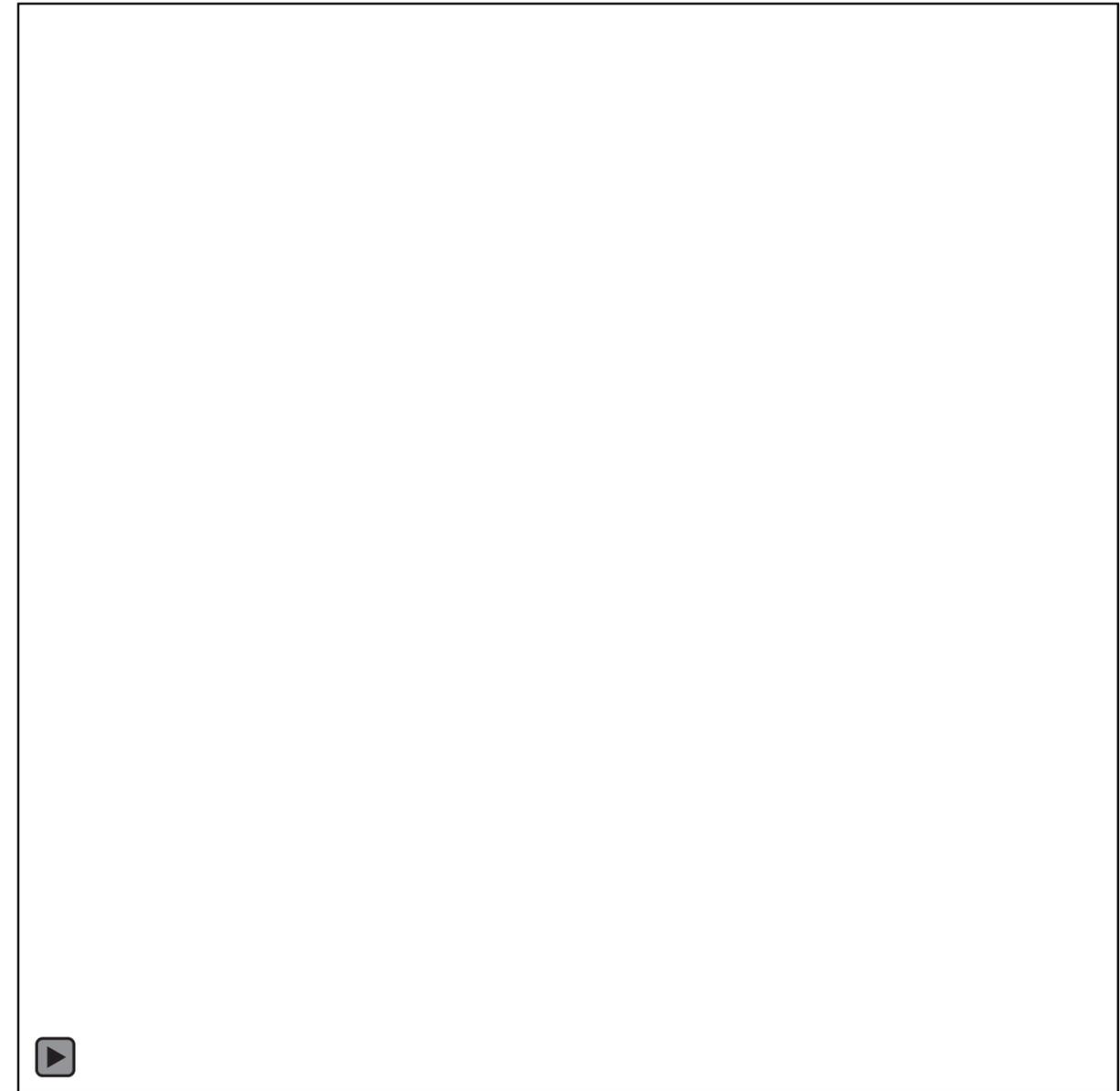
- Lab run by Alyson Neufeld, PhD in Environmental Chemistry, from University of Toronto
- Variety of ongoing bench-tests for PHCs, PAHs, Metals treatment
- In 2025 doing research collaboration with Parsons for PFAS destruction
  - Funded by Canada R&D Grant
  - Positive initial results



## Parsons and VEI Contracting Inc. Research Collaboration Delivers PFAS Destruction Solutions for Canada

NEWS PROVIDED BY  
EIN Presswire  
Sep 03, 2025, 2:40 PM ET

KITCHENER, ONTARIO, CANADA, September 3, 2025 /EINPresswire.com/ -- VEI Contracting Inc. (VEI) of Kitchener, Ontario, announced extremely positive initial results from innovative per- and polyfluoroalkyl substances (PFAS) destruction technology for contaminated waters via technical support from Parsons Inc., a leading disruptive technology provider in the national security and global infrastructure markets, in a uniquely Canadian initiative facilitated by federal research and development (R&D) support.



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# Bench-Scale Testing – Types of Tests

## Batch Reactor Tests



## Flow-Through Column Reactor Testing





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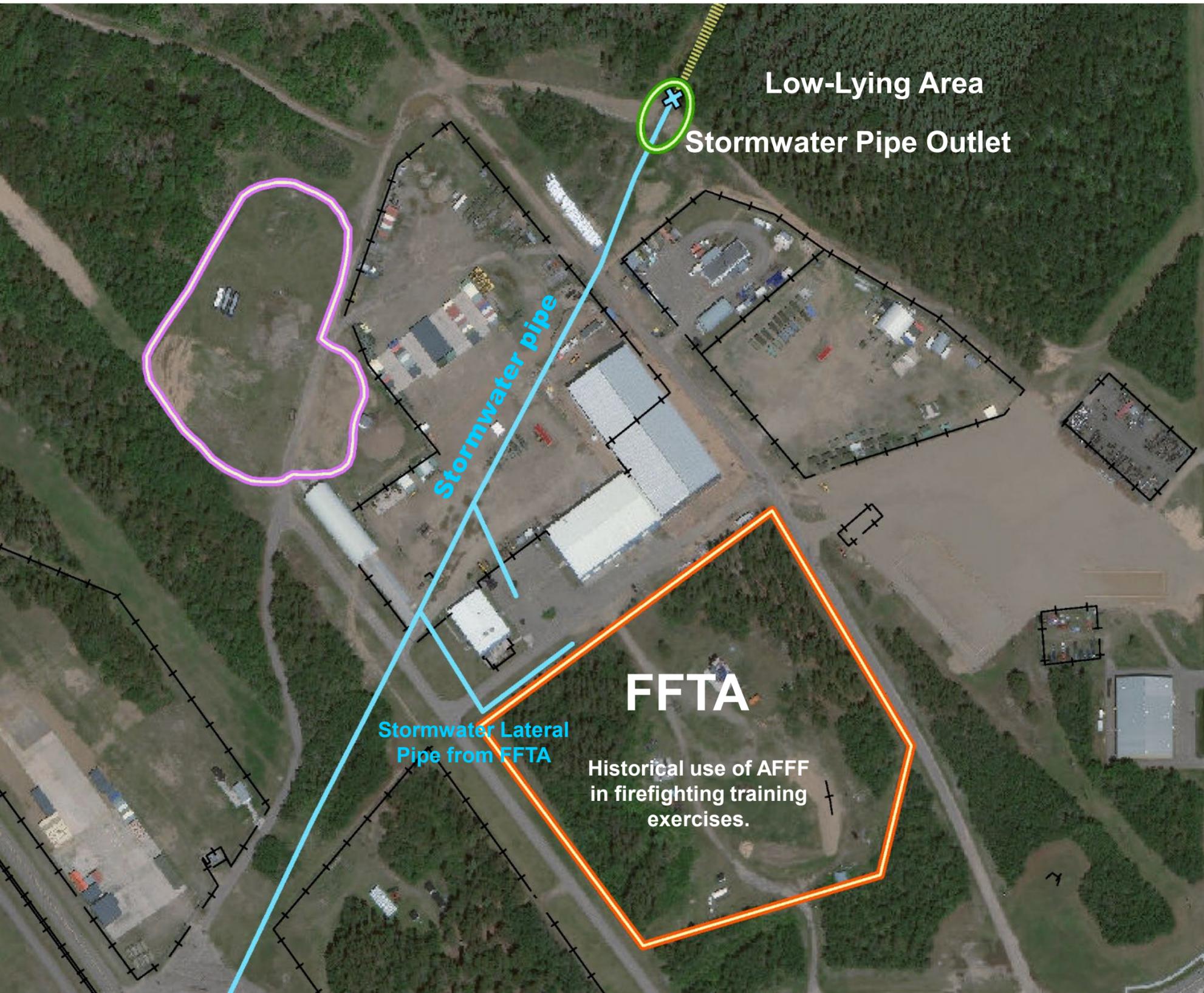
# **Case Study 1: In-Situ Permeable Reactive Barrier**

# Site Background

- Site located in Alberta
- Former Fire Fighting Training Area (FFTA)
  - Used Aqueous Film Forming Foam (AFFF) containing PFAS compounds
- A pesky sewer line runs through the FFTA and discharges into a low-lying area
- The low-lying area and downgradient river have detectable levels of PFAS
- Risk management measures are needed



# Site Layout



- FFTA (source of PFAS)
- Stormwater pipe (conduit)
- Preferential Pathway is bedding material with permeability ~ 100x that of the native sand
- Transports PFAS contaminated groundwater to low-lying area
- Low-lying area leads to river

# The Sewer Outfall



Bedding Material:  
122,000 to 135,000 ng/L

Inside Sewer Pipe:  
8,000 - 12,000 ng/L

Ponded Water:  
10,000 - 16,000 ng/L

Total PFAS  
Concentrations in ng/L



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# **Case Study 1: PRB Design - What will work here?**

**How do you address up to 135,000 ng/L flowing  
quickly through sewer bedding?**

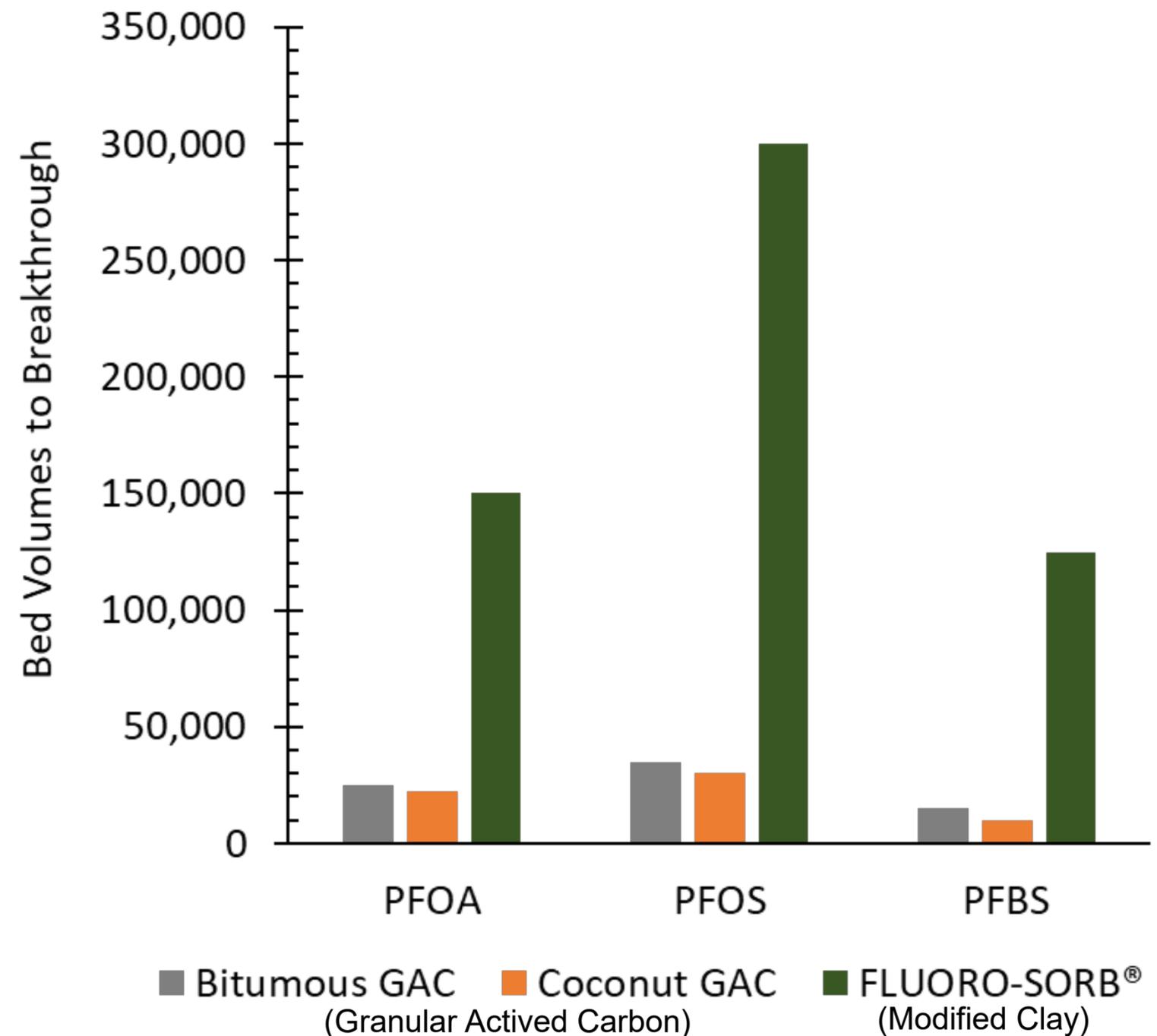
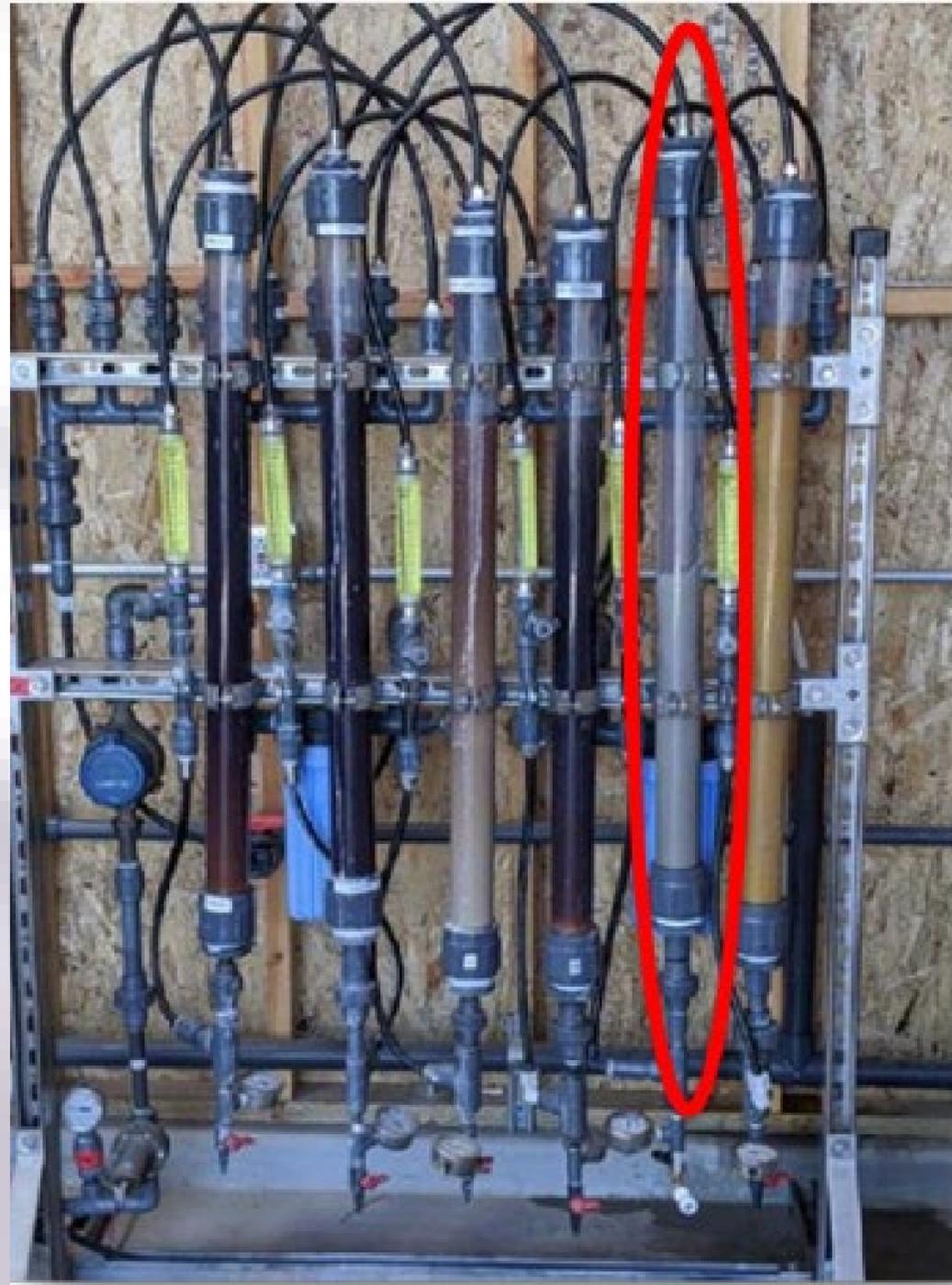
# Remedial Amendment Selection



- Approach: Adsorption / Stabilization
- How to select the proper design? Review the requirements of the Site:
  - Long Term effectiveness
  - Ability to handle high PFAS concentrations
- Amendments exist that readily adsorb PFAS:
  - Activated Carbon
  - Modified Clay
- Review Process:
  - Review of published studies
  - Internal bench test results

# Remediating PFAS – Activated Carbon vs Modified Clay

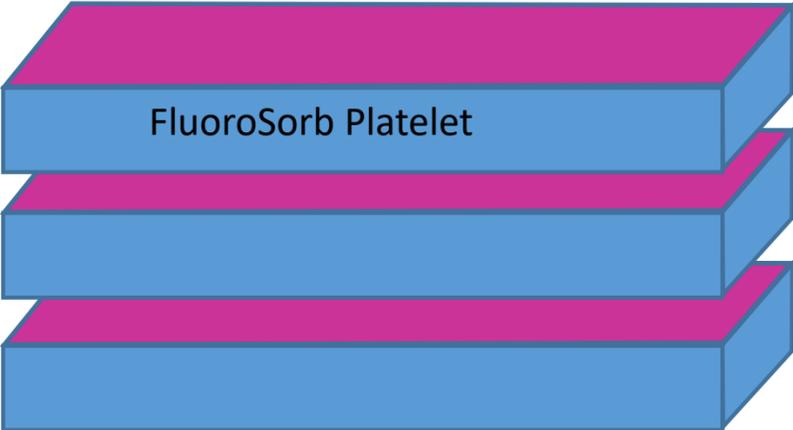
- Long-term effectiveness: who has greater capacity of PFAS adsorption?



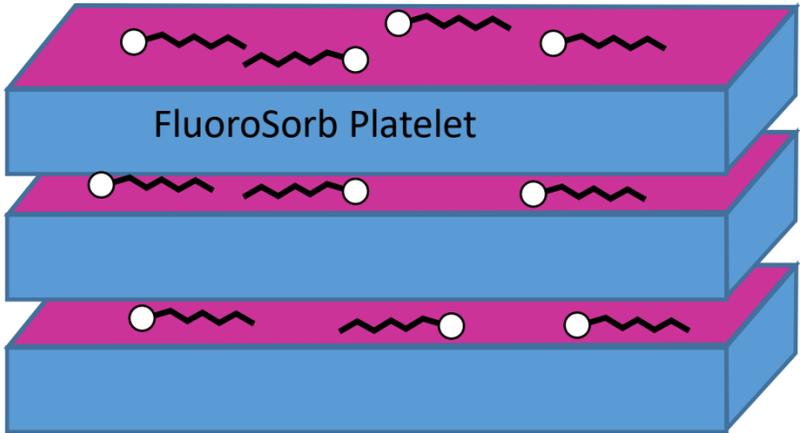
# Modified Clay Media

Modified Clay Sorption Mechanism – it becomes better with increasing PFAS concentration

Modified Clay:  
Platelet-like structure

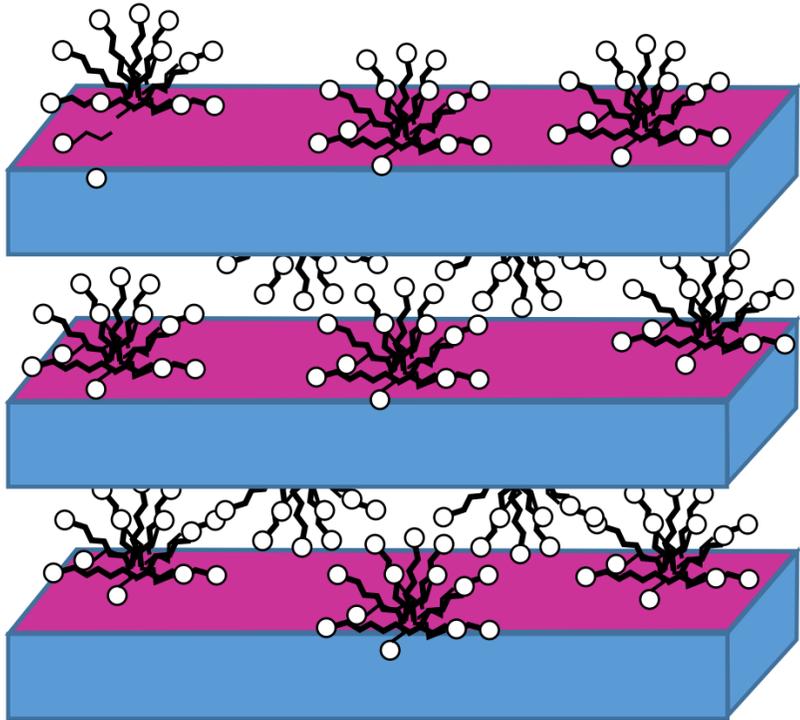


How PFAS is Sorbed



 = PFAS Molecule

Increasing PFAS Adsorption

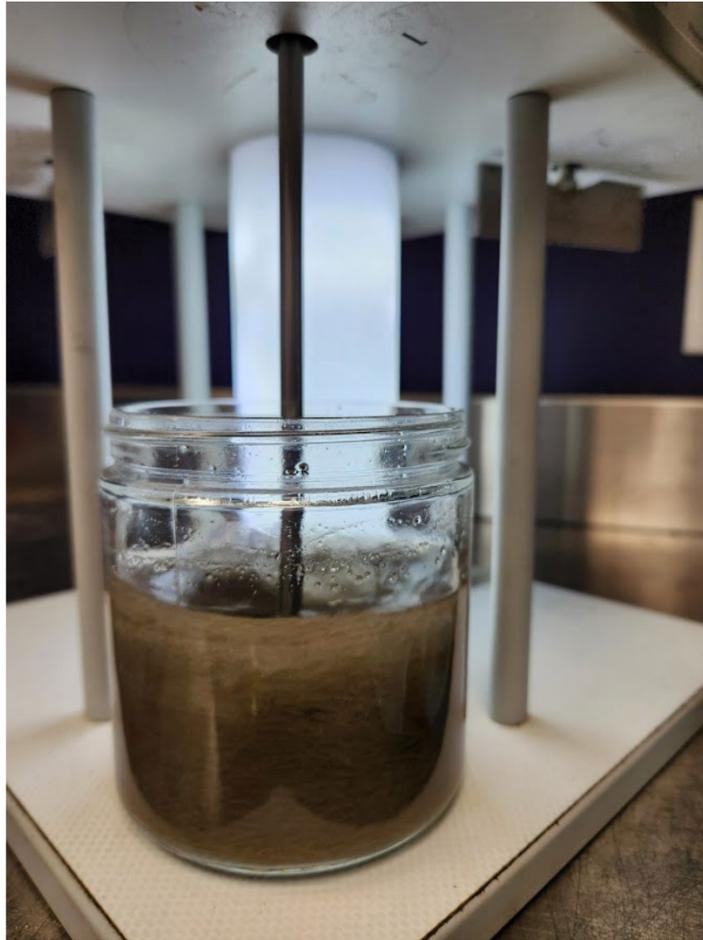


But...for injection will it:

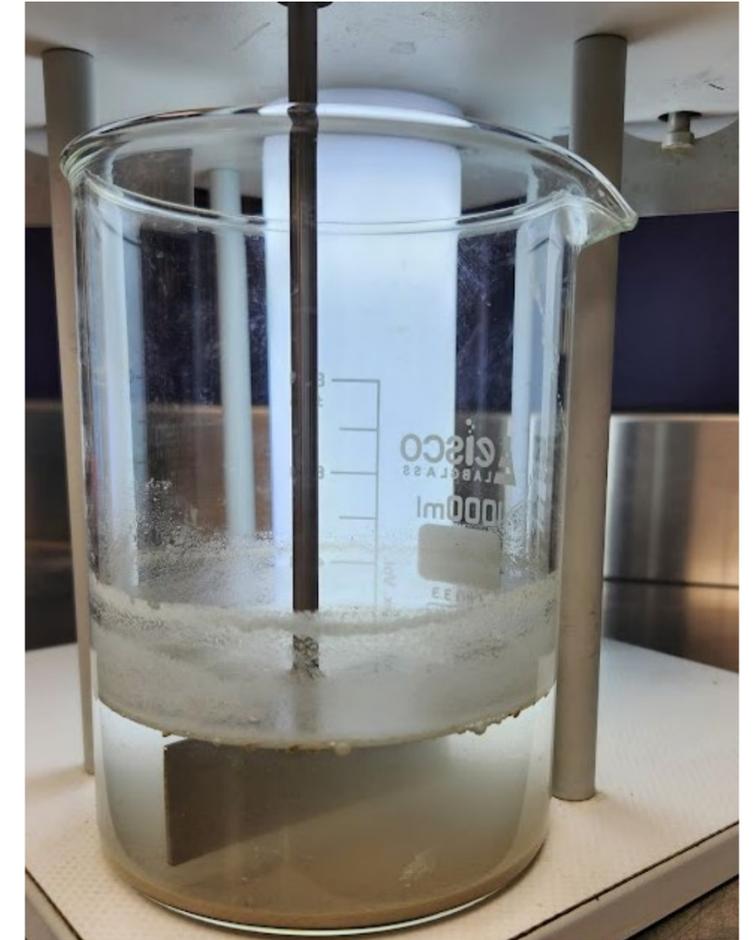
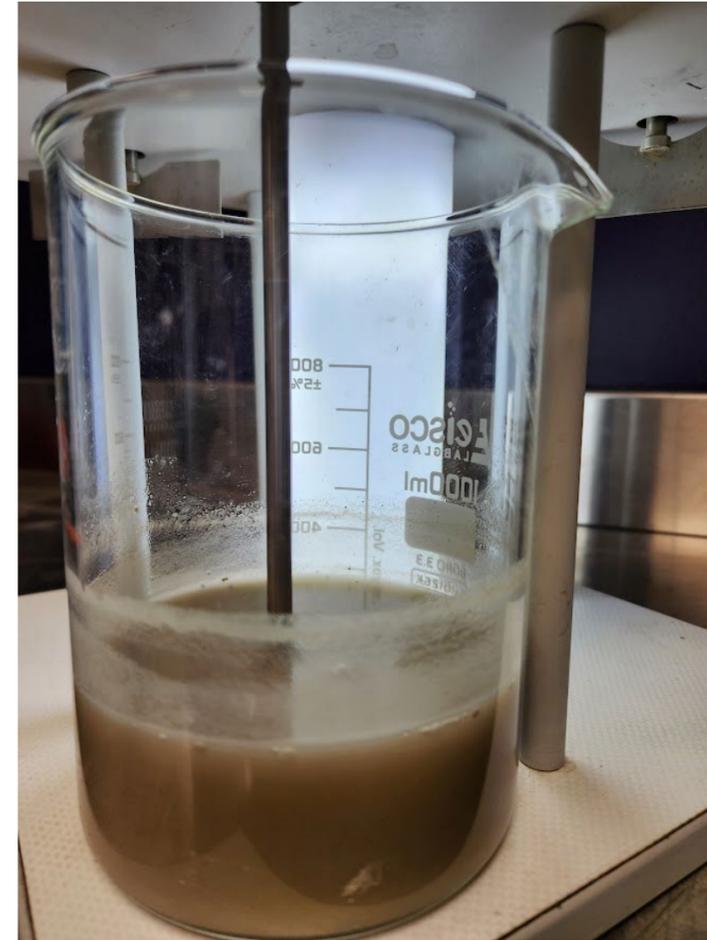
- Agglomerate?
- Clog the formation?

# Modified Clay Experimentation

- Would Fluoro-Sorb® swell or agglomerate when aggressively mixed in water?
- A series of mixing tests were completed in our in-house laboratory



Fluoro-Sorb® 200\*: fully mixed; 1 min settling



Fluoro-Sorb® P: fully mixing; 5 min settling

- Conclusion: it did not swell, it did not agglomerate

\*Note the Fluoro-Sorb® 200 sample had been sitting in water for 1.5 years prior to completion of the bench test

# Modified Clay Experimentation

- Pilot-scale injection testing was completed at a clean site, to assess mixing techniques, slurry weights, injection pressures, radius of influence (ROI)



- Fluoro-Sorb® could be mixed and injected as a particulate suspension using proprietary injection technology without clogging equipment or aquifer



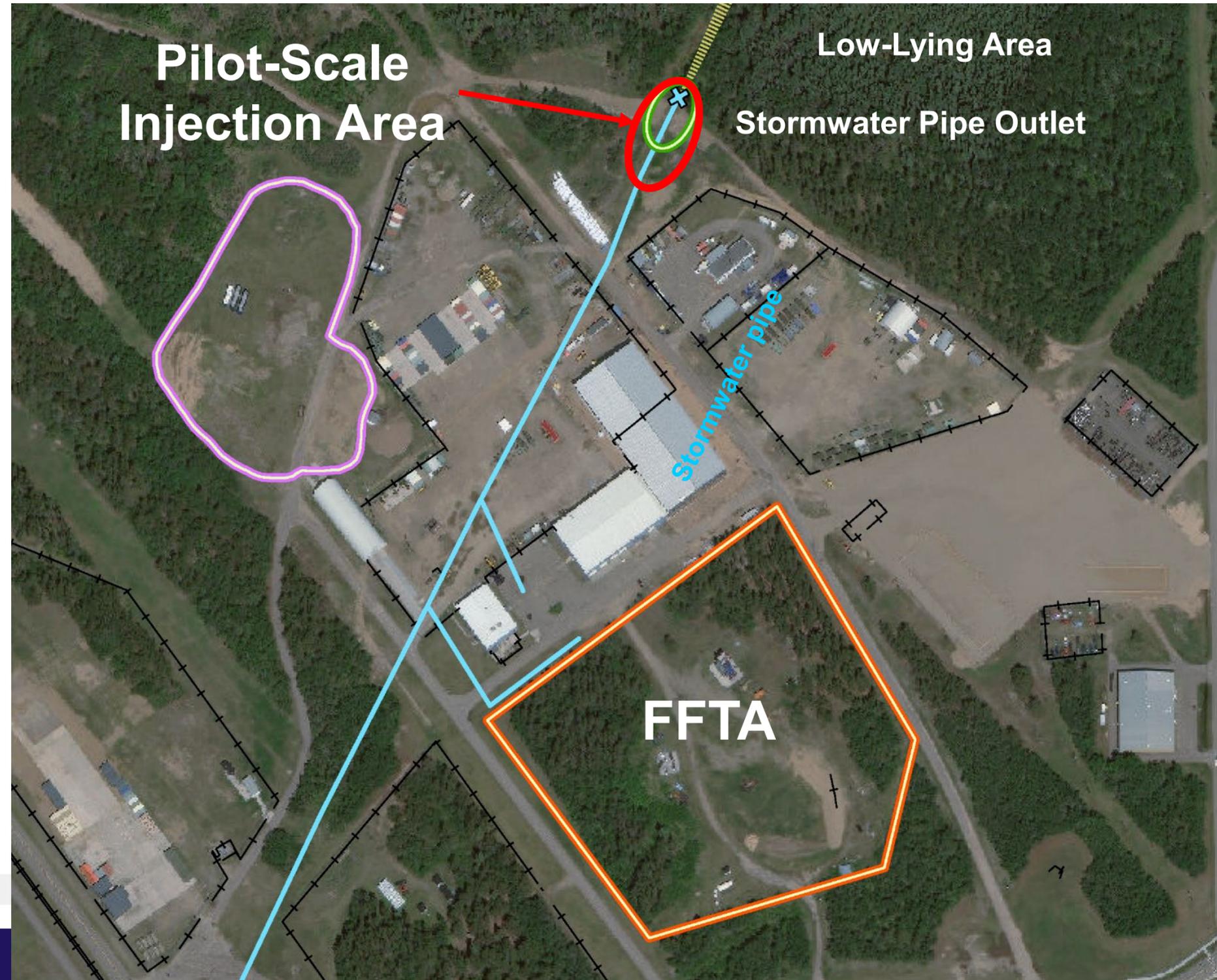
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# **Case Study 1: Execution of Plan Pilot-Scale Work**

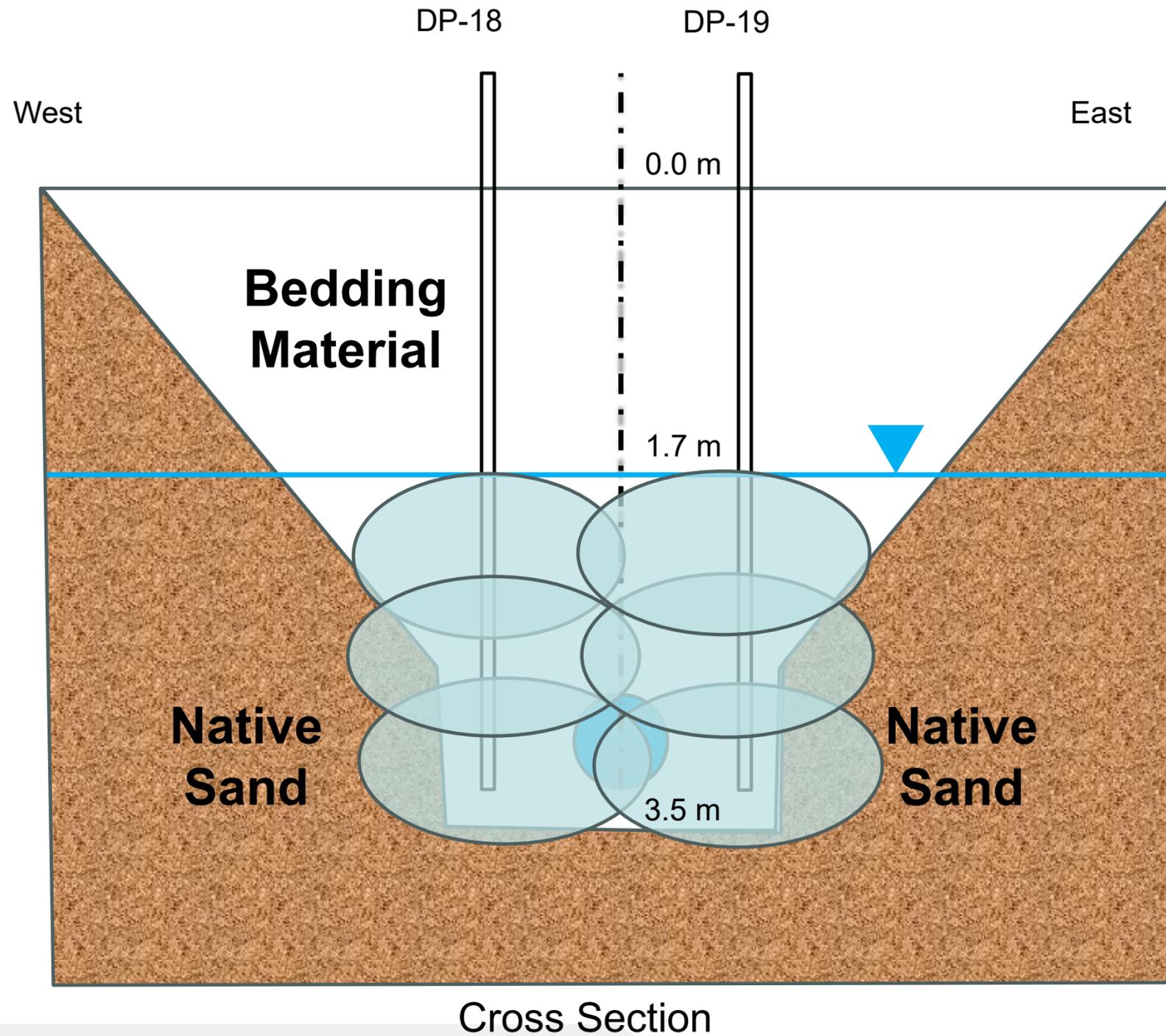
# Pilot-Scale Work

## Injection Activities:

- Install Reactive Zone just upstream of stormwater pipe outlet
- Work completed Oct 2023



# Pilot-Scale Work



## Injection Activities:

- Top-down injections
- Area was approx. **9 m in length** along both sides of stormwater pipe (assumed 2 m wide bedding)
- **14 injection points @ 1 m spacing** & injections from 1.8 to 3.5 mbgs
- **728 kg Fluoro-Sorb<sup>®</sup> P** in 1,680 L of suspension (~43% slurry)
- ~1.3% wt./wt. loading rate
  - Fluoro-Sorb<sup>®</sup> / Aquifer Material

# Pilot-Scale Work





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## **Case Study 1: Results**

**Did we plug the conduit with clay?**

**Did we create an effective barrier for PFAS?**

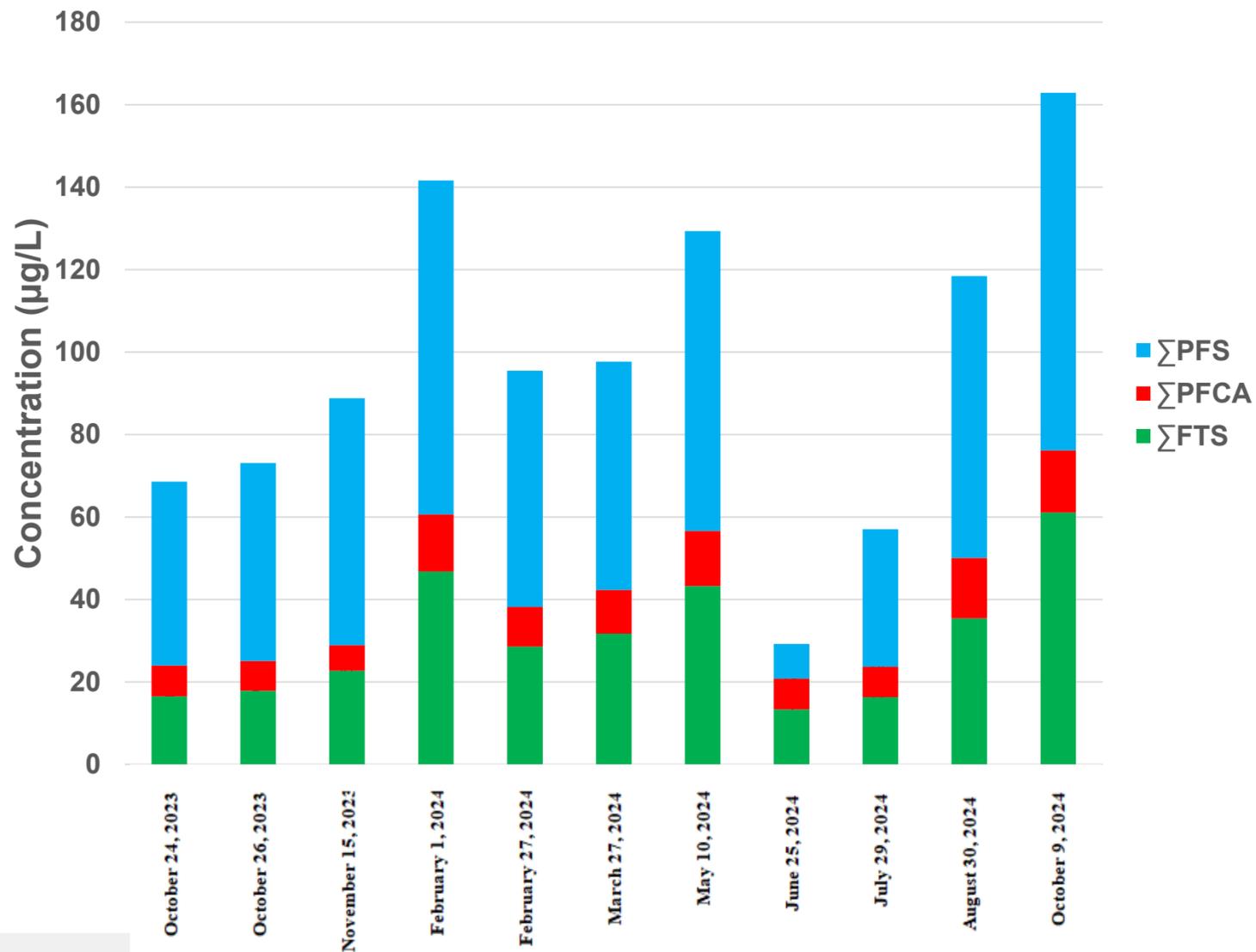
# Hydraulic Conductivity (K) Results

- Slug testing completed before, and after, the modified clay injection
- Results:
  - A small reduction in K was measured (~0.2 Order Of Magnitude)
  - Falls within slug test margin of error
  - This K reduction is considered to be small
- Great aquifer loading rates can be achieved via injection
  - 1.3% wt./wt. within the aquifer for this pilot-test
- The modified clay PRB is **not expected** to impede or redirect groundwater flow

# Monitoring Results – PRB Effectiveness

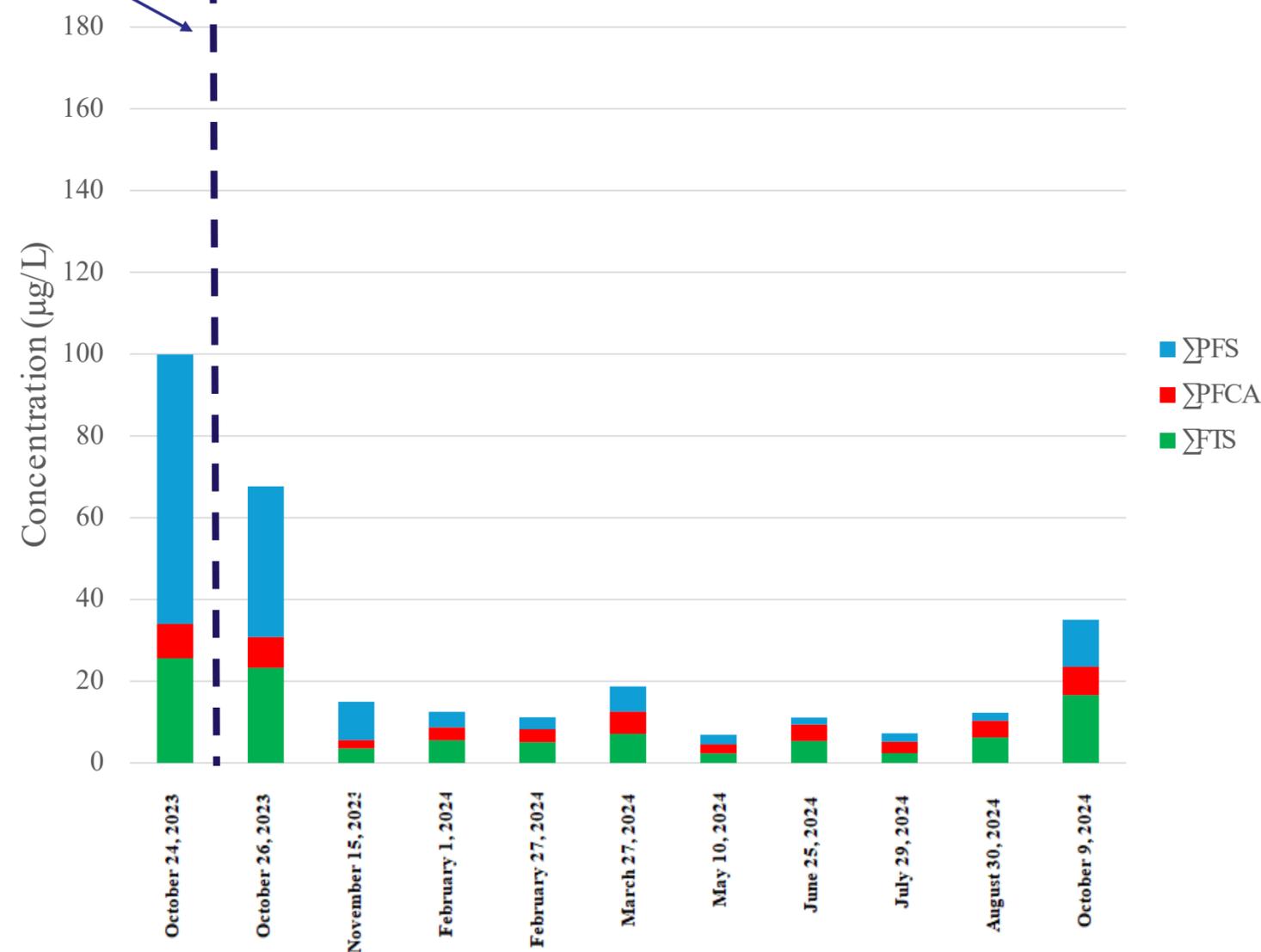
## Upgradient Zone

FFTA-23-DP-15



## Within Reactive Zone

FFTA-23-DP-18



Even with upgradient increase to >160,000 ng/L PFAS, treatment was robust (80-90% reductions)



## Closing Thoughts

- Modified Clay can be injected
  - Quick installation
  - Minimal disturbance to the Site
- PFAS concentration reductions achieved
  - Total PFAS concentrations decreased in all zones
  - Consistent 80%-90% reductions
    - even as influent fluctuated between 29,000 ng/L and 163,000 ng/L
- The world's first modified clay injection was a success!!



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## **Case Study 2: Ex-Situ Lagoon Water Treatment**

***Only 156,000,000 liters of water***

# PFAS in a Complex Treatment Situation



Lagoon Volume: 156,000 m<sup>3</sup>

- Industrial client accidentally released PFAS to sewer system
- A municipal wastewater treatment plant (WWTP) was affected
- Remediation of this WWTP lagoon was required
- Notably the lagoon water also had:
  - High Total Suspended Solids (TSS)
  - High Dissolved Organic Compounds (DOC)
  - Petroleum Hydrocarbons
  - ...and who knows what else?!

# PFAS in a Complex Treatment Situation



Lagoon Volume: 156,000 m<sup>3</sup>

## Problems

- Total PFAS concentrations were about 200 ng/L
- Total DOC was about 34,000,000 ng/L
- Issues to Overcome:
  - PFAS is an emerging contaminant. How to treat?
  - DOC was dominant in the water matrix
  - Could PFAS rollover from adsorptive media be significant?

## Solutions

- Coagulation and Flocculation for TSS & DOC
- Identifying the best technology for PFAS removal



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## **Case Study 2: Bench Scale Testing**

**How do we ensure the 200 ng/L of PFAS get picked out of this haystack of contaminants and confoundants?**

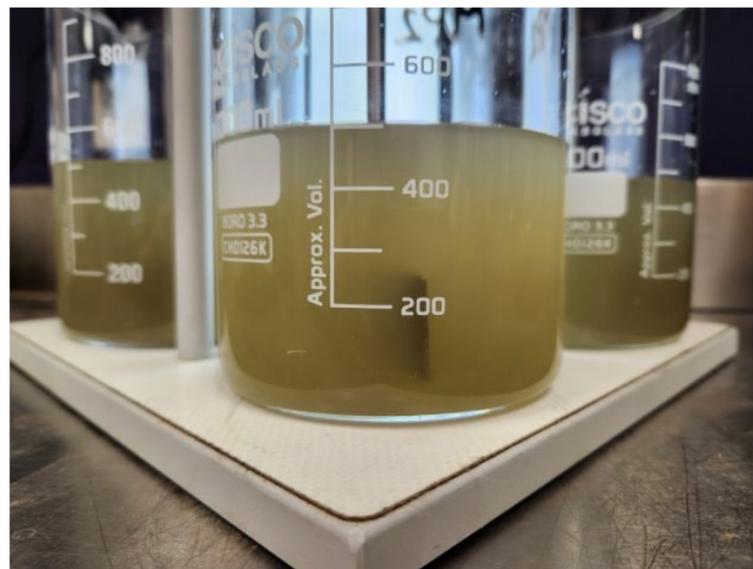
# PFAS Bench-Scale Testing – TSS & DOC Reduction

## Step 1) Upfront Solids Removal

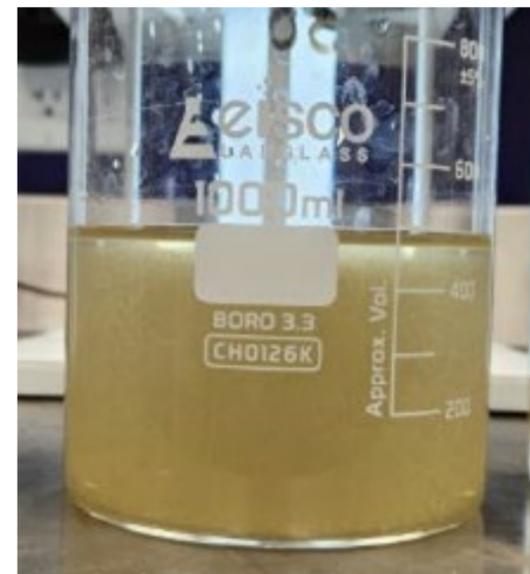
Variety of chemical coagulants and flocculants were tested at a range of doses

Objective is TSS & DOC reduction (TSS = Total Suspended Solids, DOC = Dissolved Organic Carbon)

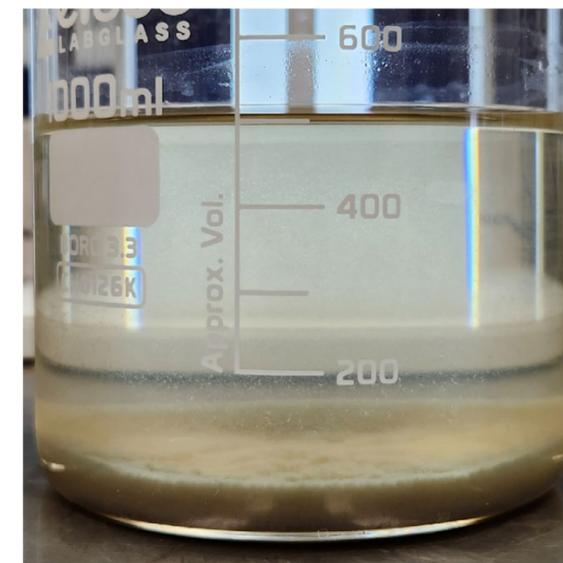
Original Lagoon Water



Coagulant



Coagulant (after 5 min)



Flocculant (after 1 min)



### Results:

Turbidity from 100 FAU to 0 FAU after 60 min settling time

31% decrease in DOC concentrations (34 mg/L to 23.5 mg/L)

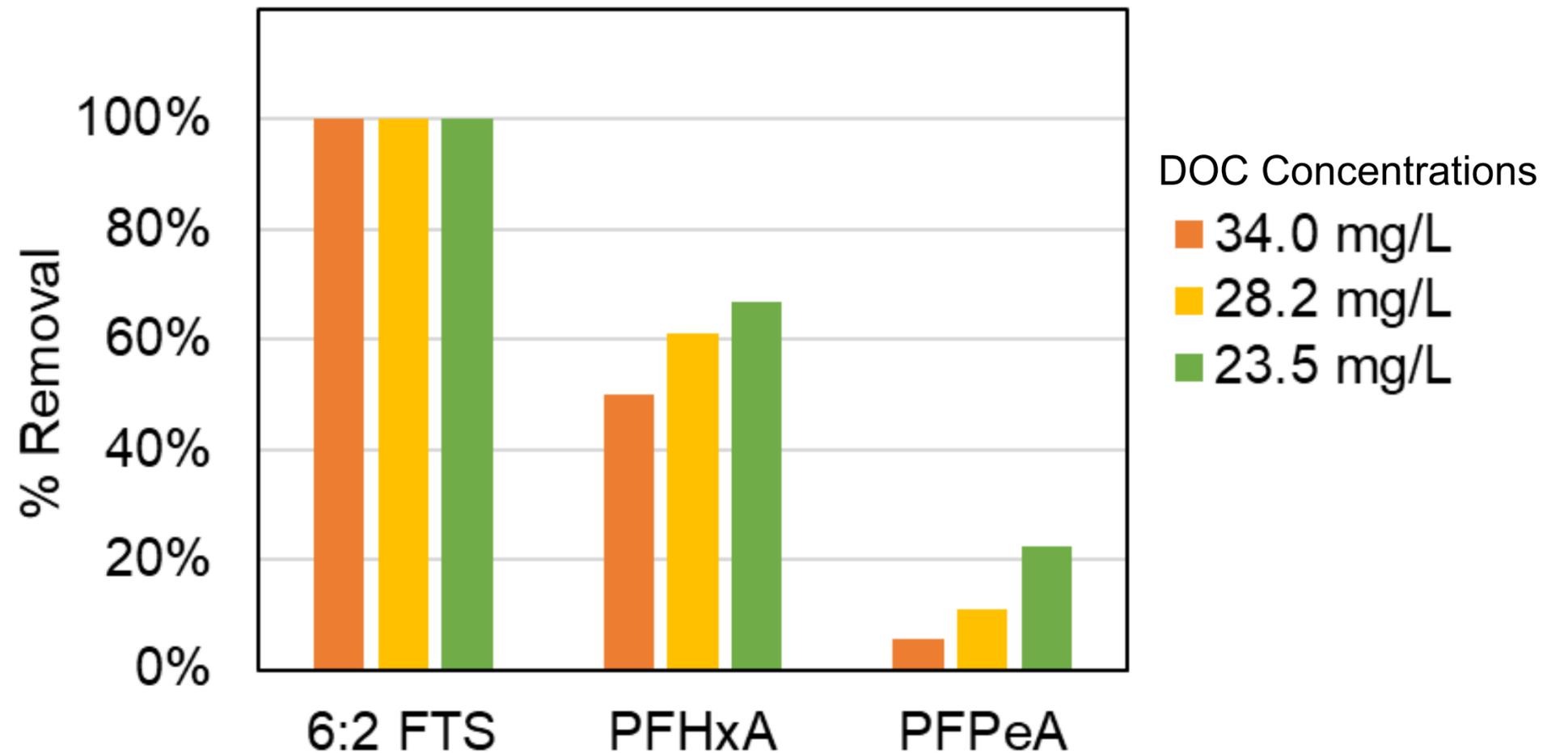
# PFAS Bench-Scale Testing – TSS & DOC Reduction

## Step 1) Upfront Solids Removal

PFAS Removal at different DOC (dissolved organic carbon) concentrations

### Concentration Comparison

23,500,000 ng/L to  
34,000,000 ng/L DOC vs  
200 ng/L PFAS



Only 6% reduction  
in PFPeA concentrations  
at 34 mg/L DOC

# PFAS Removal Technology



Lagoon Volume: 156,000 m<sup>3</sup>

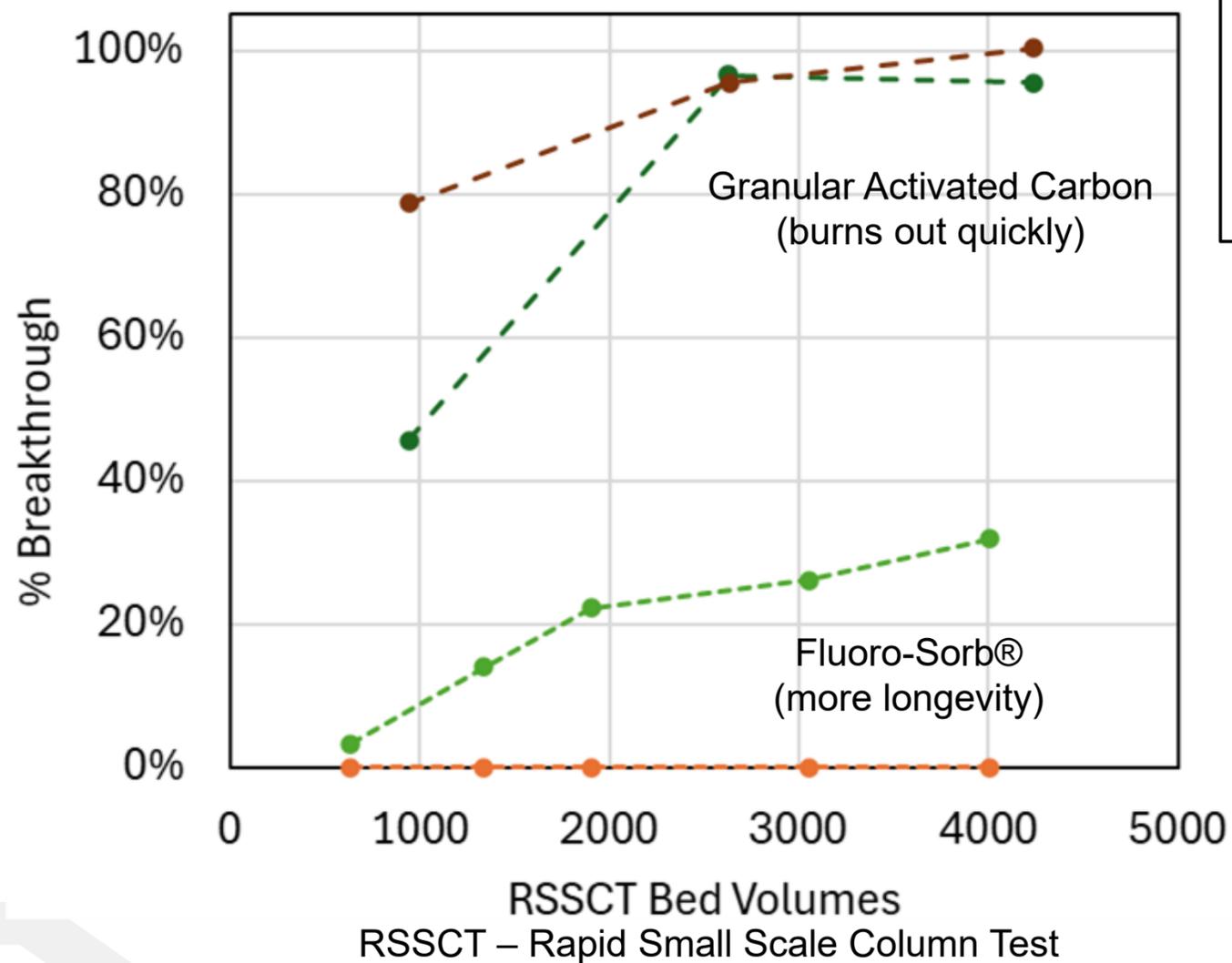
- Technologies considered:
  - Ion Exchange (IX) and Reverse Osmosis (RO)
    - but Lagoon water expected to lead to fouling problems
  - Granular Activated Carbon (GAC), selected
  - Modified Clay Amendment, Fluoro-Sorb®, selected
  - Foam fractionation, selected
- Ultimately adsorption was most practical at full-scale:
  - VEI worked with media suppliers for estimates
  - Bench-scale testing: To confirmed media capacity

# PFAS Bench-Scale Testing – Column Study (RSSCT)

## Step 2) Dissolved Phase Treatment

Bench-Scale Column Tests (RSSCT - Rapid Small Scale Column Test)

Assessing Activated Carbon vs Modified Clay (Fluoro-Sorb®)



### Results:

- Fluorosorb significantly outperformed GAC
- But the complex water chemistry led to both media under-performing expectations

- PFHxA - GAC Granular Activated Carbon
- 6:2 FTS - GAC Granular Activated Carbon
- PFHxA - FS Fluoro-Sorb® (Modified Clay)
- 6:2 FTS - FS Fluoro-Sorb® (Modified Clay)

# PFAS in a Complex Treatment Situation: Bench-Scale Results



Activated Carbon



Modified Clay  
(Flurosorb)

- Activated carbon was not used in the final full-scale design
- GAC was not economically viable (it burns out too quickly)
- And the full-scale design for the modified clay changed significantly
- Without considering bench results, the original design estimated:
  - 11,000 lbs (5,000 kg) of Fluoro-Sorb®
  - 750 litres per minute treatment flow
- After bench-scale testing:
  - 392,000 lbs (178,000 kg) of Fluoro-Sorb®
  - 2,200 lpm treatment flow

This is **35 times**  
as much media

# PFAS Full-Scale Installation



# PFAS Full-Scale Installation





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## **Case Study 2: Results**

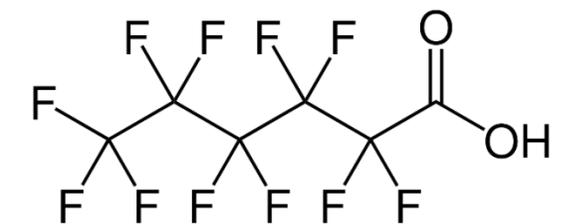
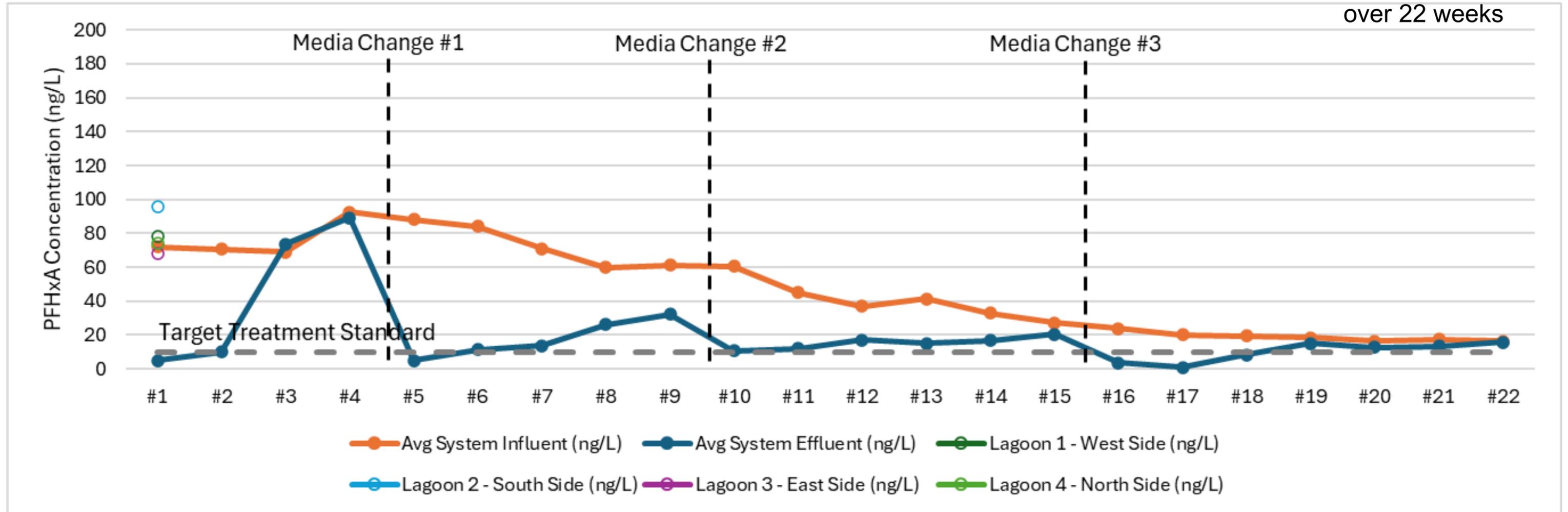
**Were we successful at pulling needles from the haystack?**





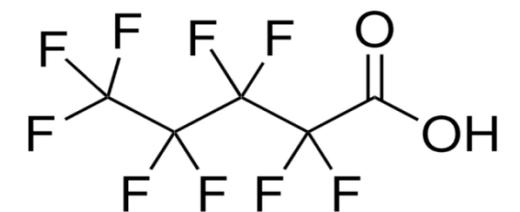
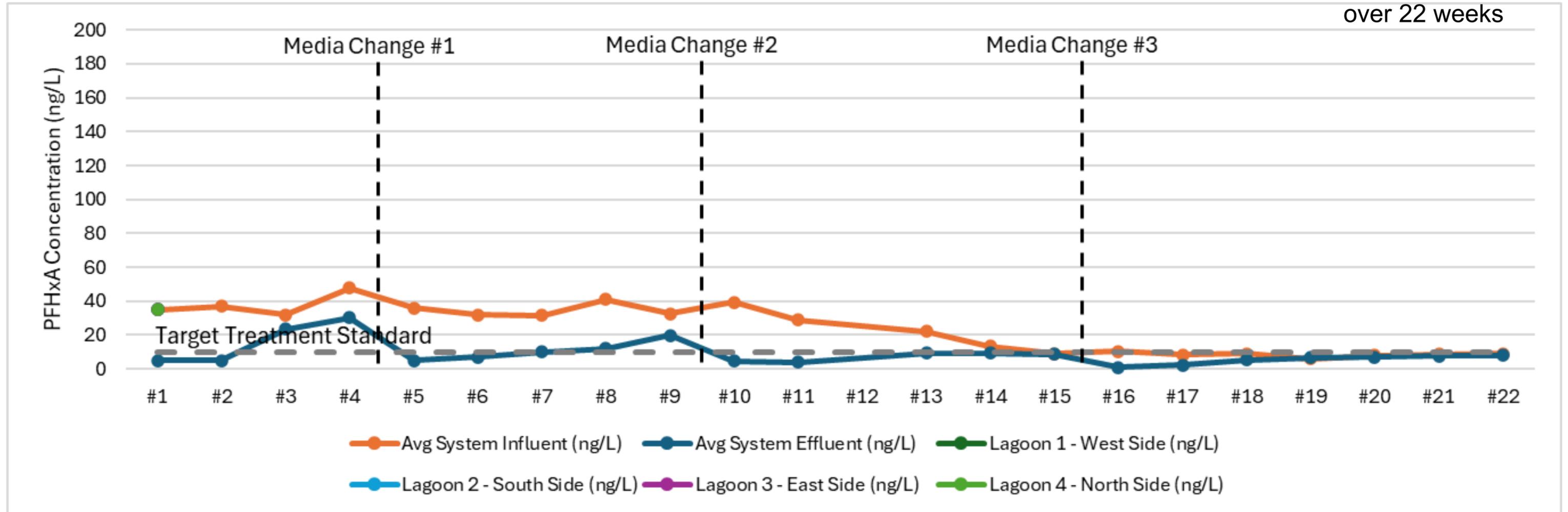
# PFAS Full-Scale Results – PFHxA

650,000,000 L treated  
over 22 weeks



# PFAS Full-Scale Results – PFPeA

650,000,000 L treated  
over 22 weeks



# Case Study 2 Summary



- Bench-scale batch reactors helped to define:
  - DOC and PFAS interactions
  - PFAS roll over challenges
  - Helped to define type of media to use
- Full-Scale:
  - Treated over 90% of the PFAS in the lagoon
  - Was successful because of the bench testing
  - Work was ultimately completed under budget

# Final Thoughts

- Our industry is still navigating the evolving regulatory landscape and various treatment methods
- Bench-scale testing is highly recommended
- PFAS treatment can be achieved in-situ or ex-situ
- When weighting options for PFAS remedial treatment methods: Fluorosorb has an advantage





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# Questions?

