Installation, Startup and Operation of the World's First Regenerable Resin System for PFAS Removal

Presented by: Steve Woodard, PhD, PE - ECT

Co-authored by: Rob Singer, PE - Wood EI&S

Presentation outline

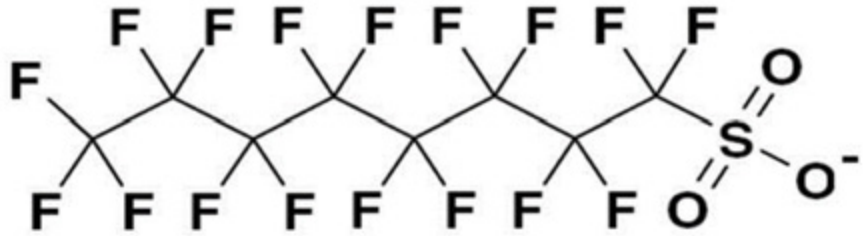
- Site history & background
- How does ion exchange resin remove PFAS?
- Pilot test at Pease AFB former FTA (Site 8)
- Full-scale design and implementation
- PFAS removal results
- Lessons learned
- Drinking water pilot test
- Summary

Site history and background: Former Pease AFB

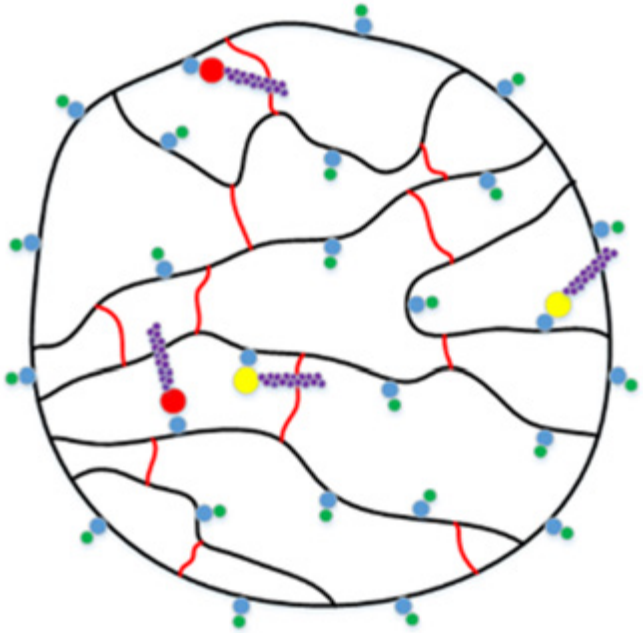
- ✓ History of Site and circumstances leading up to action
  - Sampling in 2014- first detected in drinking water well
  - Receptor survey- complete pathway to on-site day care and off-site residents
  - AOC issued in 2015- August
    - ✓ Citing the SDWA
    - ✓ Interim Emergency Actions and design build and operate of remediation systems within 8 and 16 months
    - ✓ New criteria in May 2016
- ✓ 2019-
  - ✓ Two mitigation systems operating along with one DW treatment system
  - ✓ PFAS Blood Testing Program
  - ✓ Risk assessment and remediation

How does Ion Exchange resin remove PFAS?

Dual mechanism of removal: IEX and adsorption



PFOS Molecule



Simplified Resin Bead

Polystyrene polymer chain

Divinylbenzene crosslink

Fixed ion exchange group, e.g., quartenary ammonium, $-\equiv N^{+}$, for anion IEX

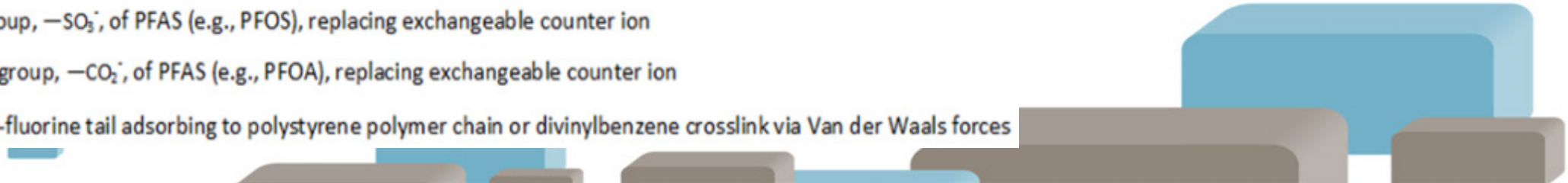
Exchangeable counter ion, e.g., chloride ion, Cl-, for anion IEX

Sulfonate group, $-SO_3^-$, of PFAS (e.g., PFOS), replacing exchangeable counter ion

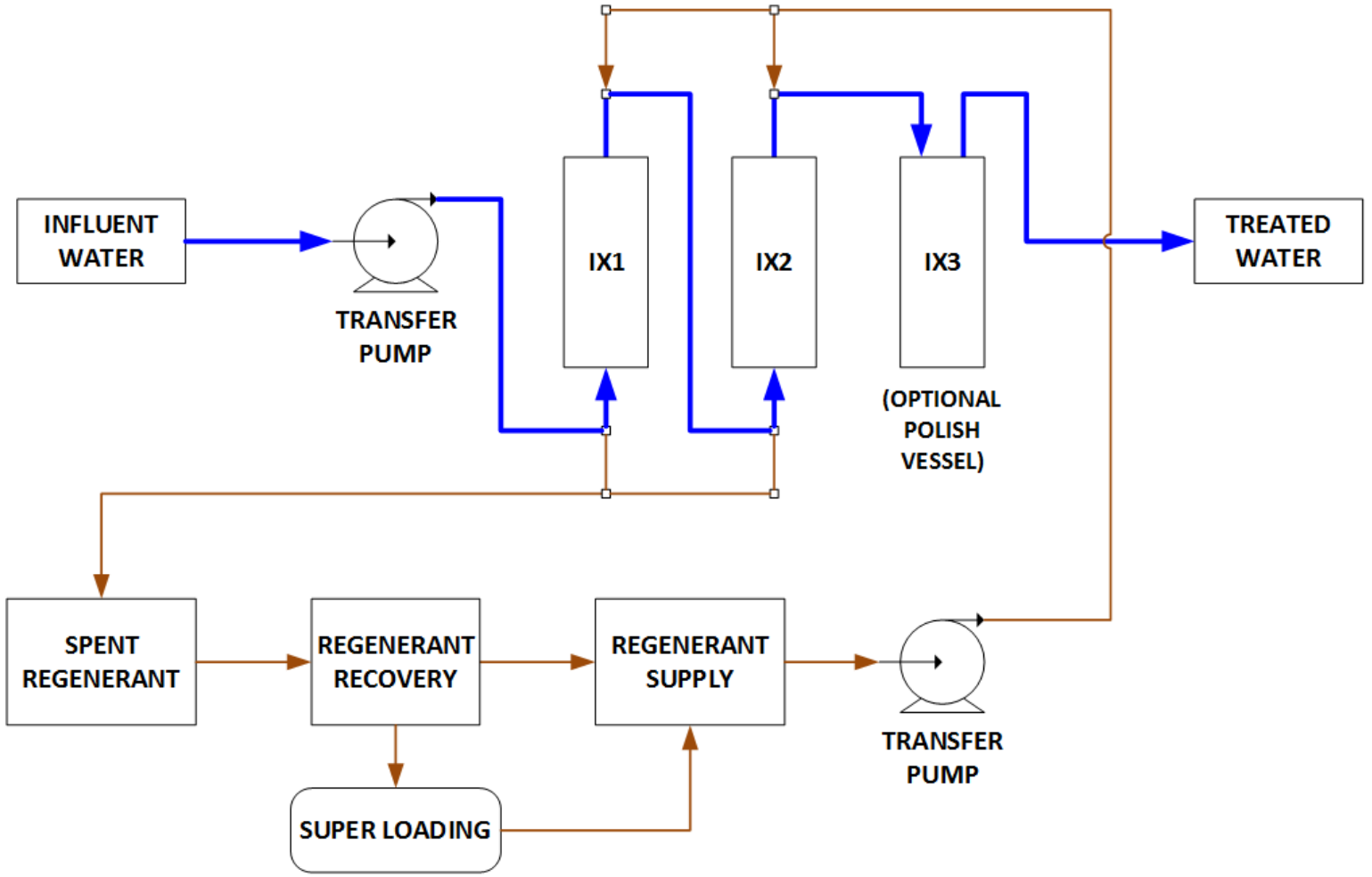
Carboxylate group, $-CO_2^-$, of PFAS (e.g., PFOA), replacing exchangeable counter ion

PFAS carbon-fluorine tail adsorbing to polystyrene polymer chain or divinylbenzene crosslink via Van der Waals forces

GAC only has Adsorption

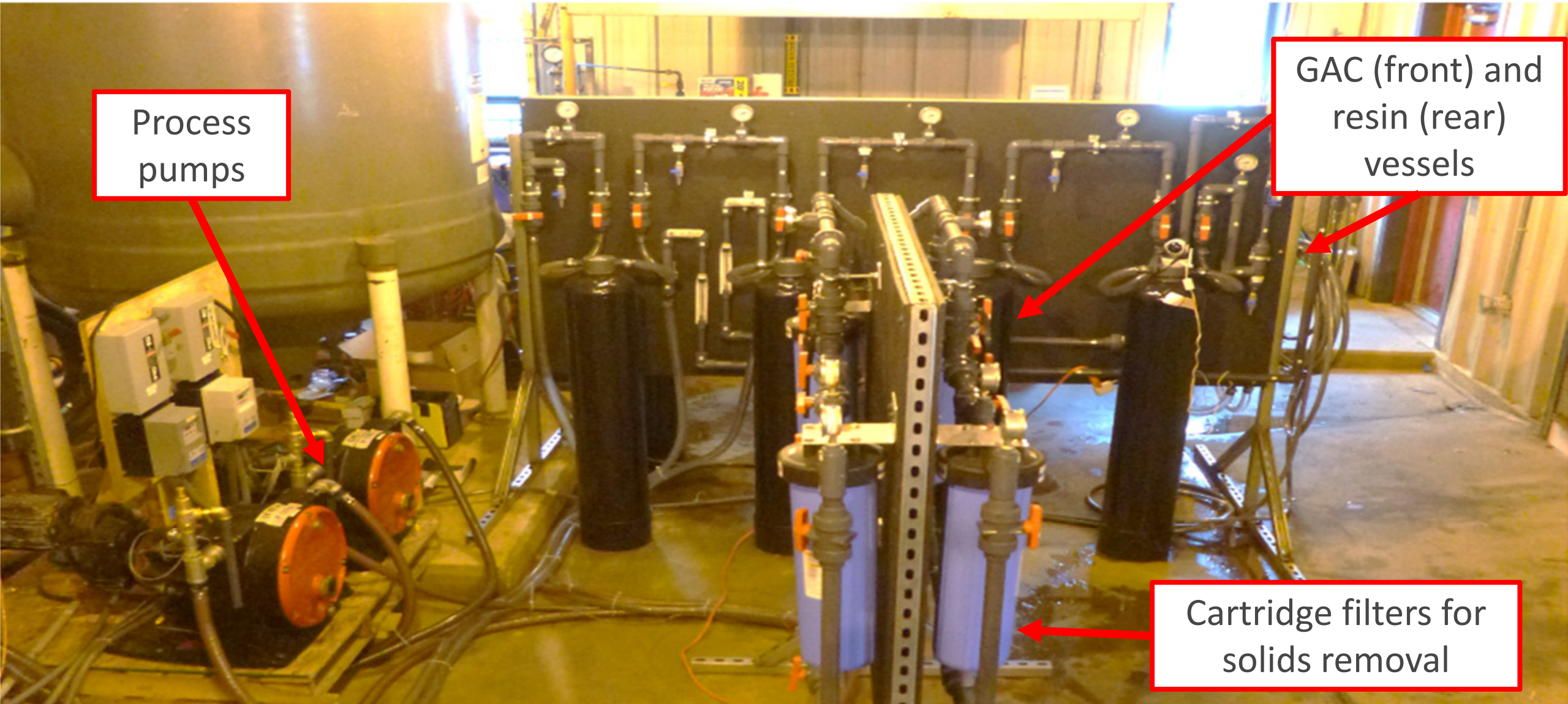


SORBIX™ A3F Regenerable Process Flow



Regenerable IEX Resin
SORBIX A3F

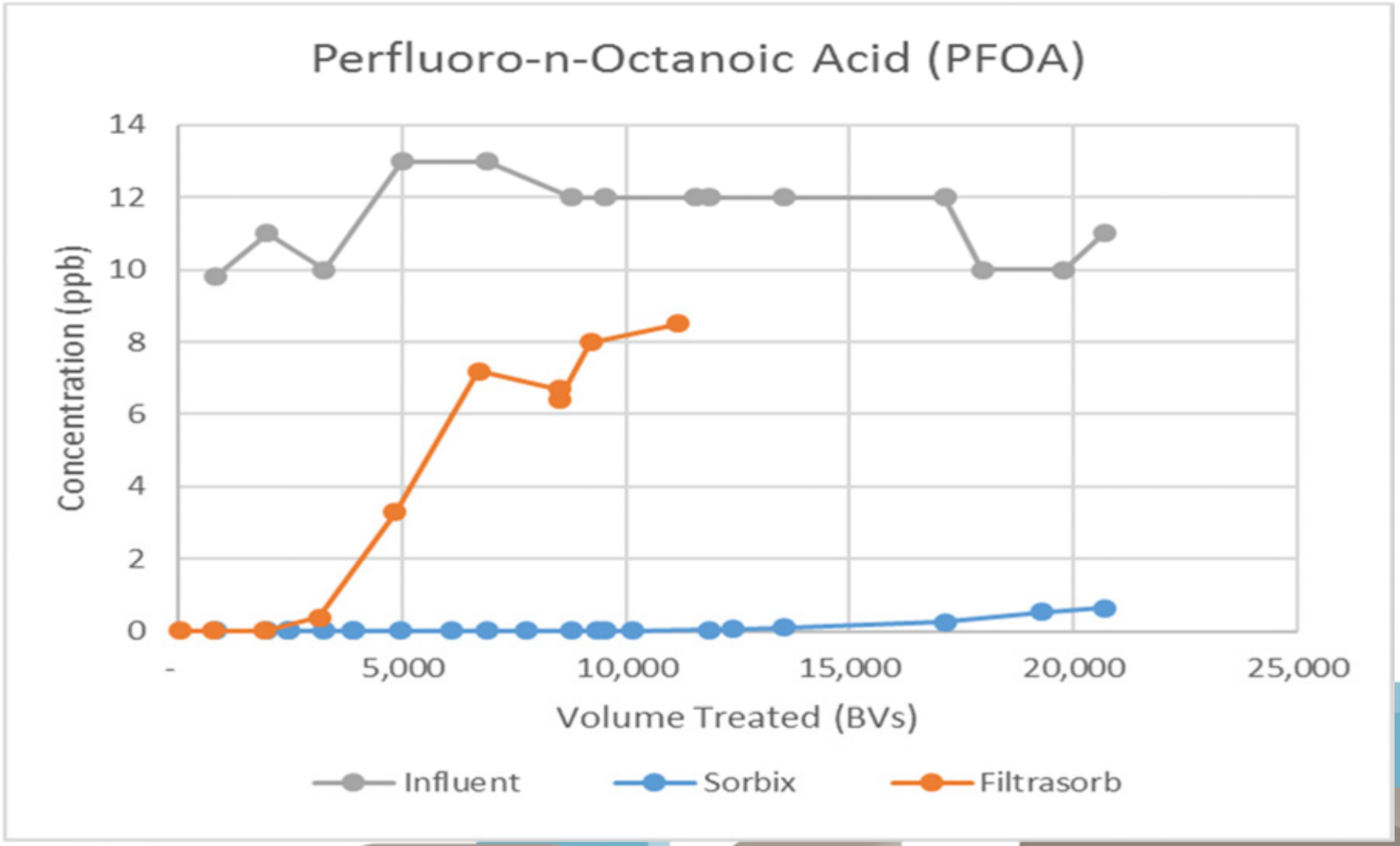
Former FTA (Site 8) pilot test: IX resin vs. GAC



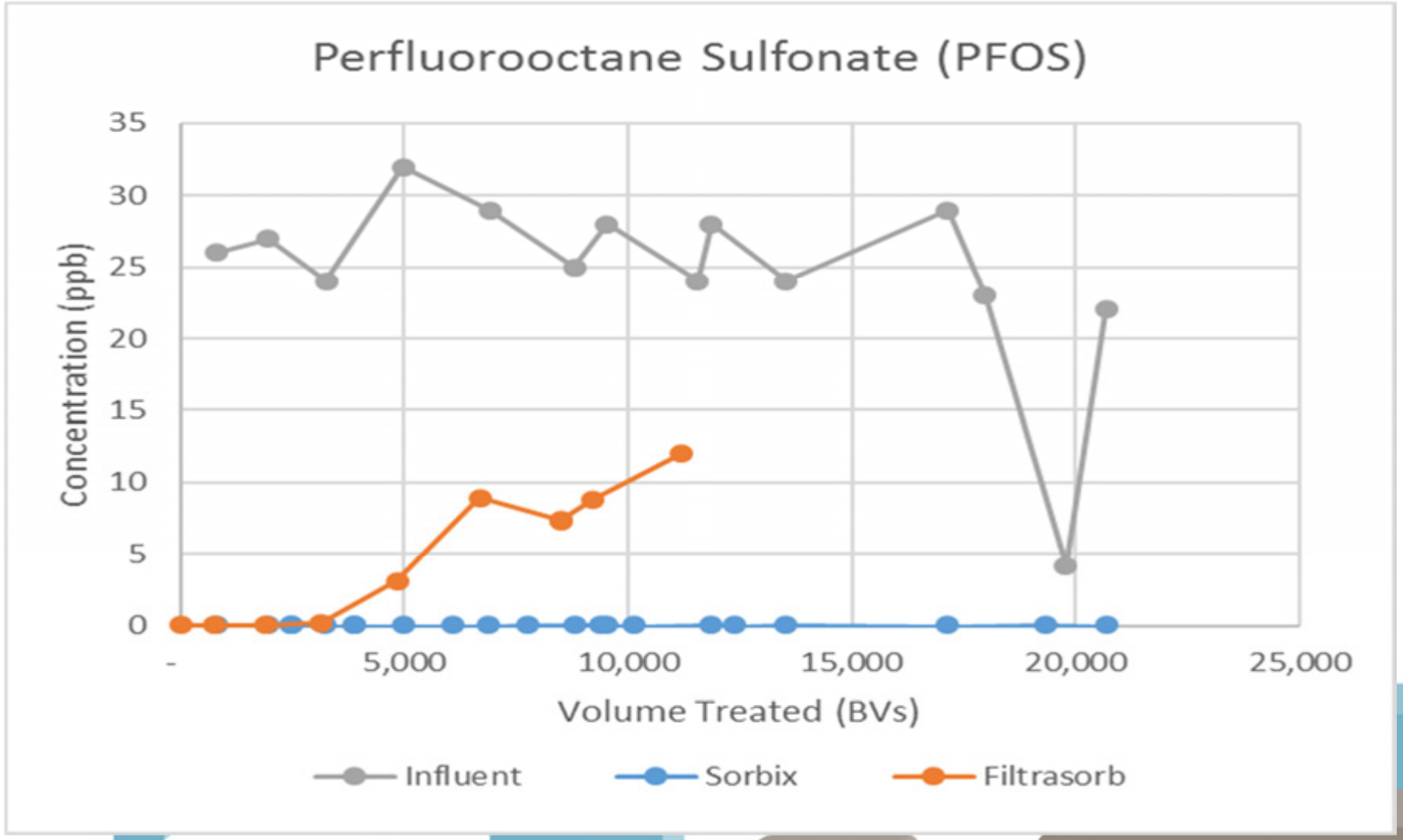
Influent PFAS concentrations

PFAS Compound	Average Influent Concentration (µg/L)
PFOA	11.5
PFOS	27.4
Other PFAS	55.6
Total PFAS	**94.5**

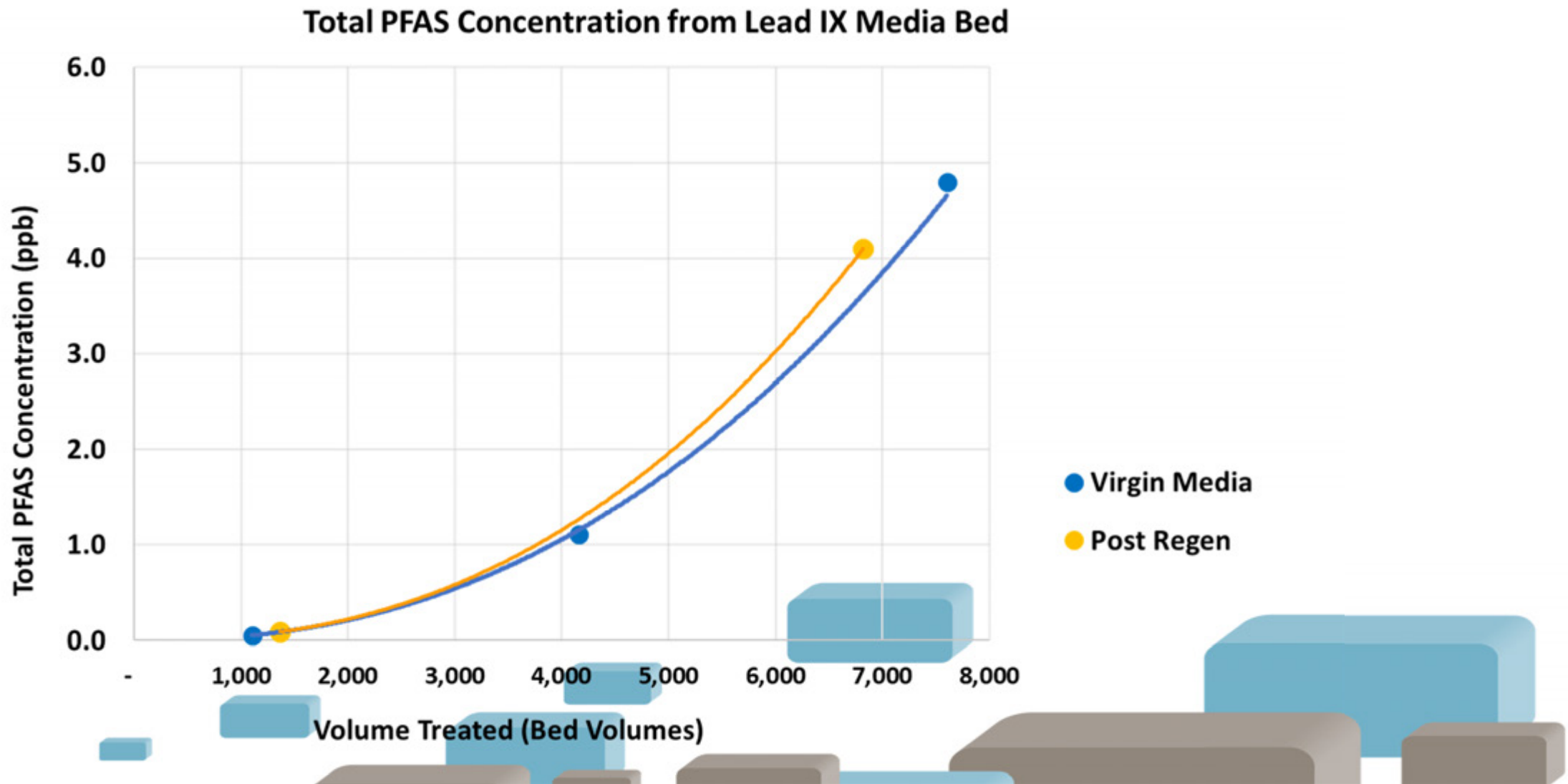
PFOA breakthrough at 5-min EBCT



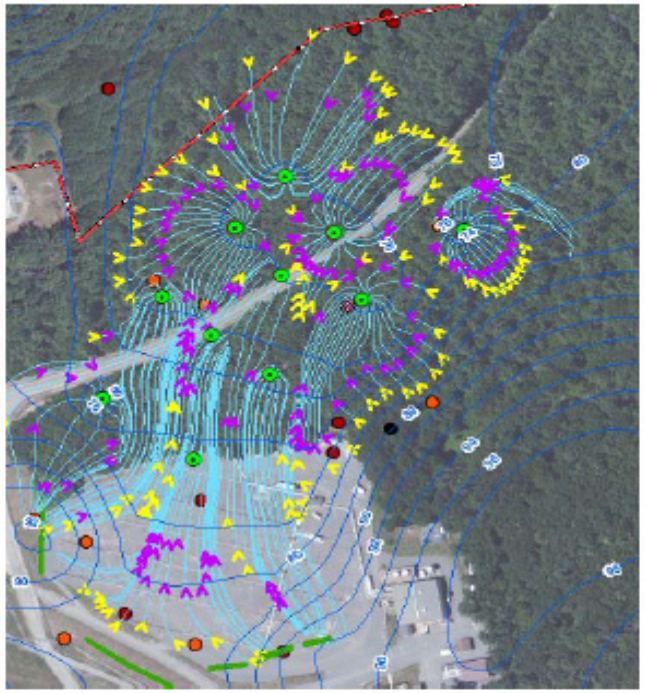
PFOS breakthrough at 5-min EBCT



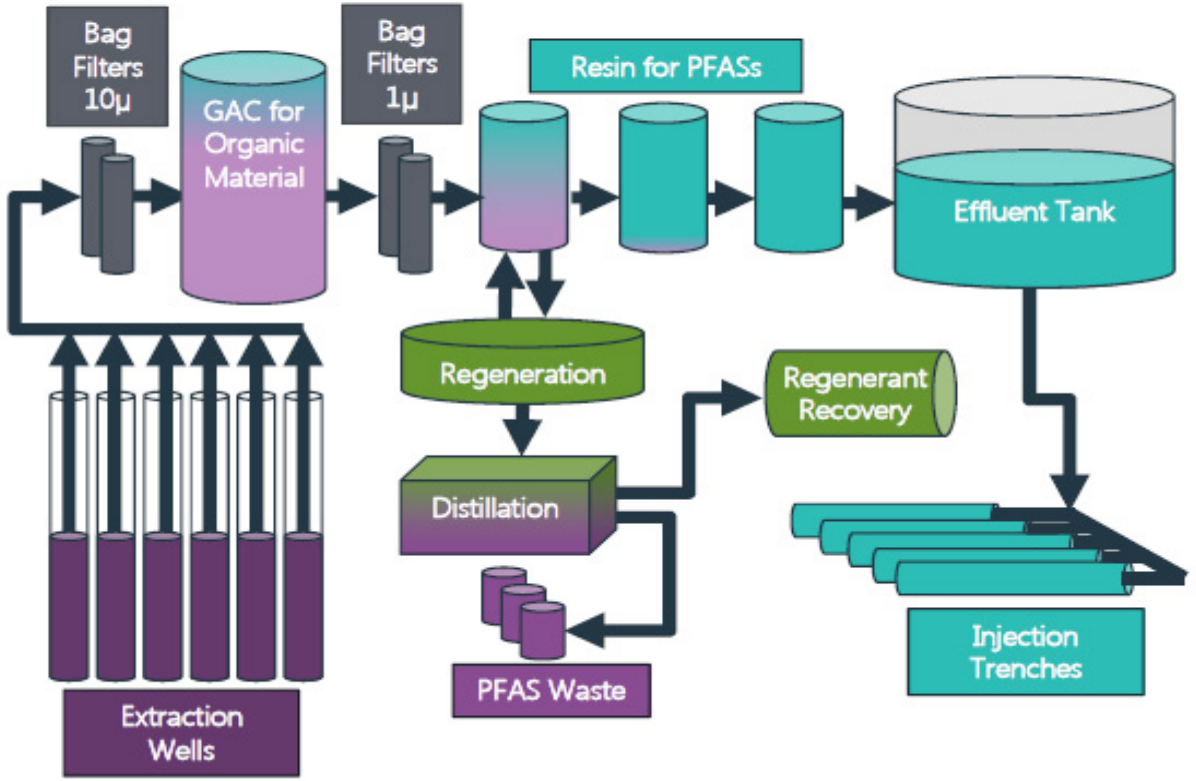
Successful regen at pilot scale



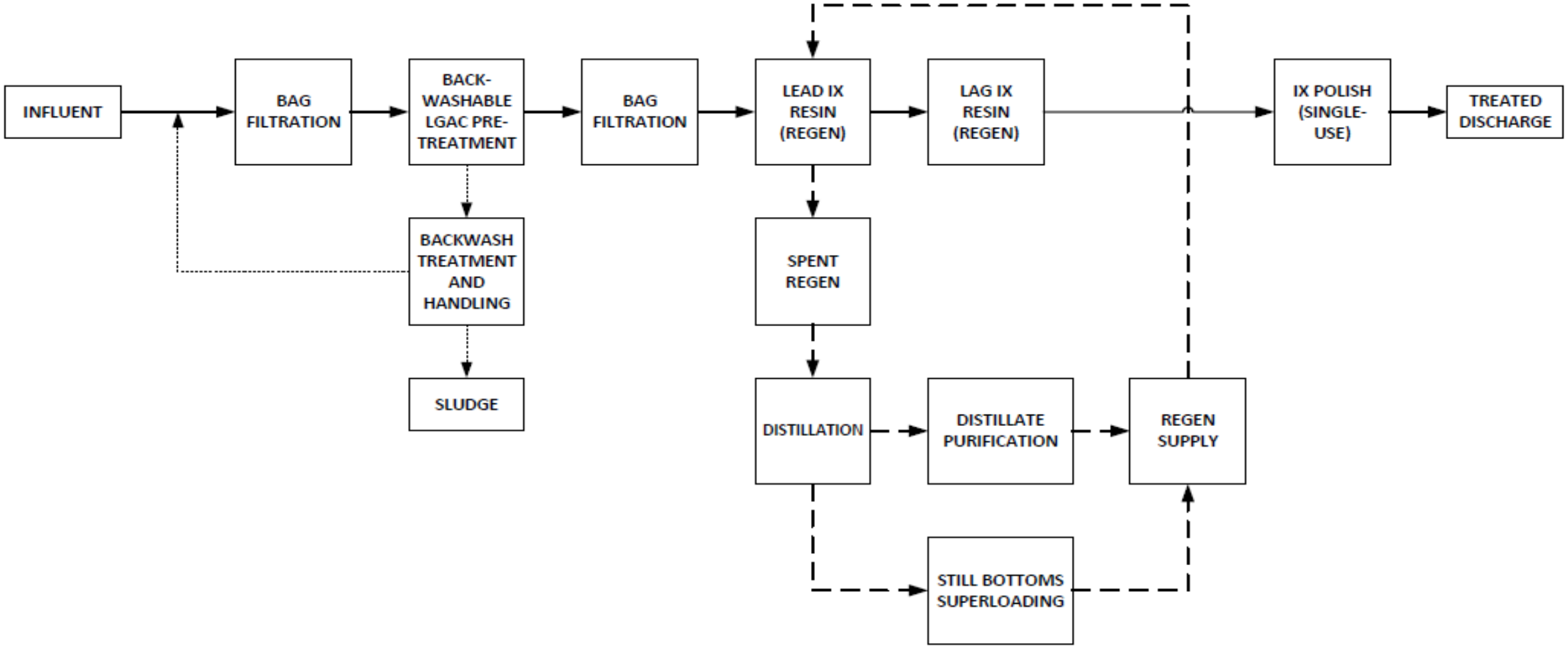
Full-scale design and implementation



- Extraction design: 110 gpm
- Treatment capacity: 200 gpm



Full-scale process flow diagram

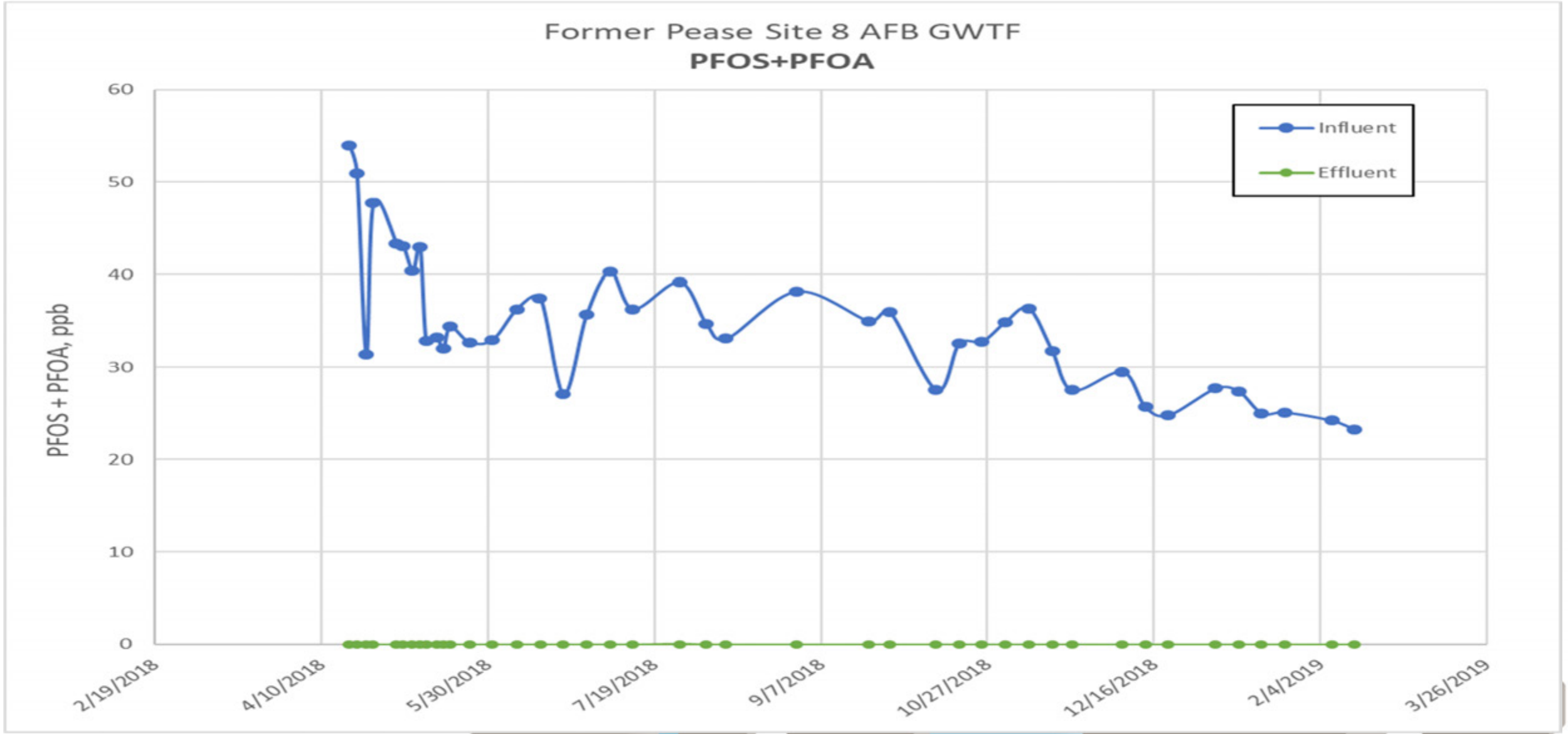


Full-scale Site 8 resin system

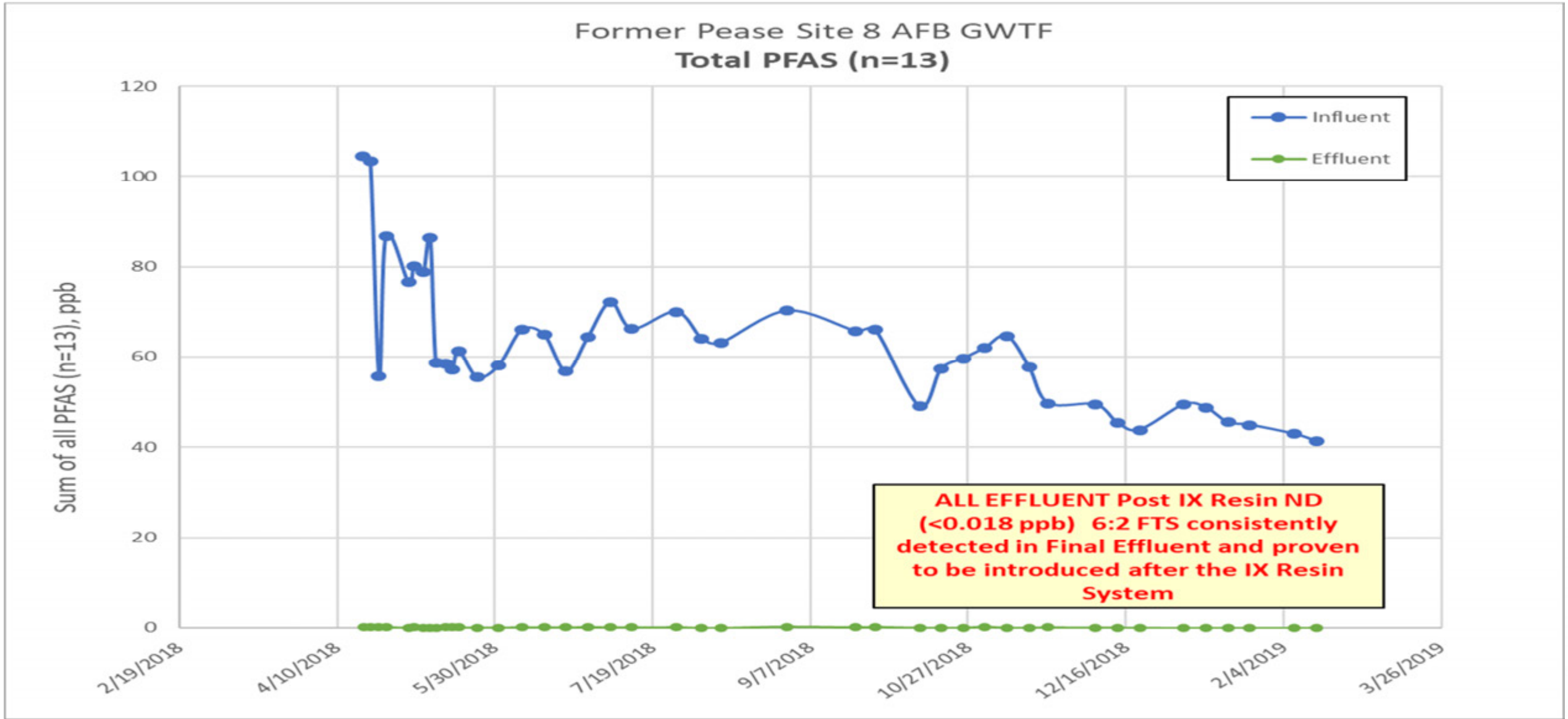
In-vessel resin regen system

Distillation for recovery/reuse of regen solution

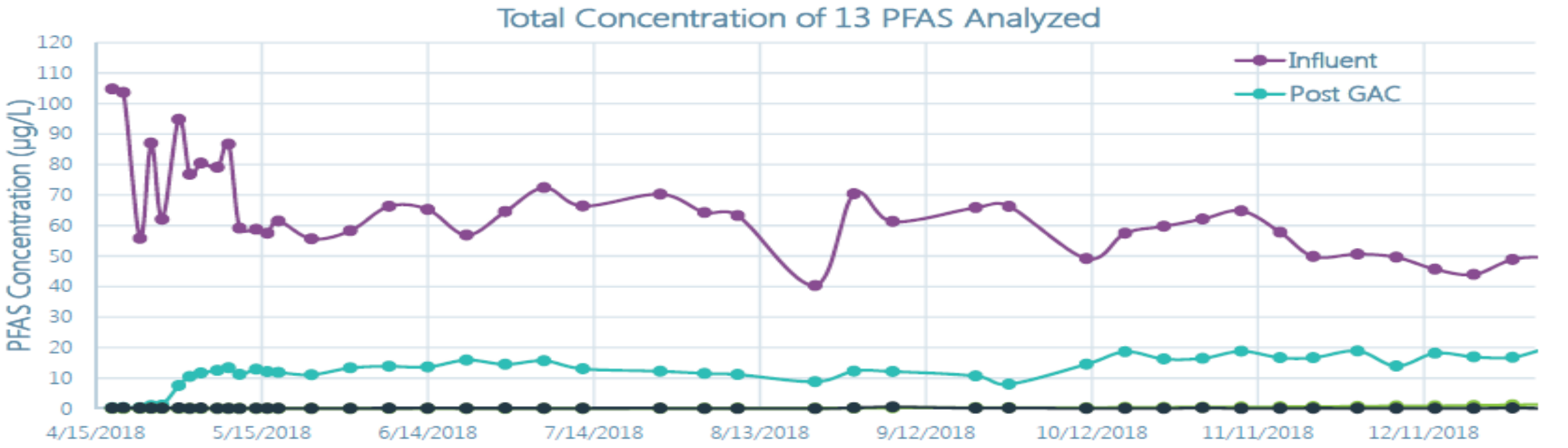
Influent and effluent PFOS + PFOA

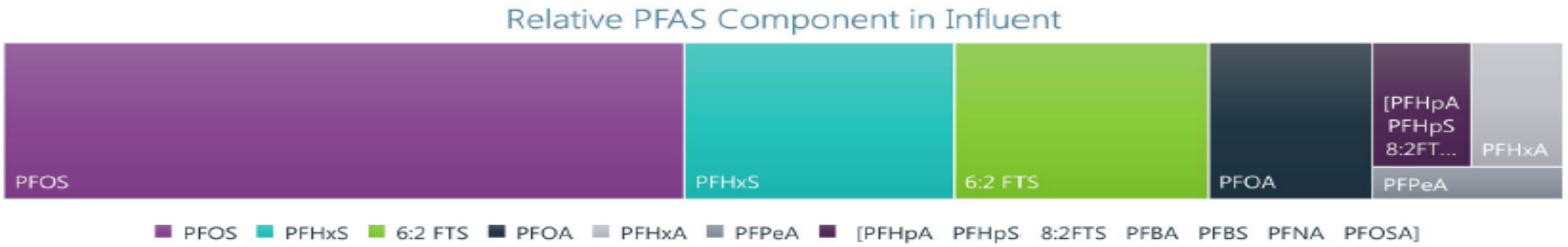


Influent and effluent total PFAS



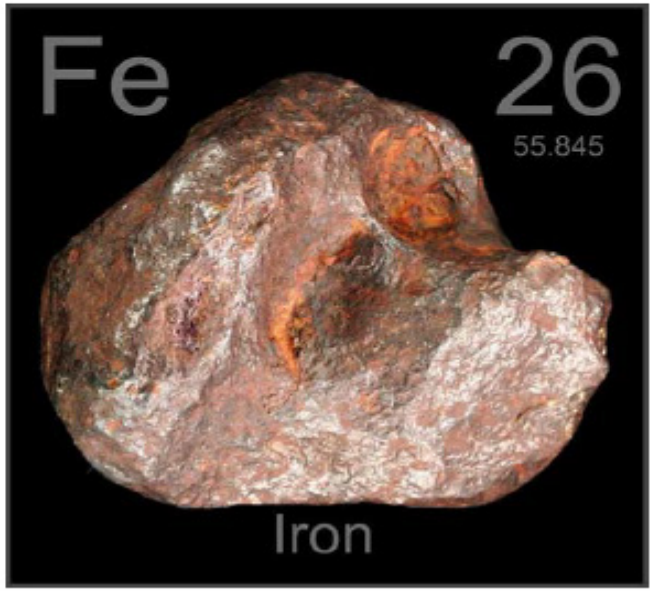
Breakdown of PFAS compound removal





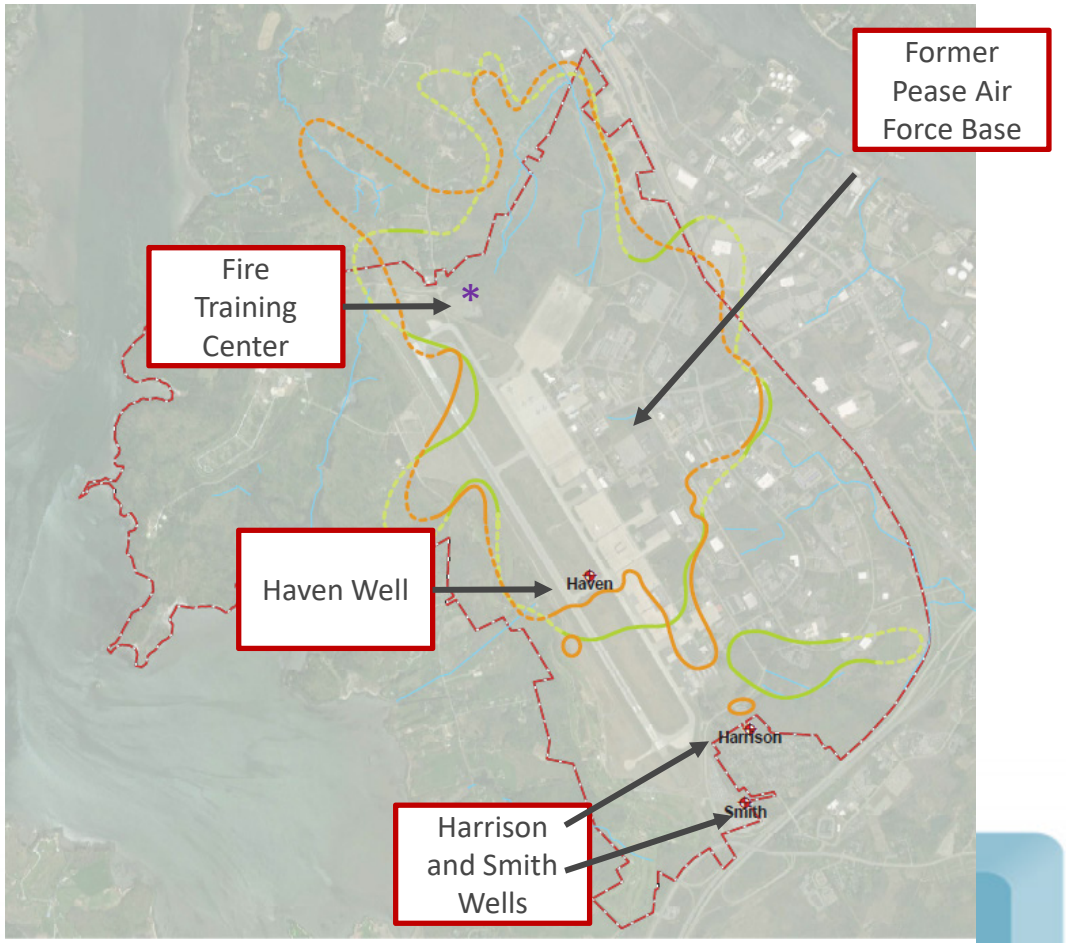
Challenges and lessons learned

- Iron fouling at the front end of the plant
- Iron <0.5 mg/L during initial pumping tests of three wells
- Iron >8 mg/L with ten wells operational
- Required shutdown of seven wells



PFAS contamination of City of Portsmouth water supply

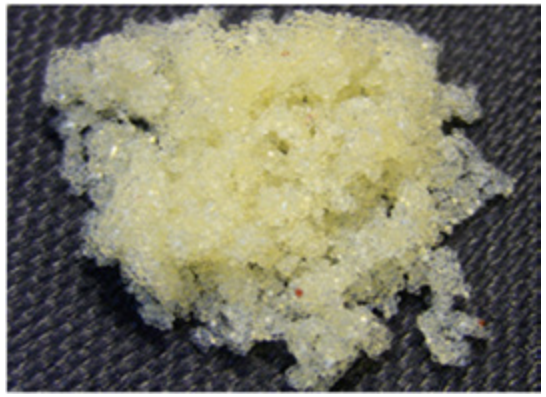
- **April 2014** – NHDES contacts **City of Portsmouth** to sample the three Pease Tradeport water system wells for PFAS due to detections at former Fire Training Center and past use of AFFF
- **May 12, 2014** – City staff are notified that PFAS levels in Haven Well exceeded the EPA's Health Advisory Standard for PFOS
  - 2,500 ppt (Preliminary Health Advisory = 200 ppt)
- **May 12, 2014**
  - Haven Well is shut down
  - Smith and Harrison wells remain in service
  - Portsmouth water supplements water lost from Haven Well



Map courtesy of Air Force Civil Engineering Center

Pilot test at Haven Well

ECT's SORBIX single-use resin versus Activated Carbon



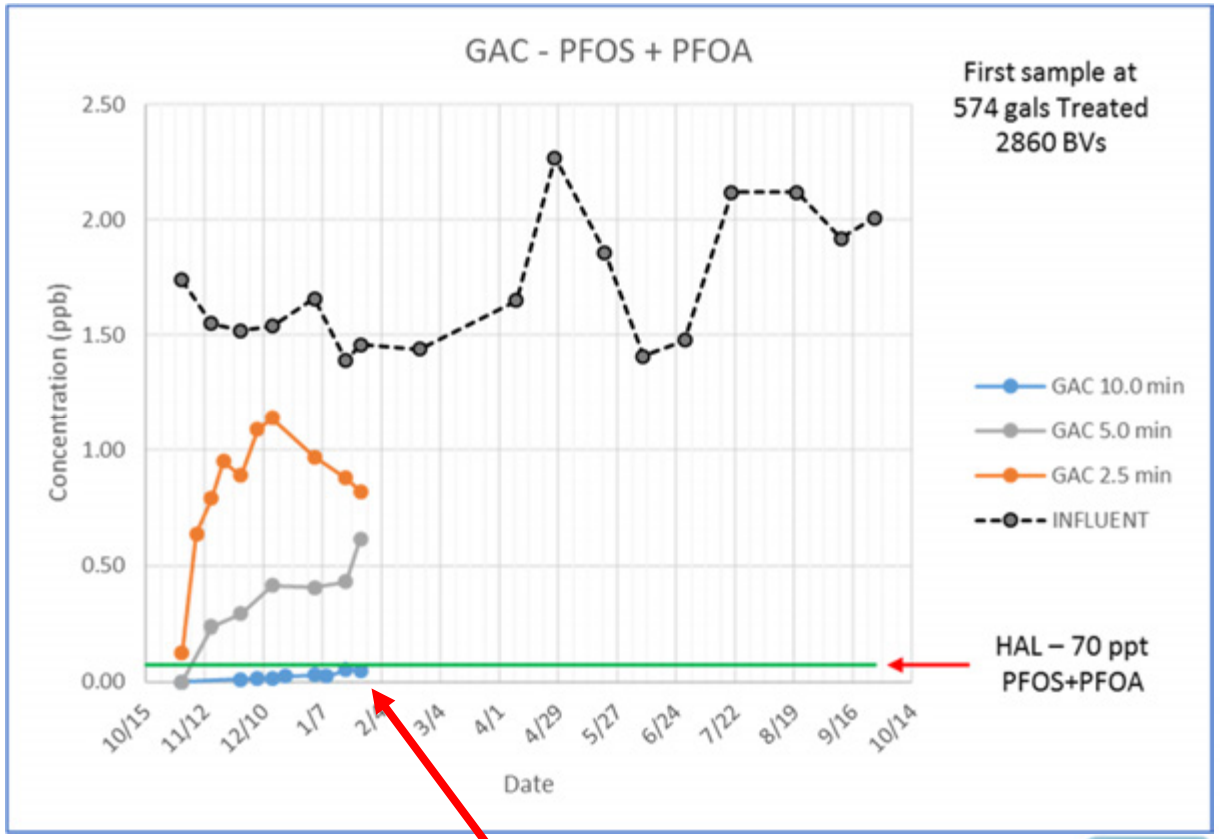
Side by Side test

Inlet PFAS = 3,000 ng/l

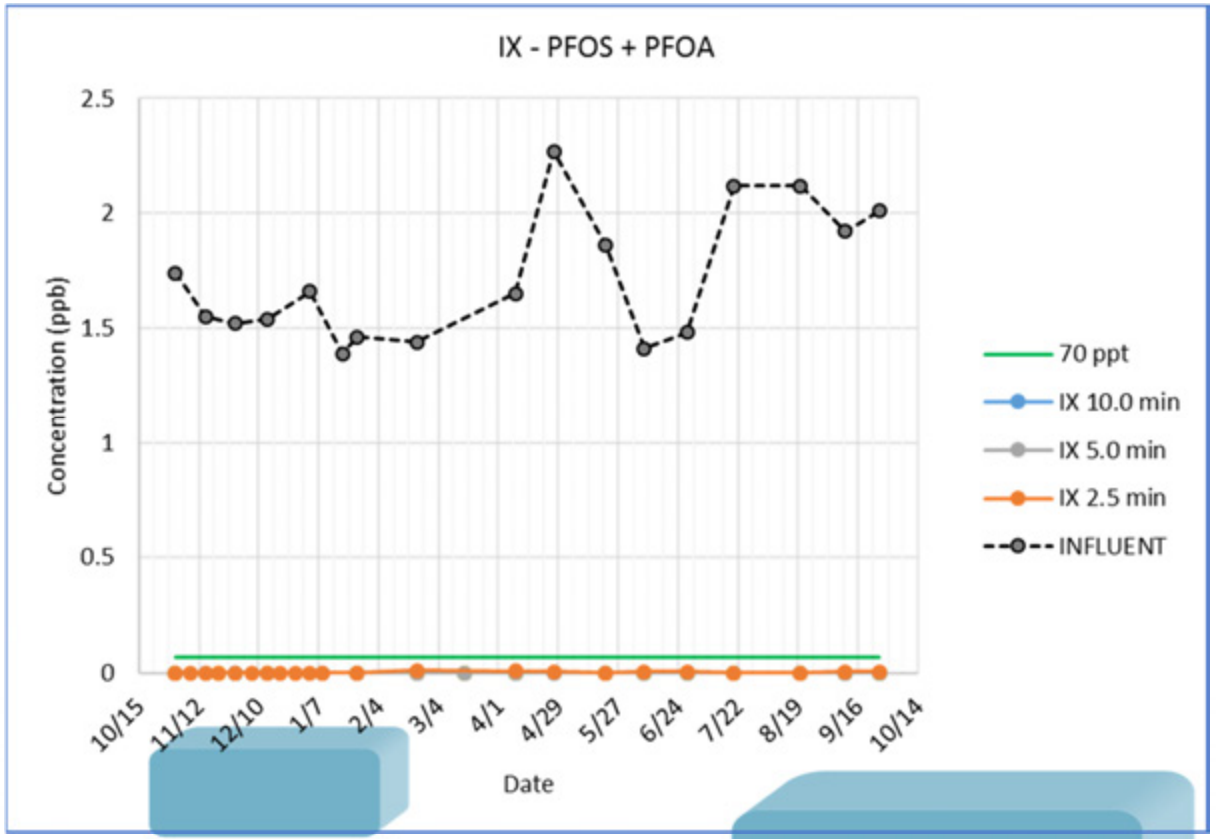
Public water supply, Portsmouth, NH USA

Removal Comparison – PFOA + PFOS

GAC



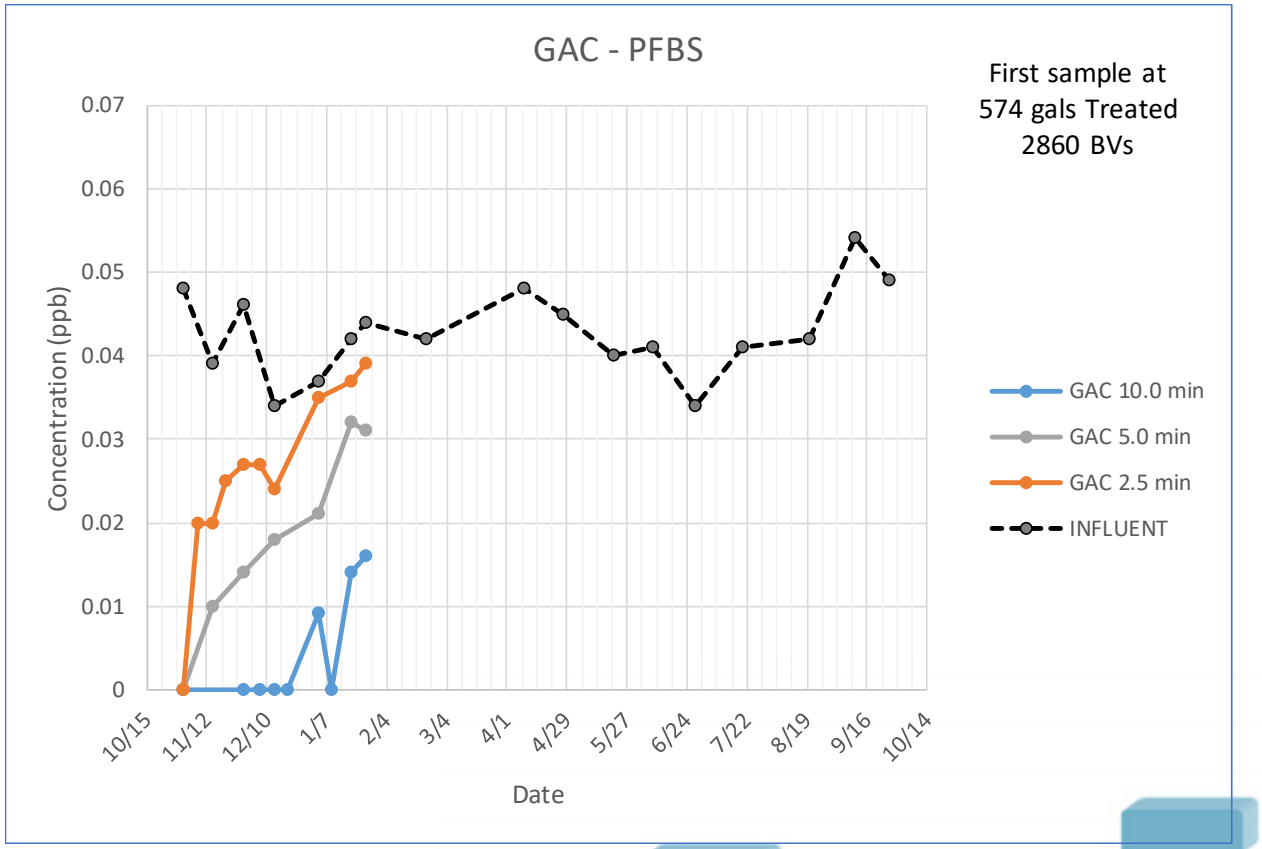
IX Resin



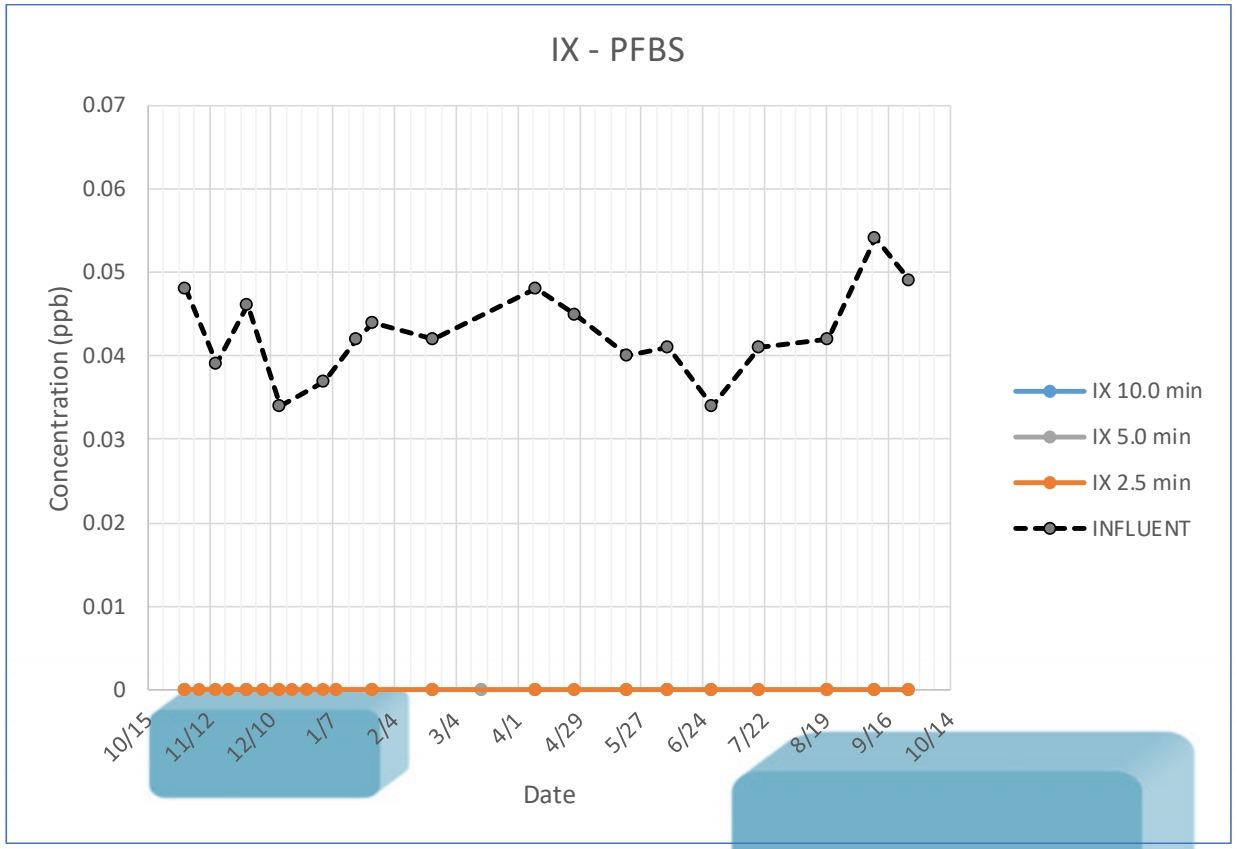
City Stopped GAC at 10,400 gal Treated

Short Chain Sulfonic Acid - PFBS

GAC



IX Resin



Summary & conclusions

- The regenerable resin system is very effective at treating waters impacted by PFAS
- The ability to regenerate on site, coupled with distillation and super-loading greatly reduces waste generation and provides protection against fluctuations in PFAS concentration
- The technology reduces the liability associated with transporting waste offsite
- Single-use IX resin significantly out-performed GAC in a head-to-head pilot test on the Haven Well drinking water supply
- The combination of regenerable and single-use resin systems can be a powerful combination to provide both source zone PFAS remediation and drinking water treatment

Thank you!

Steve Woodard
207-210-1551
swoodard@ect2.com