From Bench Test to Reality:
Comparing Operations of Full-Scale PFAS Treatment Facilities to Preliminary Bench Scale Test Results

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LAKEWOOD WATER DISTRICT

Kennedy Jenks

WQTS
Water Quality & Treatment Solutions, Inc.
An environmental engineering and science consulting company

emwd EASTERN MUNICIPAL WATER DISTRICT

Outline

- Background
- PFAS Treatment Alternatives
- GAC Bench Testing
- Full Scale Design
- Full Scale Results
- Summary

Background: What are PFAS?

CHEMICAL

- Long name: Per- and polyfluoroalkyl substances
- Long chain: PFOA and PFOS
- Short chain: 12+
- ~6,300 compounds

SOURCE

- Man-made
- **Fire-fighting foams**
- WWTPs
  - Teflon pans
  - Textiles
  - Cleaning products
- Landfills

HEALTH EFFECTS

- Increases cholesterol levels
- Affects growth, learning, and behavior of infants and older children
- Potential increase in risk of cancer

REGULATIONS

- EPA Health Advisory Level: 70 ppt (PFOA+PFOS)
- WA State Action Levels (SALs)
- PFAS Chemical Action Plan

Environmental Working Group Study

>200M Americans Could be Exposed

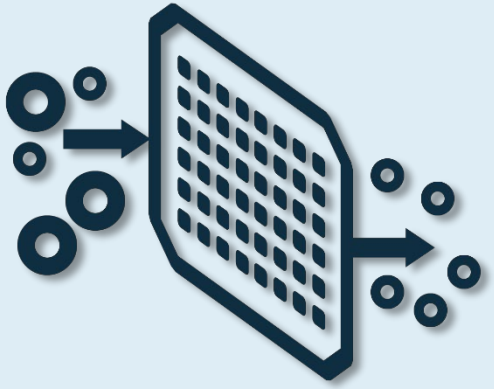
PFAS Treatment Alternatives

GAC Treatment

- Coal-Based Carbon
- Surface Modified Coconut Shell Carbon

Ion Exchange

- Single Use Ion Exchange Resin



Reverse Osmosis/ Nanofiltration

- High pressure membranes to reject PFAS ions

Blending

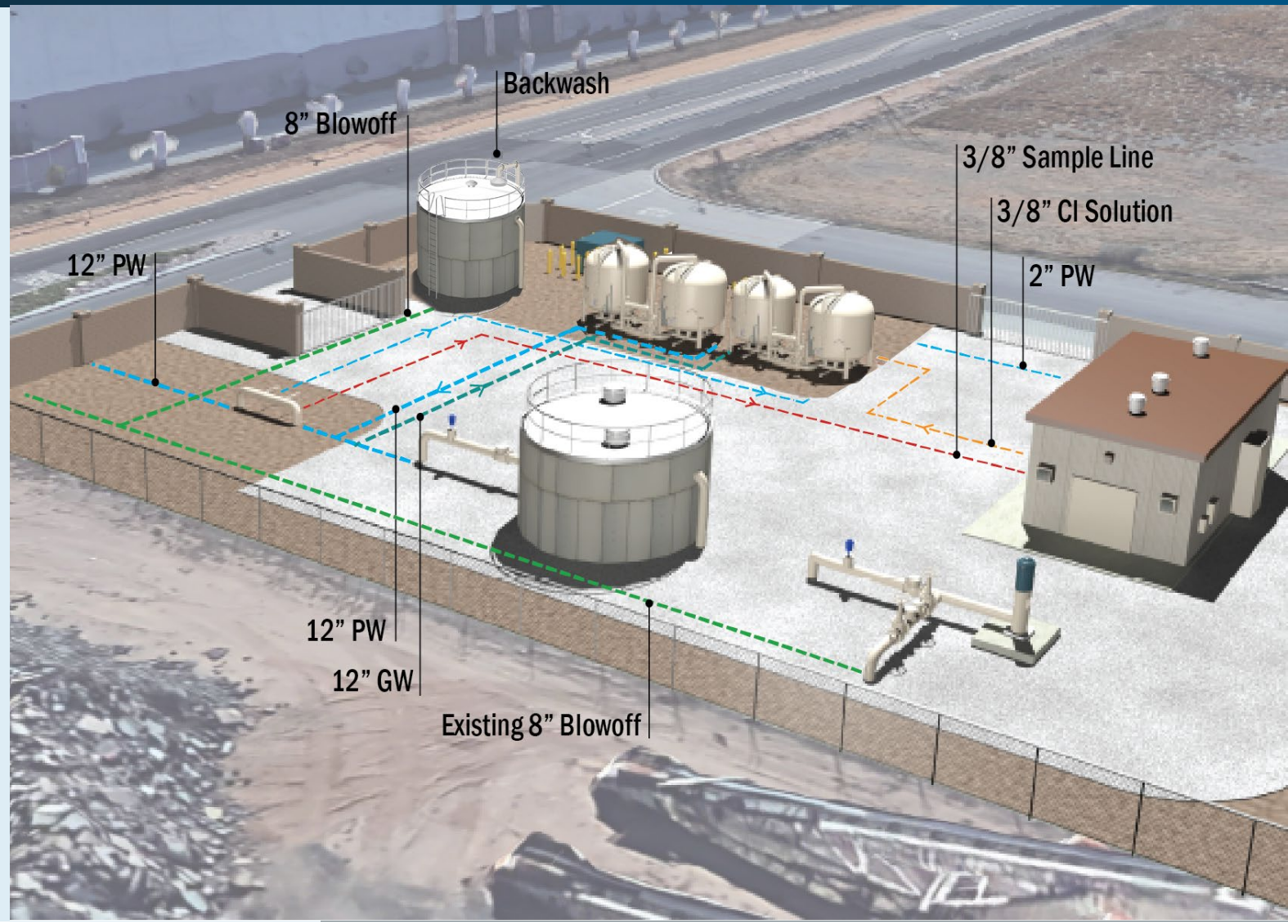
- Blends contaminated water with un-impacted source

Comparing GAC and IX

Treatment Alternative	Pros	Cons
	✓ Proven technology ✓ Widely used for PFAS removal ✓ Good for long-chain PFAS	× Requires 10 min EBCT × Less effective for short-chain PFAS × TOC can limit bed life
	✓ Smaller footprint; 2 min EBCT ✓ IX offers longer bed life than GAC ✓ Good for higher PFAS concentrations	× New and relatively untested for PFAS × Other anions can limit bed life × IX resin is 4 to 5 times more expensive than GAC

Bench Testing: Eastern MWD Well 59

- Well taken offline in 2016
- PFOS + PFOA
- 1,000 gpm
- **GAC Selection**
  - **Proven Technology**
  - **High sulfate**
  - **Cost (?)**



GAC Media Alternatives

Coal-Based GAC

- Medium-sized pores

Coconut-Based GAC

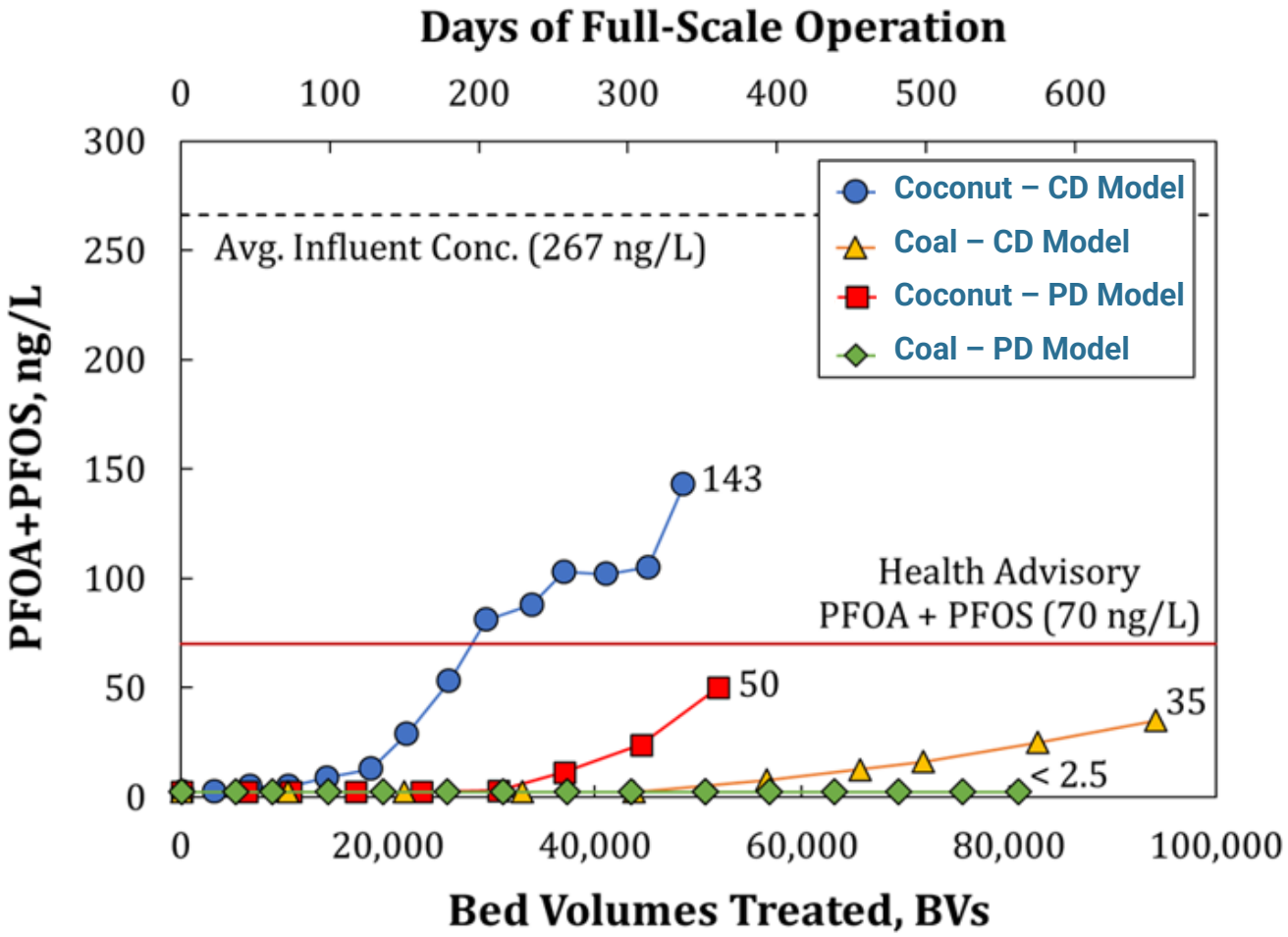
- Pretreatment process that opens smaller pores into medium-sized pores

Bench Scale Testing Goals

- Determine GAC with longest bed life
- Predict replacement frequency at full-scale

Bench Testing– RSSCT Column Testing Layout

Bench Testing– RSSCT Column Results



CD Model Tests

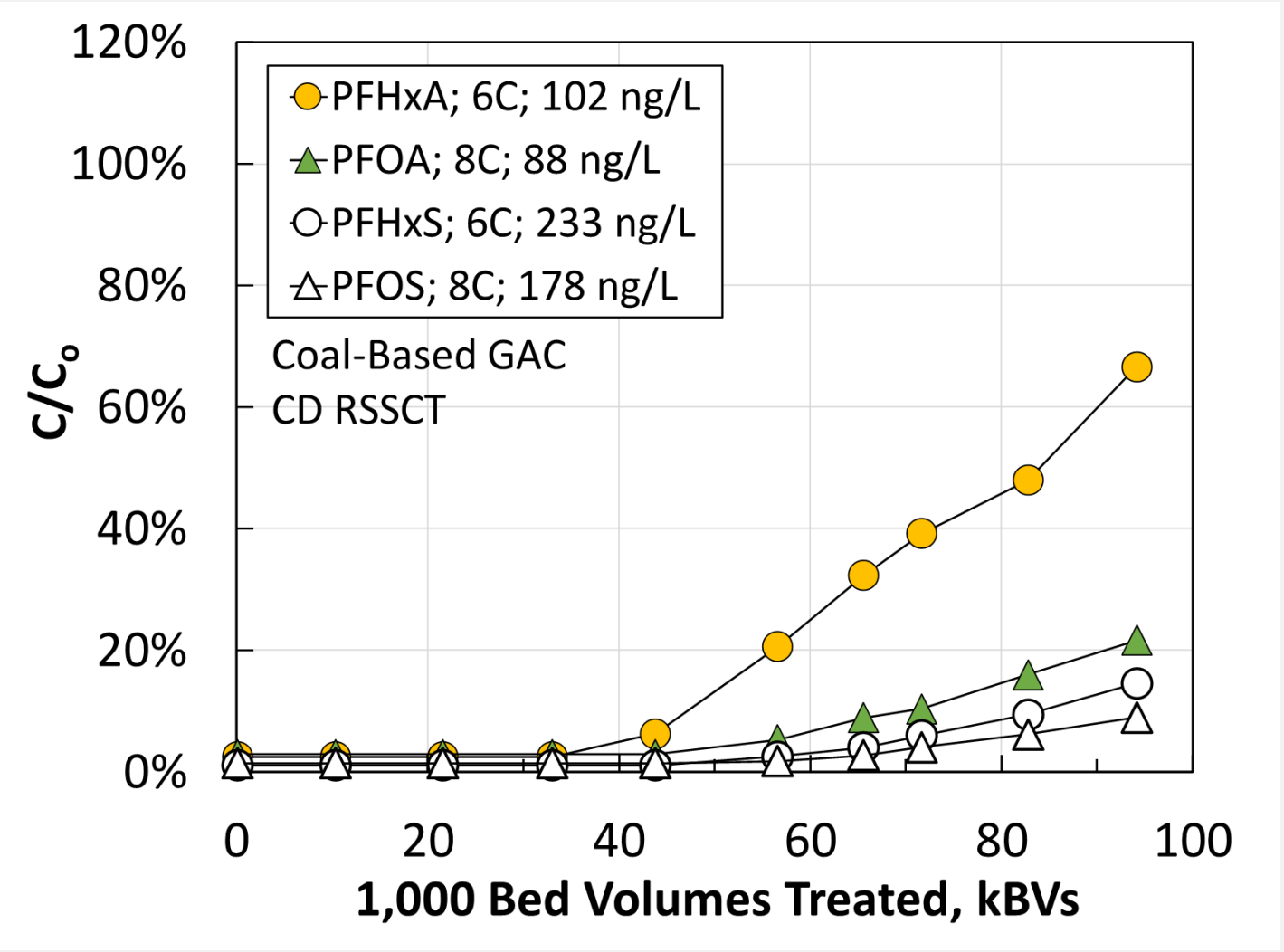
CONCLUSION: Coal-based F400 had a bed life 4 times that of the enhanced coconut GAC

PD Model Tests

Similar findings as CD test

Bench Testing– RSSCT Column Results

- Coal > Coconut
- Longer Chain = Better Removal
- Sulfonates= higher removal
- Estimated >33,000 BV to breakthrough: PFHxA
- Estimated >44,000 BV to breakthrough: rest

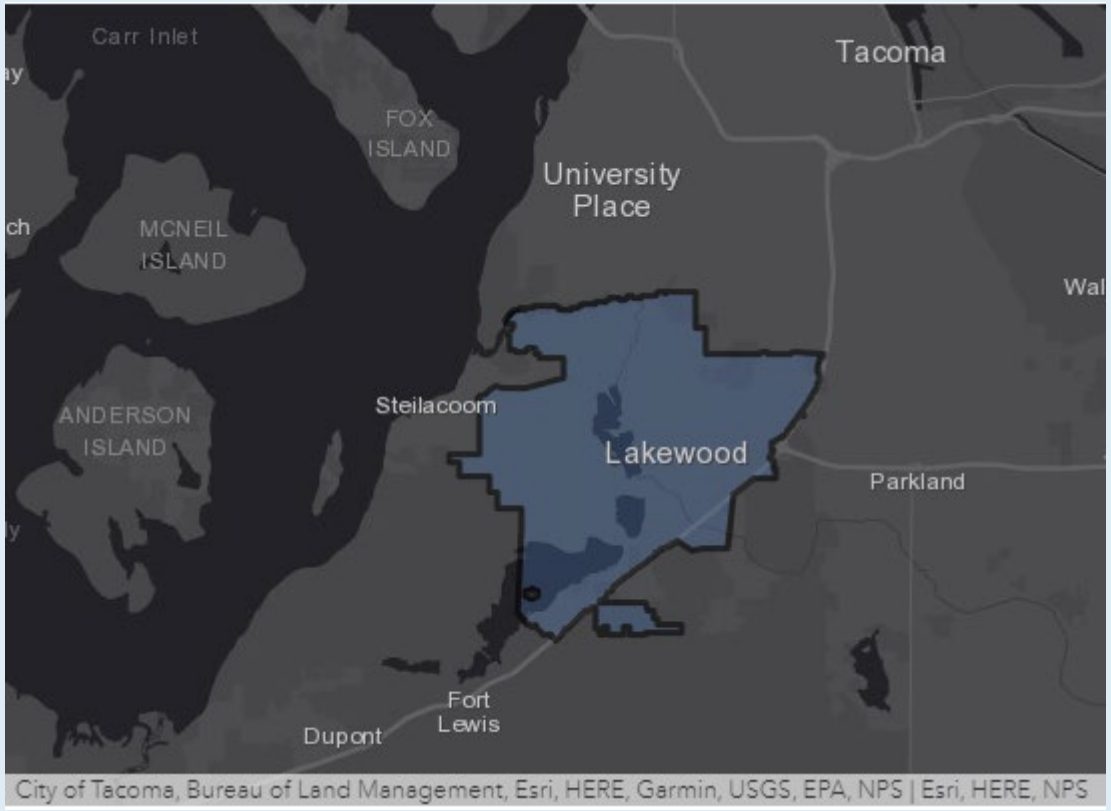


EMWD Well 59

- Constructed in 2020
- Back in service Jan 2021

Lakewood Water District

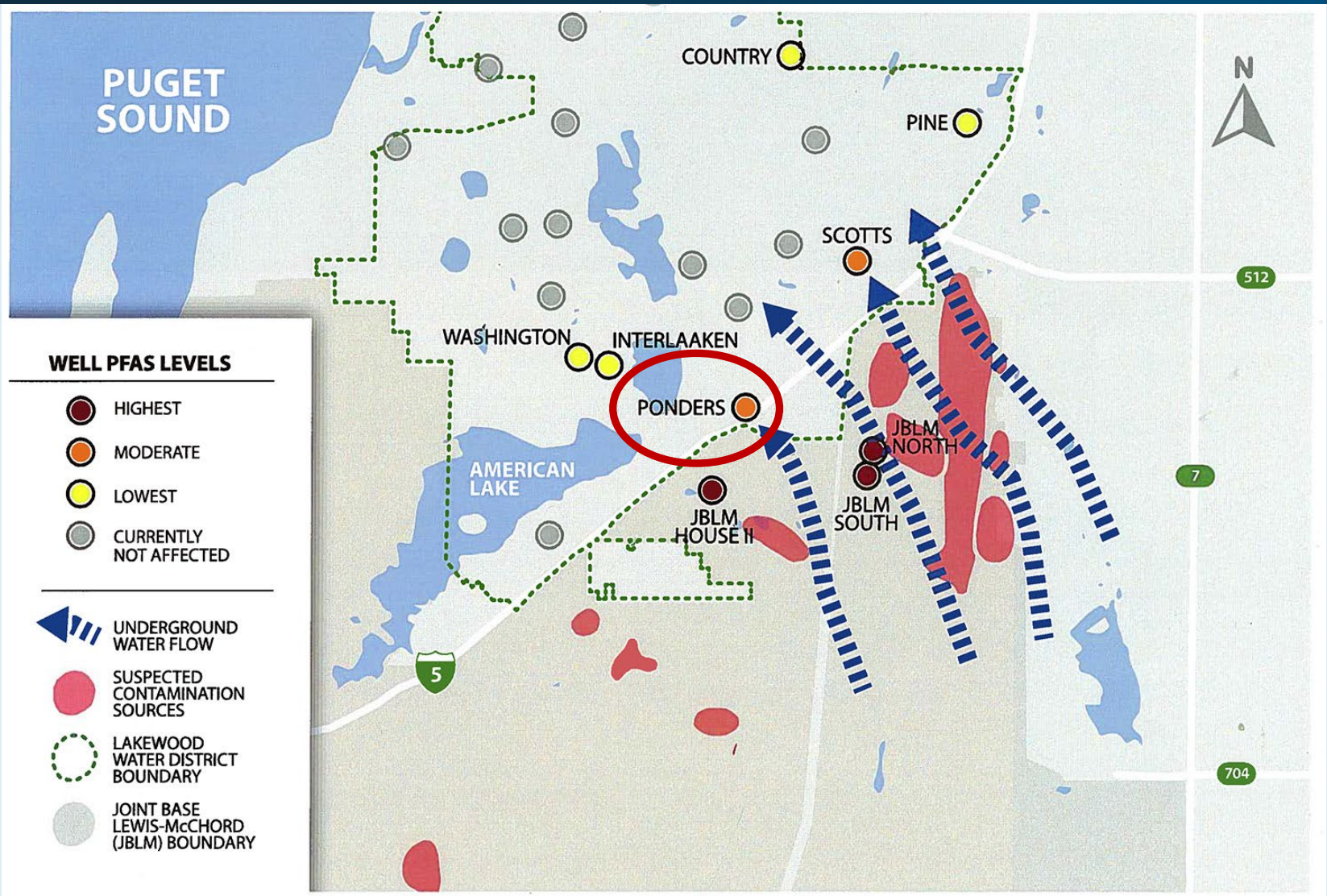
- **Serves**
  - Over 60,000 retail customers
  - 55,000 wholesale customers
- **Groundwater Supply**
- **30 Active Wells**
- **Ponders Wells**
  - H1 1,200 gpm
  - H2 800 gpm



LWD Ponders Wells

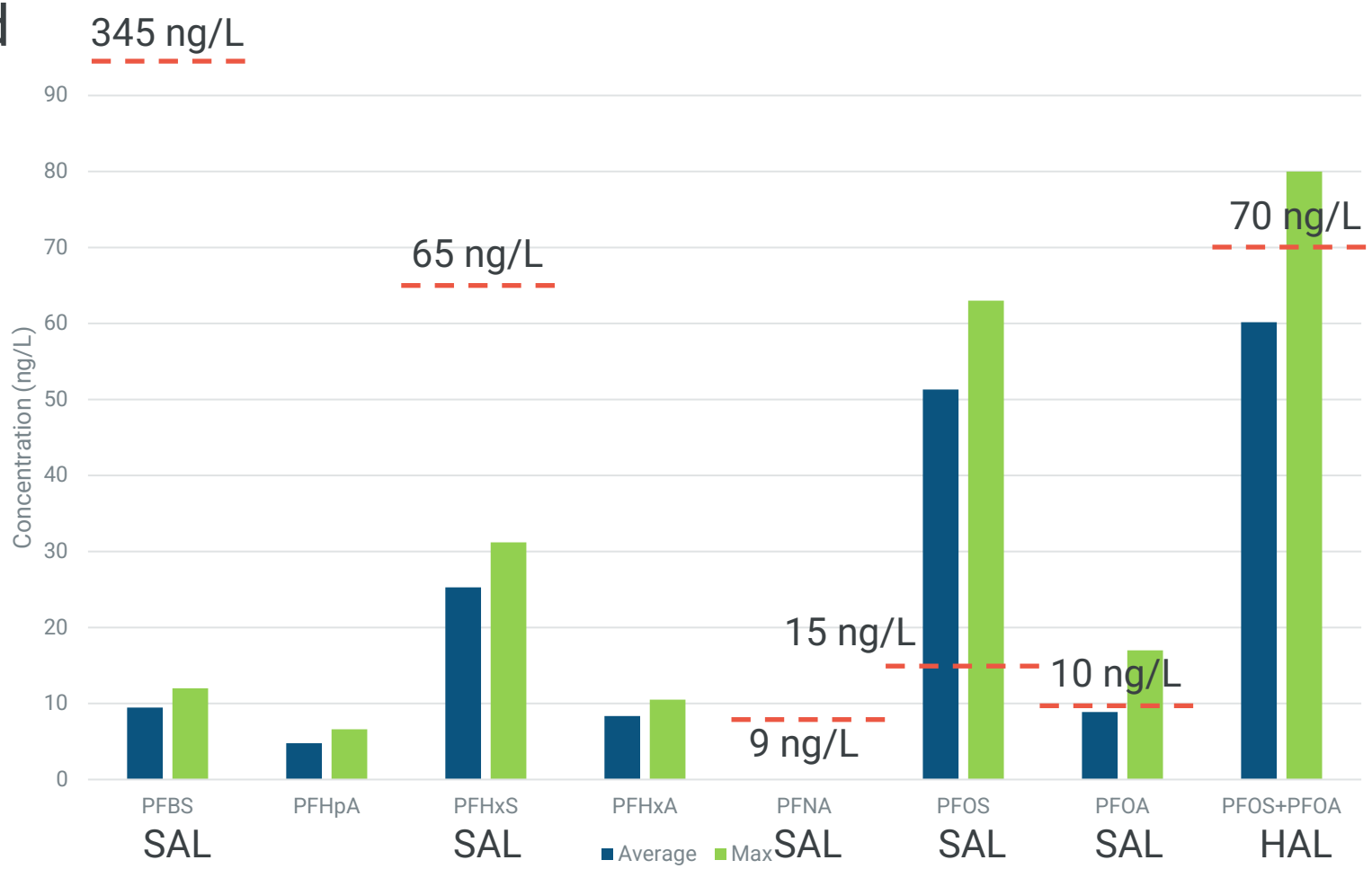
- Former Superfund Site (PCE)
- Infrastructure needed replacement
- Equipment Pre-purchased

PFAS Migration (2018)



Lakewood Ponders PFAS Data

- Concentrations increased through 2019
- Relatively constant now
- PFOS dominant compound
- PFOS+PFOA has exceeded HAL



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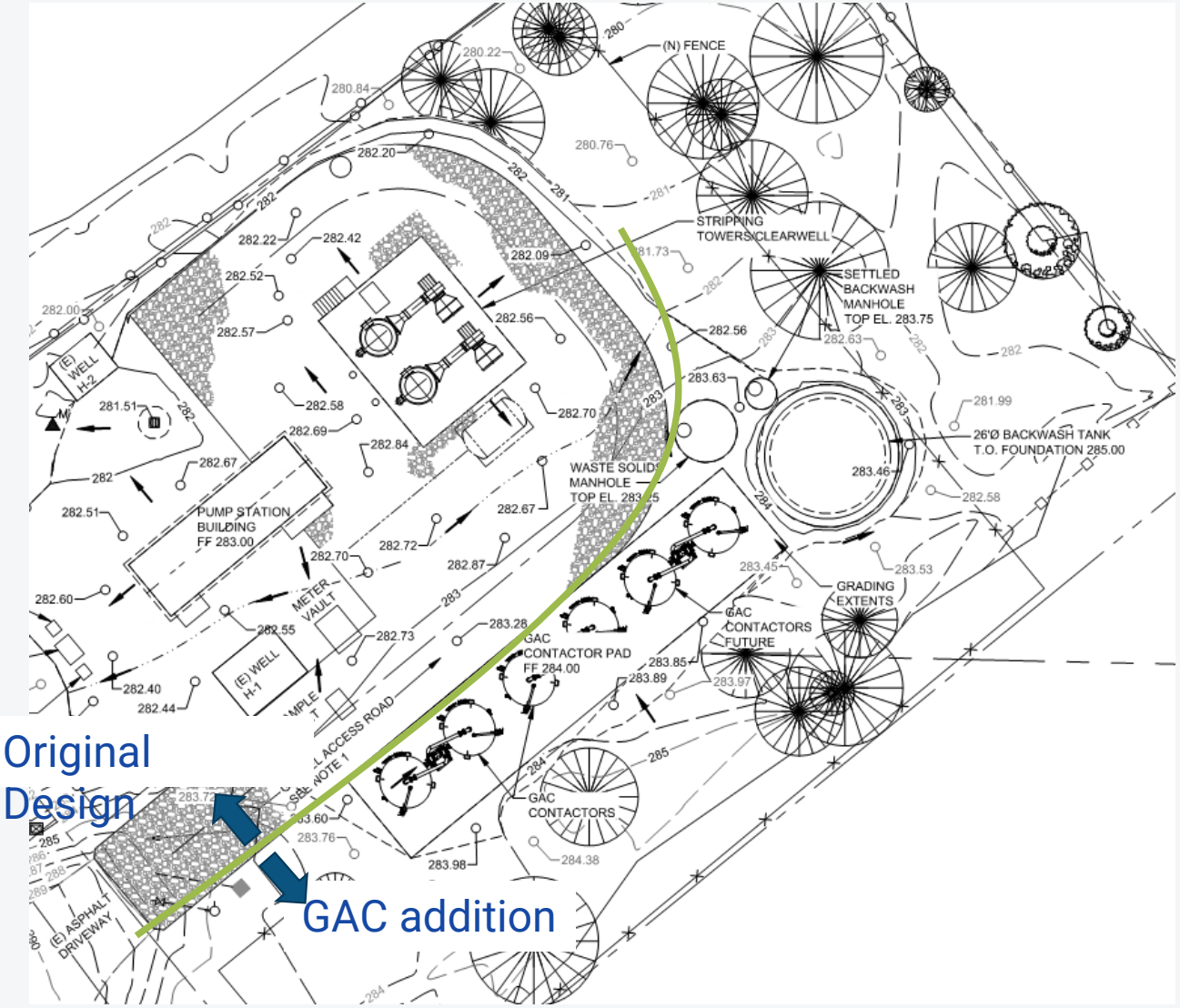
Changing Conditions

90% Design Complete

- New Pump Station
- Replacement Stripping Towers
- Equipment Pre-purchased

PFAS Treatment Selection

- Speed a Priority
- Regulatory Approval
- Favorable Water Quality
- No Time to Pilot



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PFAS

- H1 & H2 shutdown in Fall 2018
- District decided to add GAC for PFAS treatment
- Used Rapid Small-Scale Column Test data from EMWD given short time frame
  - Similar TOC
    - Ponders 0.2 mg/L TOC
    - EMWD Well 59 0.32-0.47 mg/L TOC
  - EMWD Well 59 – higher PFAS concentration
    - PFOS 170 ng/L
    - PFOA 90 ng/L

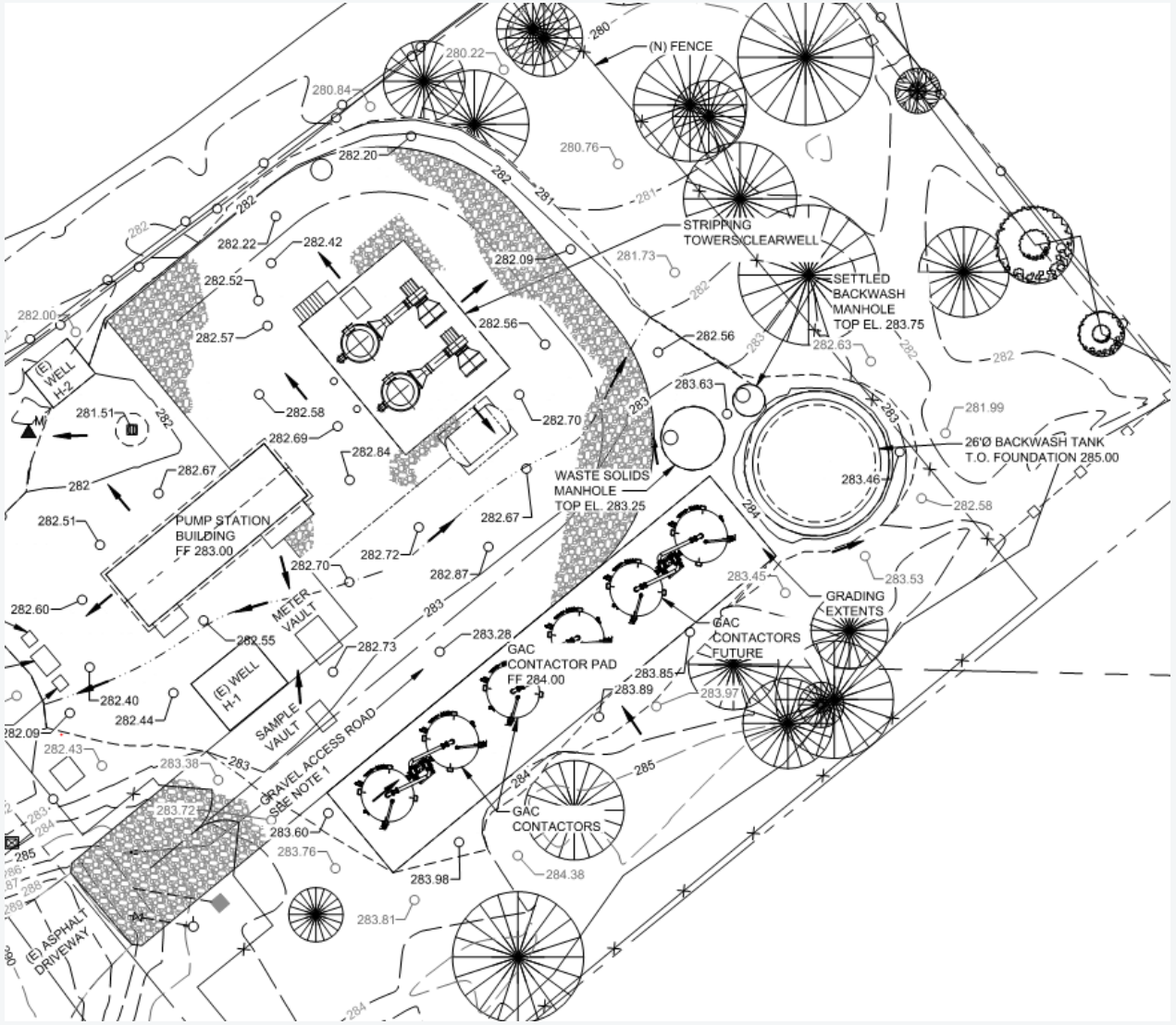
GAC Design

GAC Vessels

- 12’ Diameter
- 40,000 lbs carbon each
- Lead-lag configuration
- Two trains (4 vessels), expandable

Backwash handling

- Media changeouts
- 96,000 gal backwash tank



Completed Ponders Facility

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Full Scale Operations

- GAC Vessels equipped with multiple sample ports
- Track PFAS breakthrough

Full Scale Operations

- Jan 2020- ND

Full Scale Operations

- Jan 2020- ND
- Sept 2020 – Detections at 25%

Full Scale Operations

- Jan 2020- ND
- Sept 2020 – Detections at 25%
- Jan 2021 – PFBS, PFHxA at 50%

Full Scale Operations

- Jan 2020- ND
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- April/May 2021 - PFBS, PFHxA at 75%

Full Scale Operations

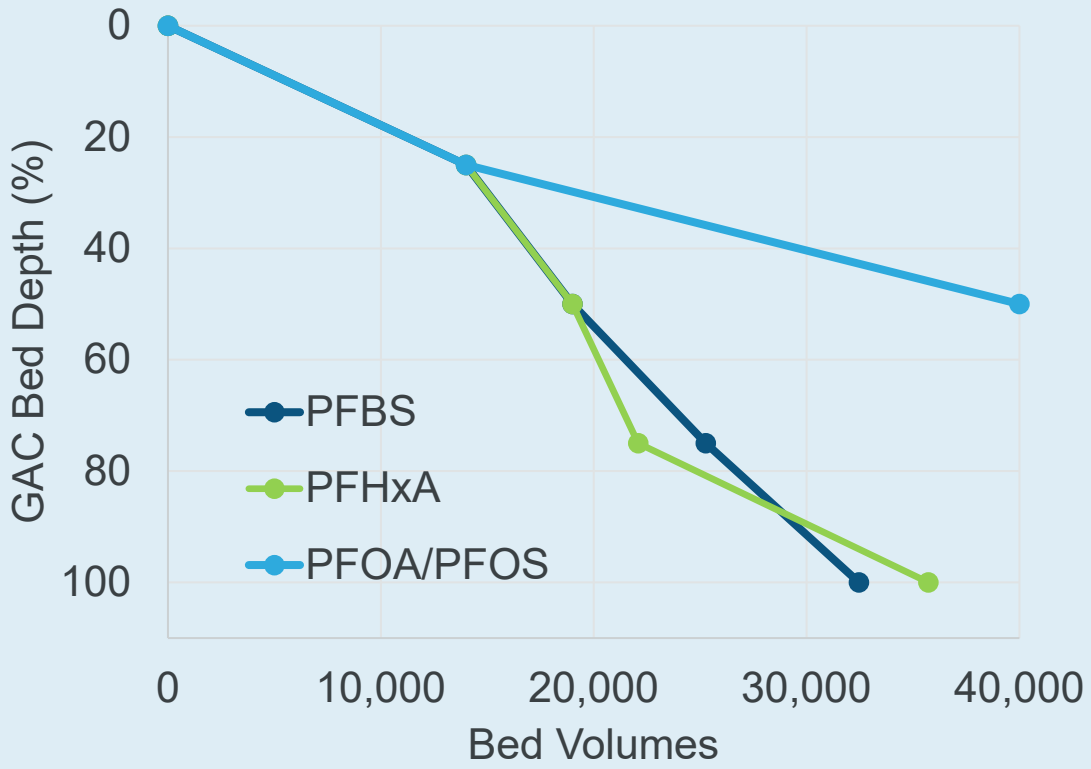
- Jan 2020- ND
- Sept 2020 – Detections at 25%
- Jan 2021 – PFBS, PFHxA at 50%
- April/May 2021 - PFBS, PFHxA at 75%
- Aug/Sept 2021- PFBS, PFHxA breakthrough

Full Scale Operations

- Jan 2020- ND
- Sept 2020 – Detections at 25%
- Jan 2021 – PFBS, PFHxA at 50%
- April/May 2021 - PFBS, PFHxA at 75%
- Aug/Sept 2021- PFBS, PFHxA breakthrough
- Oct/Nov 2021- PFOA, PFOS at 50%, 75%

PFAS Breakthrough

- PFBS and PFHxA had similar breakthrough
- PFBS ~32,000 BV
- PFHxA ~36,000 BV
- Predicted: 44,000/33,000 BS/HxA
- No PFOA, PFOS breakthrough yet



Summary

- Online in January 2020
- ~28 months of operation
- 46,000 BV
- Shorter chain PFAS breaking through first
- Continued removal of PFOA, PFOS
- Full scale closer to constant diffusivity model

Questions?

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