



ECT2 & Enspired Solutions – Complete PFAS Removal and Destruction Process for Landfill Leachate



Nick Backman – ECT2 North American
Business Development Manager
Meng Wang – Enspired Solutions Co-Founder & CTO

Presenters



Nick Backman

North American Business Development Mgr.
nicholasbackman@ect2.com



Dr. Meng Wang

CTO and Co-founder at Enspired Solutions
meng.wang@enspiredsolutions.com

Special thank you for moderation to **Jacob Fitzpatrick, PE** and **Gredell Engineering Resources**



Presentation Outline

- Introduction to Emerging Compounds Treatment Technologies (ECT2)
- PFAS 201 Overview
- Landfill Leachate PFAS Treatment System using FOAM-X™ Foam Fractionation
- Introduction to Enspired Solutions
- Separate/Concentrate/Destruct
- Questions and comments

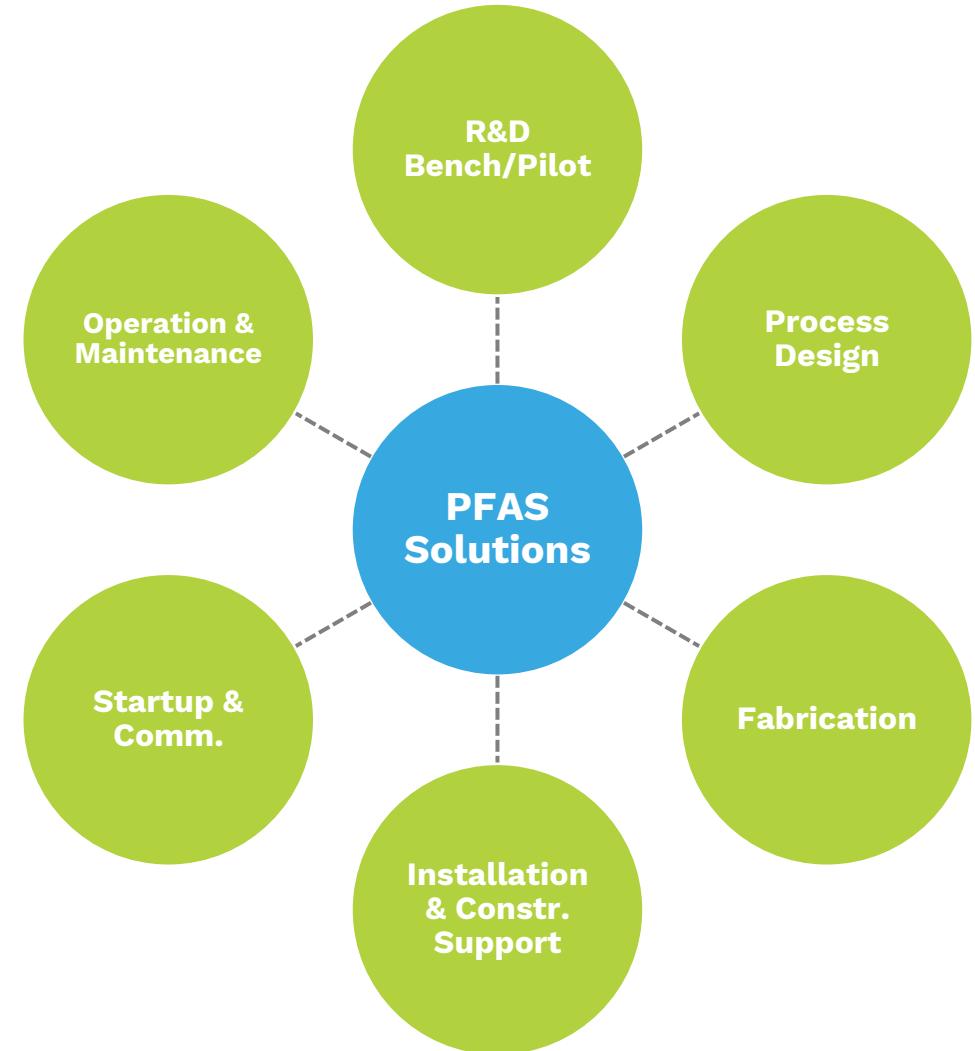


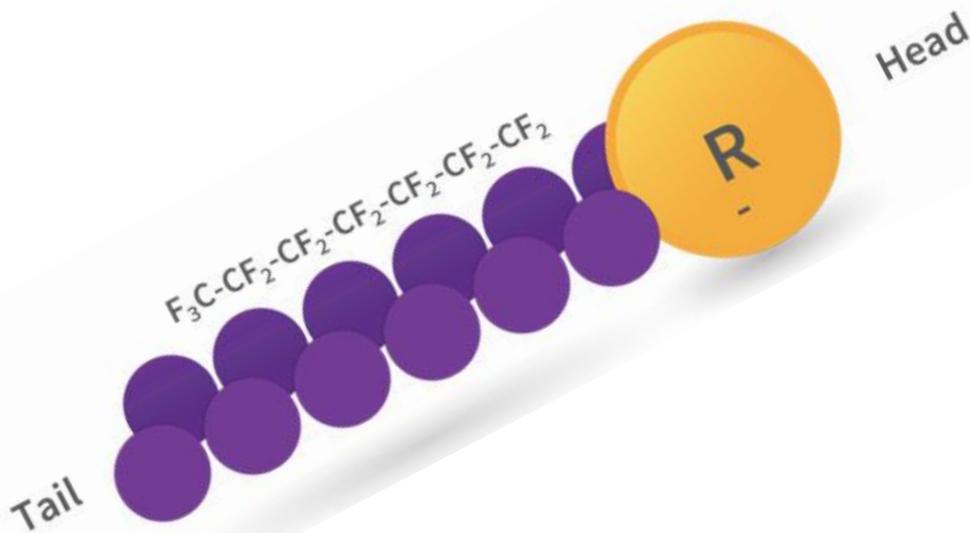
ECT2: Emerging Compounds Treatment Technologies, Inc.

ECT2 is a solutions provider of cutting-edge technology solutions to remove emerging and difficult to treat contaminants such as PFAS and 1,4-dioxane, from:

- **Investigation-derived waste**
- **Groundwater**
- **Surface Water**
- **Construction dewatering liquids**
- **Drinking water**
- **Wastewater**
- **Foam spills**
- **Landfill leachate**

ECT2's Vision: Removing emerging and recalcitrant compounds from the environment while producing as little waste as possible. Differentiate technology driven by R&D with an intense focus on efficacy, reliability, cost, and safety



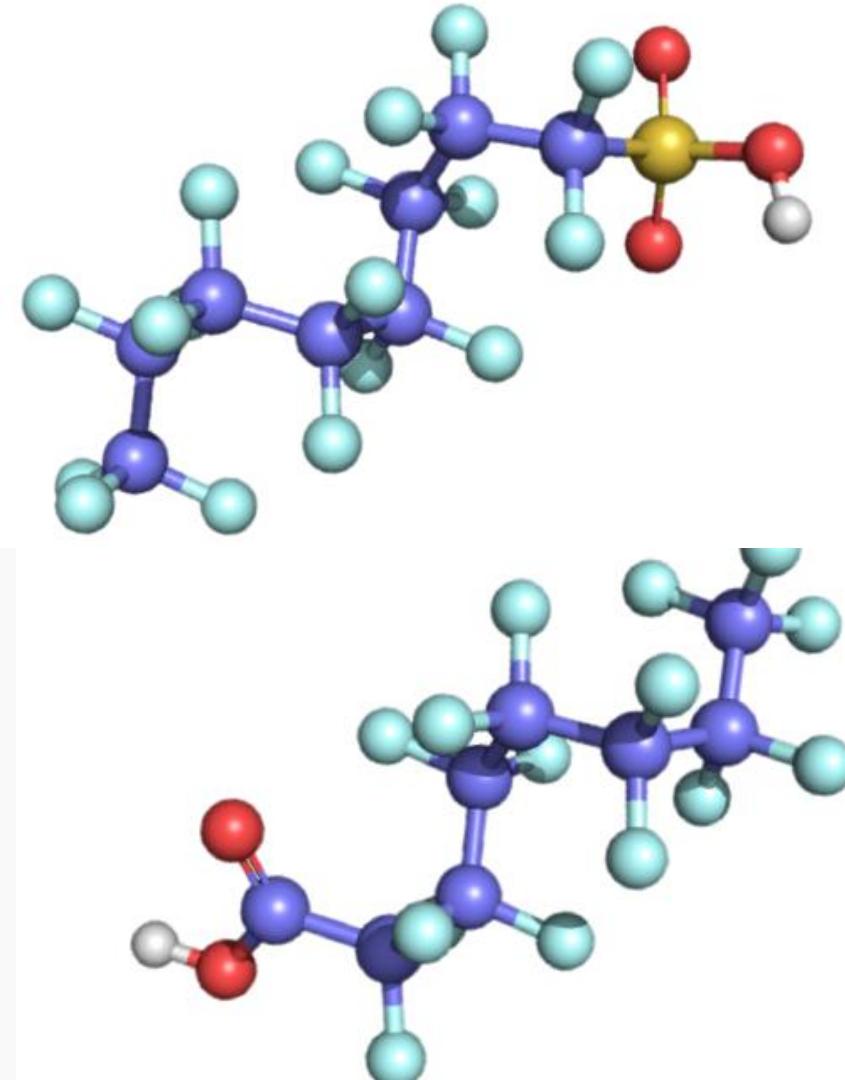


PFAS 201



PFAS Overview

- PFOA & PFOS most common form
- Very stable compound, carbon fluorine bond is strongest in nature, and considered inert
- Exhibits strong negative charge
- C-F “Tail” is hydrophobic (non-water soluble) and oleophobic (non-fat soluble)
- Each molecule has a functional group “Head” that is hydrophilic – extremely soluble in water.
- Limited health data outside of PFOA, PFOS, PFHxS, Gen-X
- Evidence suggests health impacts on kidneys, immune response, cholesterol, among other systems
- Concentrated up in breastmilk – most at risk are developing fetus, nursing baby



PFAS Names, Carbon Chains, Removal Difficulty

- Perfluorobutanonic acid (PFBA)
 - Perfluoropentanoic acid (PFPeA)
 - Perfluorohexanoic acid (PFHxA)
 - Perfluoroheptanoic acid (PFHpA)
 - Perfluoroctanoic acid (PFOA)
 - Perfluorononanoic acid (PFNA)
 - Perfluorodecanoic acid (PFDA)
 - Perfluoroundecanoic acid (PFUnA)
 - Perfluordodecanoic acid (PFDa)
- 
- 4 • Perfluorobutane sulfonic acid (PFBS)
 - 5 • Perfluoropentane sulfonic acid (PFPeS)
 - 6 • Perfluorohexane sulfonic acid (PFHxS)
 - 7 • Perfluoroheptane sulfonic acid (PFHpS)
 - 8 • Perfluoroctanesulfonic acid (PFOS)
 - 9 • Perfluorononane sulfonic acid (PFNS)
 - 10 • Perfluorodecane sulfonic acid (PFDS)
 - 11 • Perfluoroundecane sulfonic acid (PFUnS)
 - 12 • Perfluorododecane sulfonic acid (PFDs)



Demonstration Scale Testing to Inform Detailed Design

Off-site Testing Leads to Full Scale Success



Flow-Through Testing System

System in Operation:



Thorough Vetting of Design Sizing Alternatives:

Trial Number	HRT (per Fractionator)	Boost Agent (Stage 1)	Boost Agent (Stage 2)	Air Injection Rate - Stage 1 (SCFH)	Air Injection Rate - Stage 2 (SCFH)
1	40	--	--	High	High
2	30	--	--	High	High
3	20	--	--	High	High
4	40	Foam Control	Boost 1	High	High
5	30	Foam Control	Boost 1	High	High
6	20	Foam Control	Boost 1	High	High
7	40	Foam Control	Boost 1	Low	Low
8	30	Foam Control	Boost 1	Low	Low
9	20	Foam Control	Boost 1	Low	Low
10	120	N/A	N/A	N/A	N/A

FOAM-X™ Mobile Assets

Single Stage Skid Mounted



Single Stage Foam Fractionation Mobile Asset Prior to Deployment

- Ability to deploy to tight building footprints to demonstrate technology
- Dual stage mode possible with storage tank for batching
- Treat flows from 1-6 gpm depending on chemistry and discharge goals

On-site Pilot with FOAM-X™4 System

Pre-Engineered Fully Automated Flow-Through Packaged System

- Includes 4 FOAM-X Fractionators within 40-ft High Cube Container
- Operates in Series or Lead/Lag configuration
- Treat flows up to 160 gpm (single stage, 11 minute HRT)
- Onboard foamate treatment included using patented SuperLoading™ process
- Residuals concentration factors up to 10,000:1 (leachate) and 100,000:1 (remediation)

Typical Treatment Flow Range (GPM)	
Parallel	Lead/Lag
64-160	32-80



Overview of FOAM-X™ 3000

Standard and XL units to right-size approach

Compact design for high throughput in small footprint (12'x12')

Designed for install in dedicated building, along with ancillary equipment (e.g. blowers, chemicals, etc.)

Modular – can be installed in parallel/lead-lag to meet flows/treatment targets

Pairs with FOAM-X™ Concentrator or SuperLoaders for foamate handling

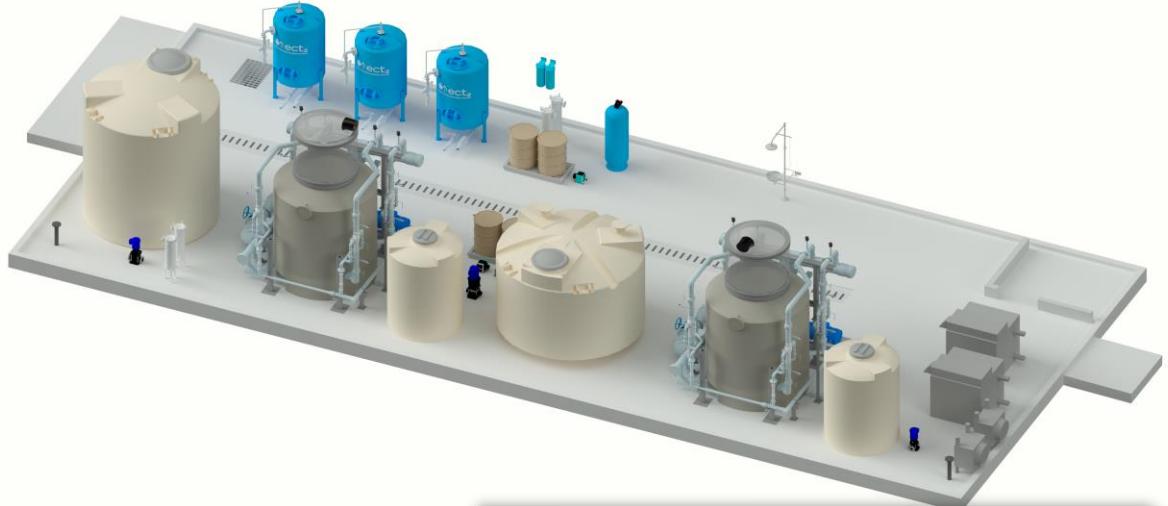
1 System Operating, 3 in design/construction phase

Typical Treatment Flow Range (GPM)	
Standard	XL
50-160	75-200

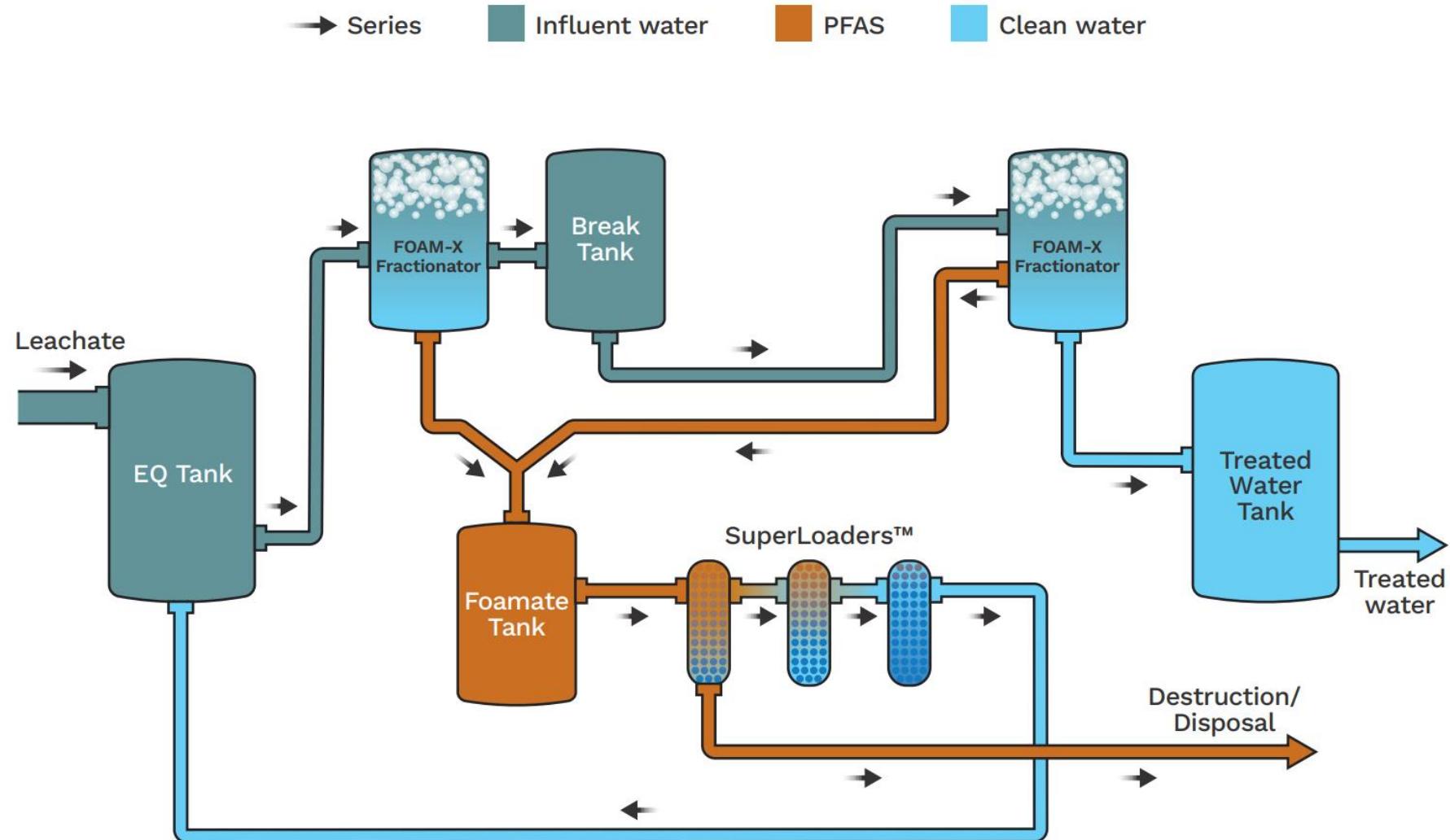


Champ Landfill, Maryland Heights, MO

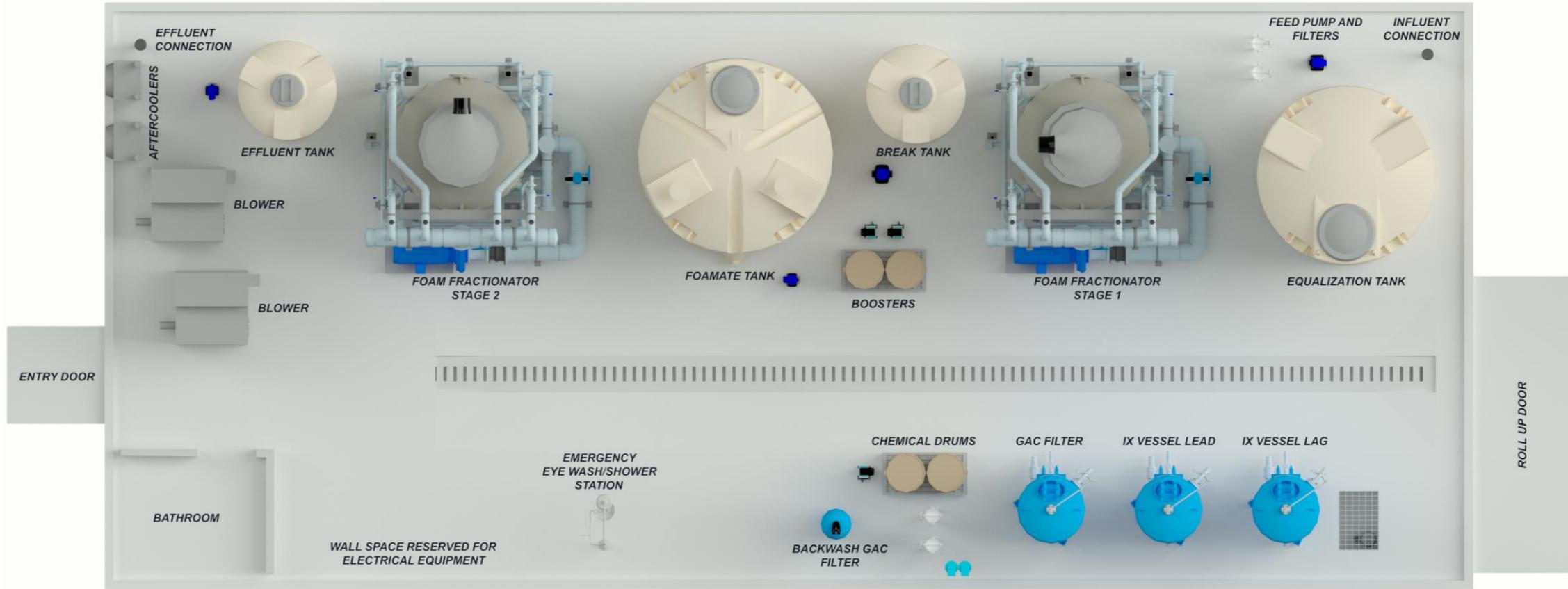
- System operating at 73 GPM treatment of Landfill Leachate 24 hrs/day
- Dual Stage FOAM-X™ 3000 with SuperLoader solution concentrating liquid raffinate to solids media



FOAM-X™ 3000 Champ Landfill Layout



ECT2 FOAM-X™ 3000 – Champ Landfill PFAS Treatment System



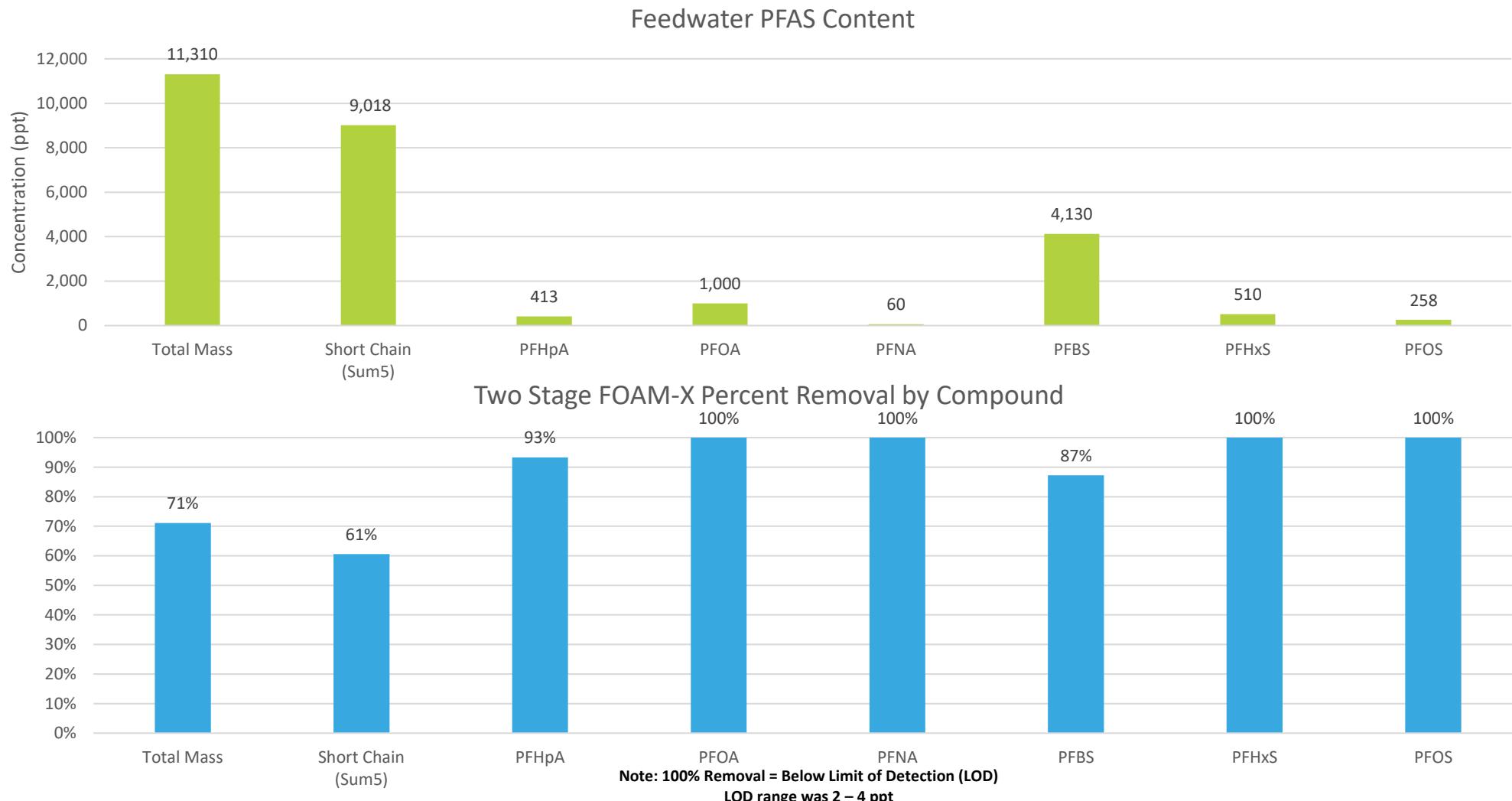
Smith's Creek Landfill – Smiths Creek, MI

- System operating at 35 gpm treatment of Landfill Leachate 24 hrs/day (with capacity for 70+ gpm)
- Single Stage FOAM-X™ 3000 Fractionator with SuperLoader solution concentrating liquid raffinate to solids media
- Treating to meet EGLE PFAS Limits for St. Clair County pre-POTW discharge without any chemical additives and very low energy consumption



Champ Landfill – Leachate Influent and Treatment Data

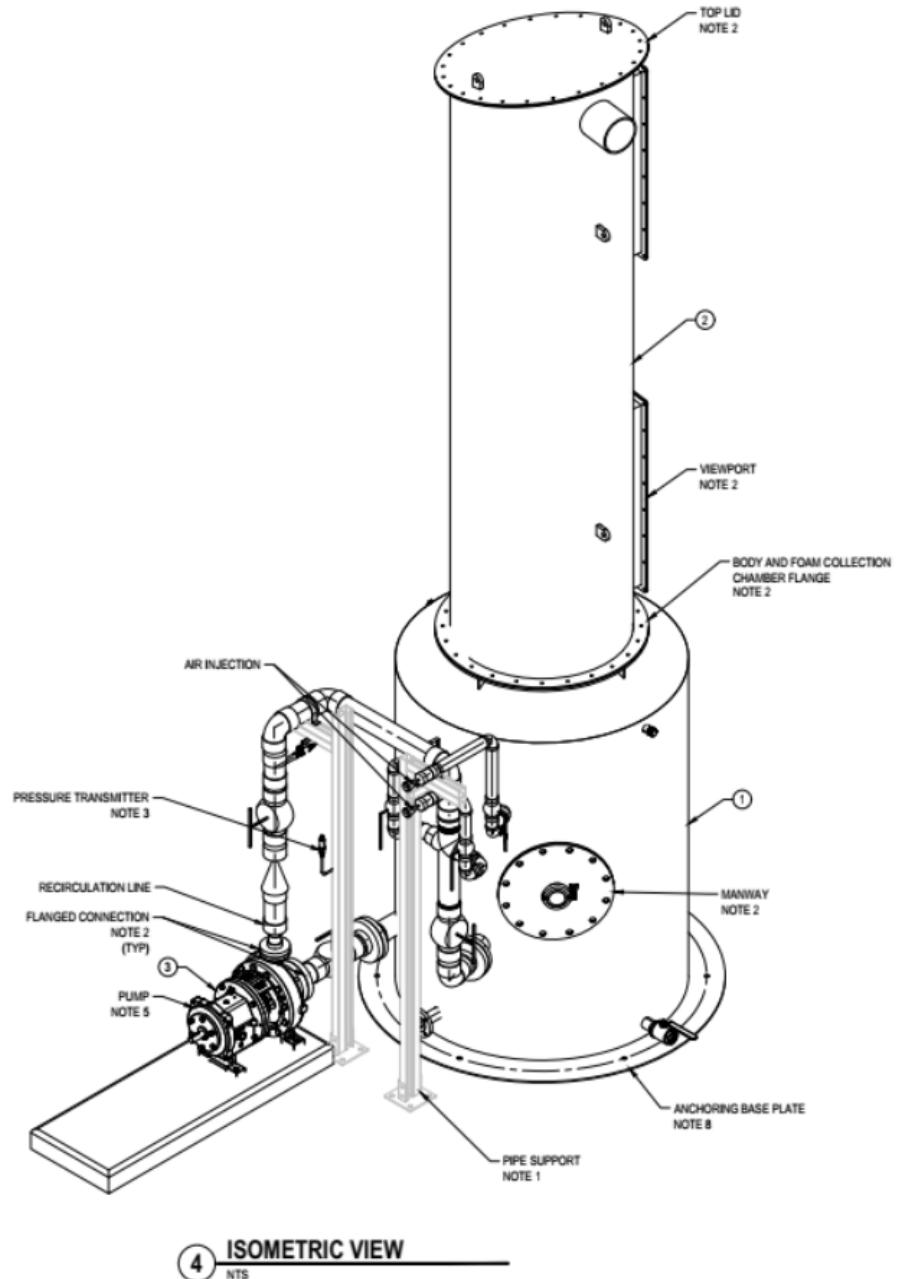
Two-Stage ECT2 FOAM-X™ 3000 Foam Fractionation System



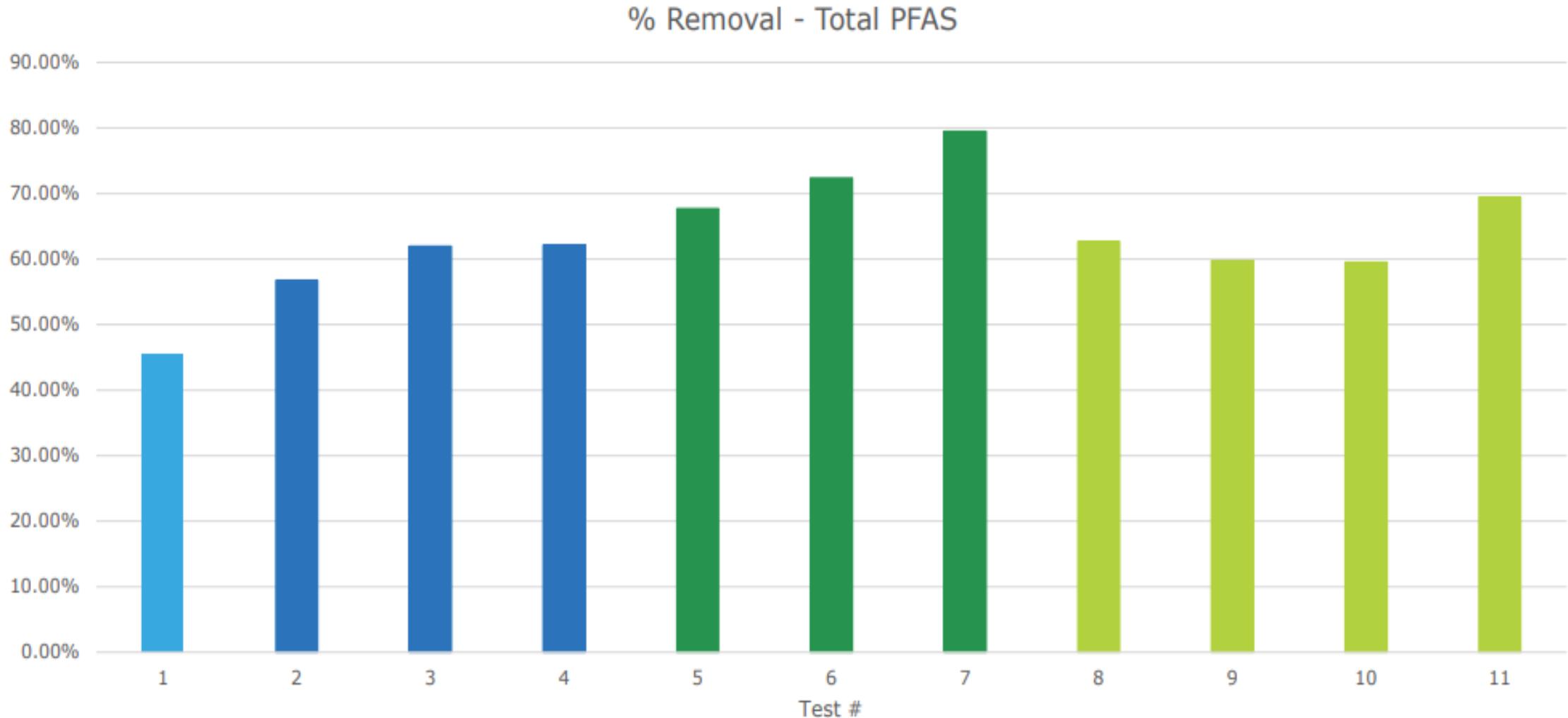
FOAM-X™ Foamate Concentrator

Concentrate Leachate Residuals up to 100x

- Foamate volume reduction while maintaining high PFAS recovery
- System overall height ~16'
- Compact footprint ~7x10'
- Intended for integration with waste destruction technologies
- Also available in FOAM-X™ 4/6 Containerized Options



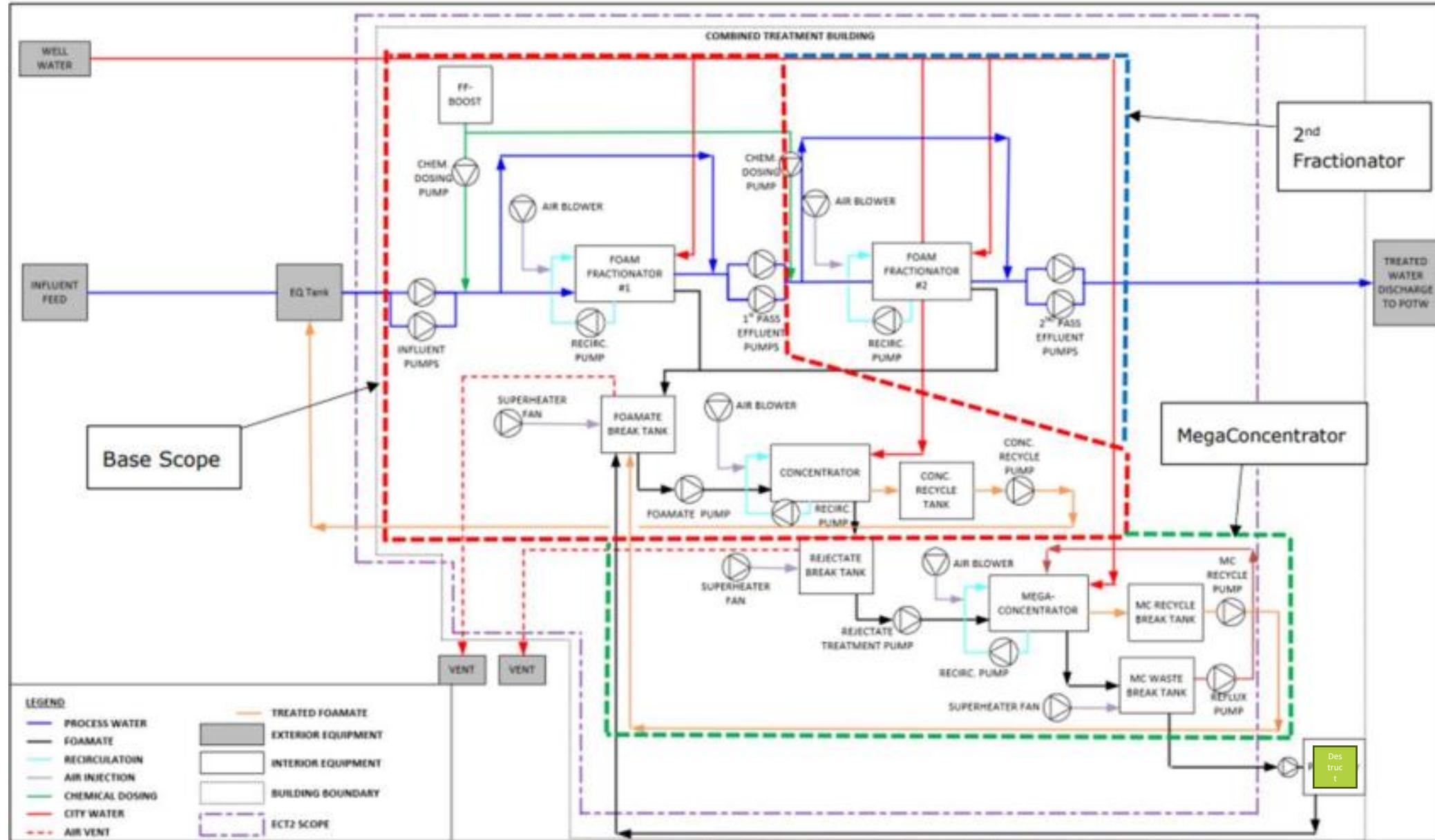
Landfill Leachate Varying Operation PFAS Removal Results



- Each test # indicated different conditions, each color notates a different boasting agent
- Test 1 has no chemical addition. Influent PFAS total 18ppb

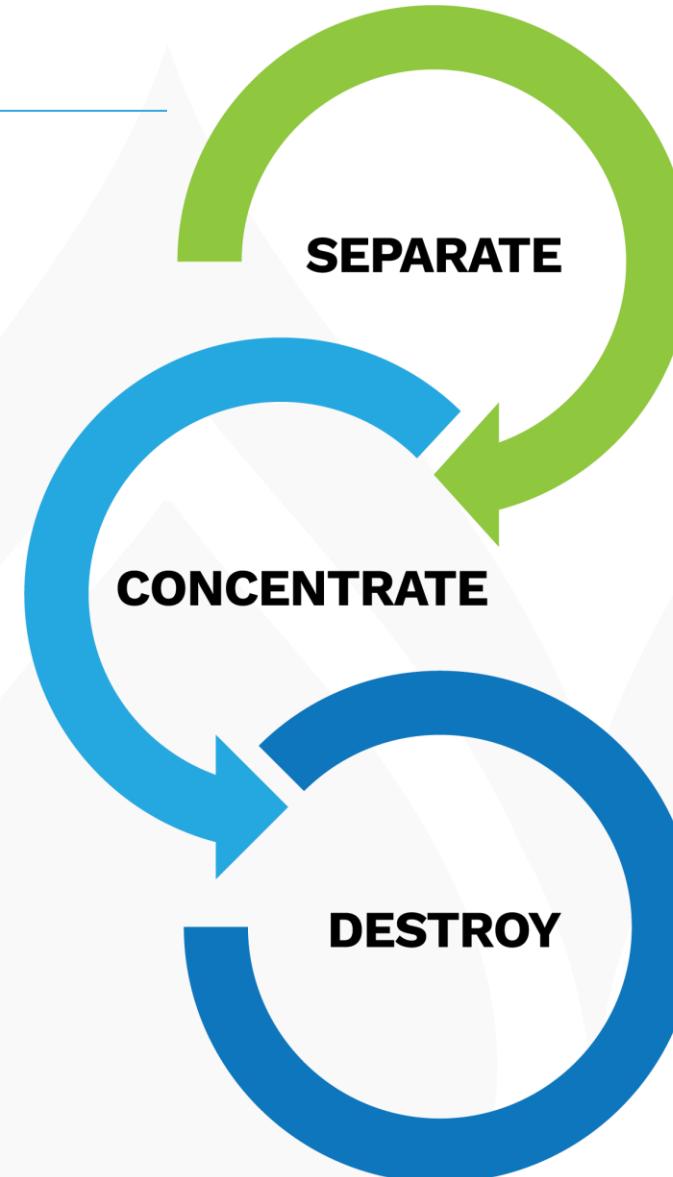


Three Phase FOAM-X™ 3000 Treatment System Approach



Applications

- Investigation-derived waste
- Groundwater
- Surface Water
- Industrial Wastewater
- Construction dewatering
- Drinking water
 - POET
 - Larger systems
- Sewage Treatment plants
- Foam spills/events
- Landfill leachate
- Fire System conversion
- Fire System maintenance/calibration/repair



Enspired Solutions

Photoactivated Reductive Defluorination

Bolt-On Destruction Technology





ENSPired SOLUTIONS

PFAS destruction innovation startup

Women-owned and women-led

Founded in 2021

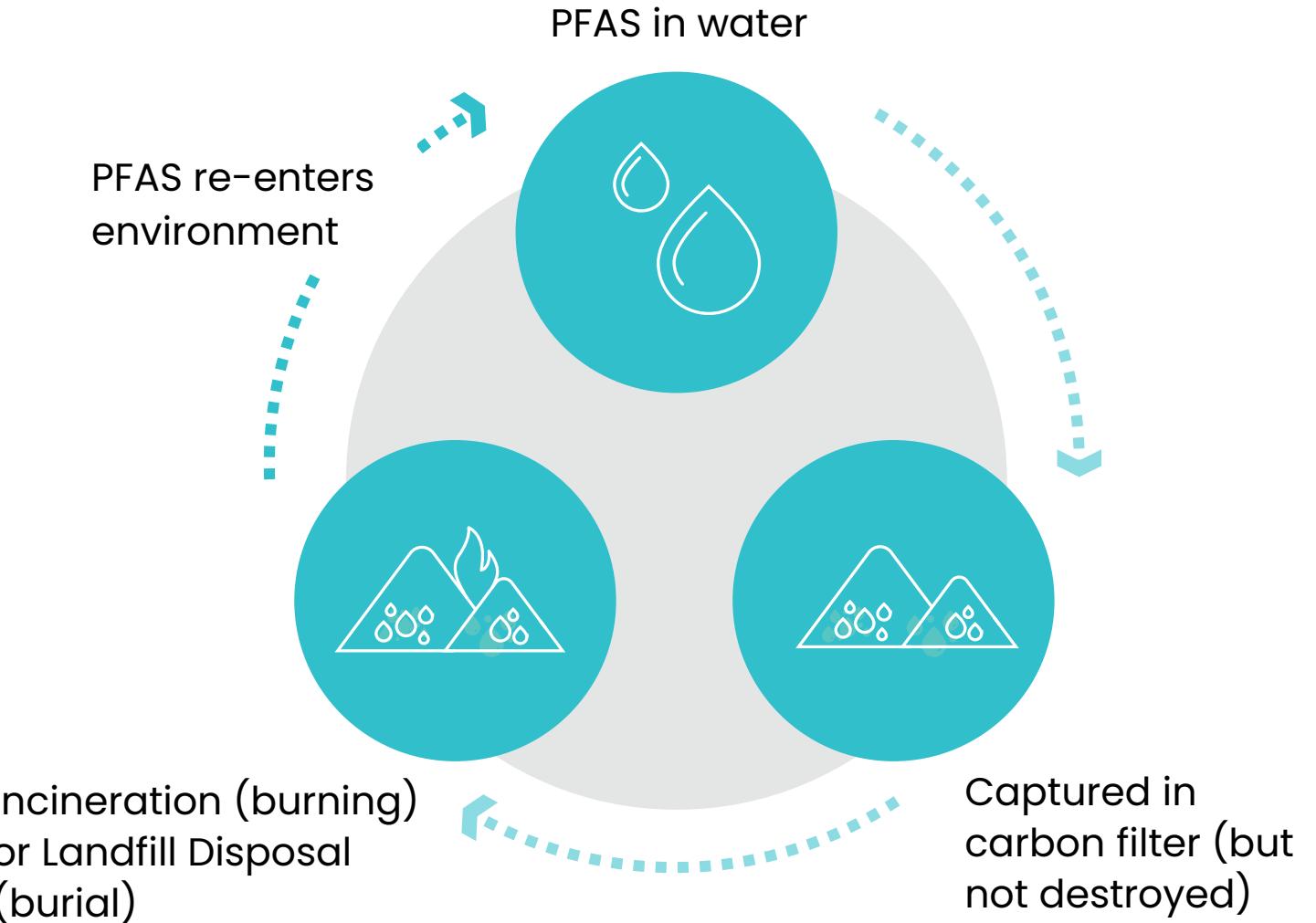
Headquartered in Lansing, Michigan, USA

SBA WOSB
Woman Owned Small Business



TECHNOLOGY INTRODUCTION

Current methods





PFAS in water

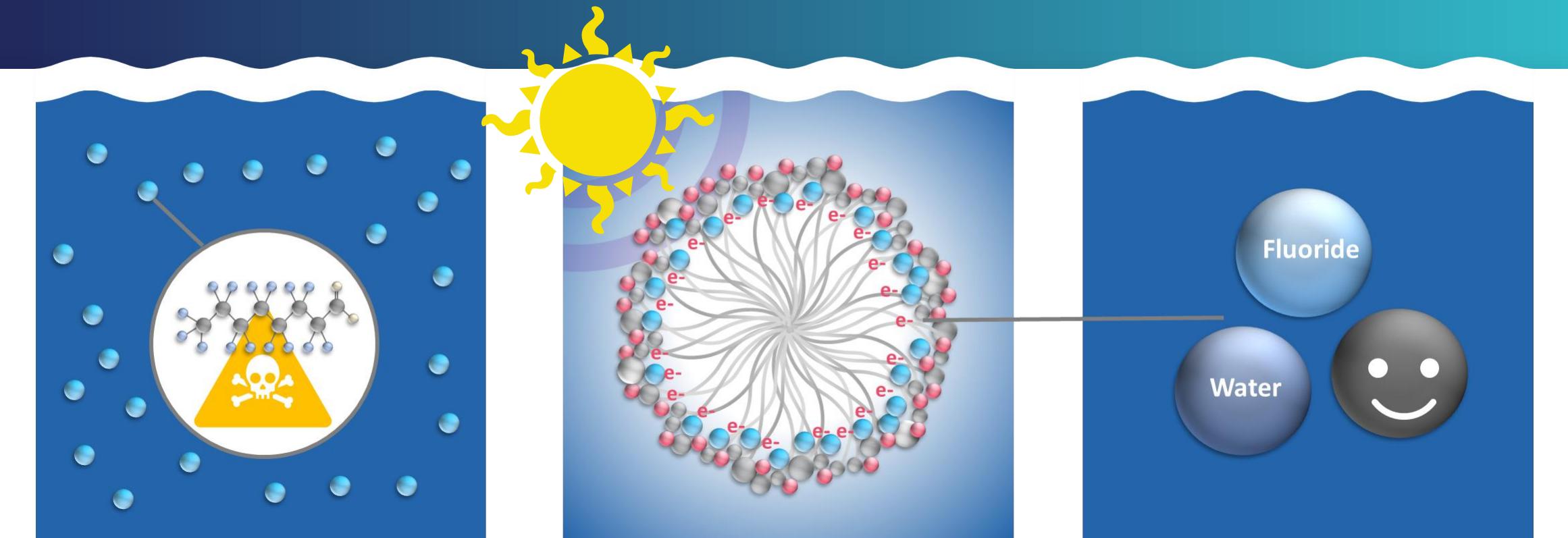
Our photo-activated reductive defluorination (PRD) process destroys PFAS and breaks the cycle of capture, disposal and re-release.

ENSPIRED
SOLUTIONS™

Non-toxic Discharge



How Photo-activated Reductive Defluorination (PRD) Works





ENSPIRED
SOLUTIONS™



U.S. Department of Defense

Recognized technology

USEPA + Dept. of Defense
AWARD-WINNING CHEMISTRY

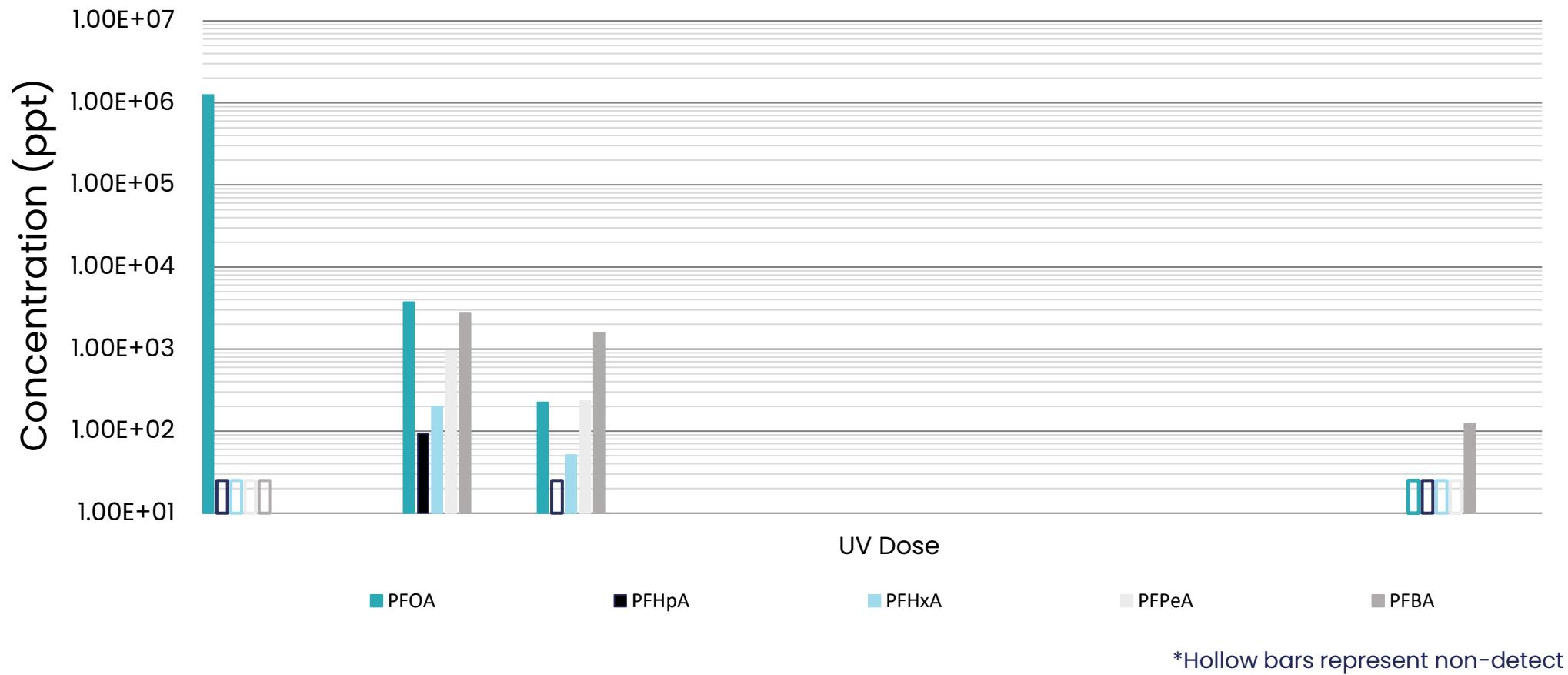


PFAS
Destruction

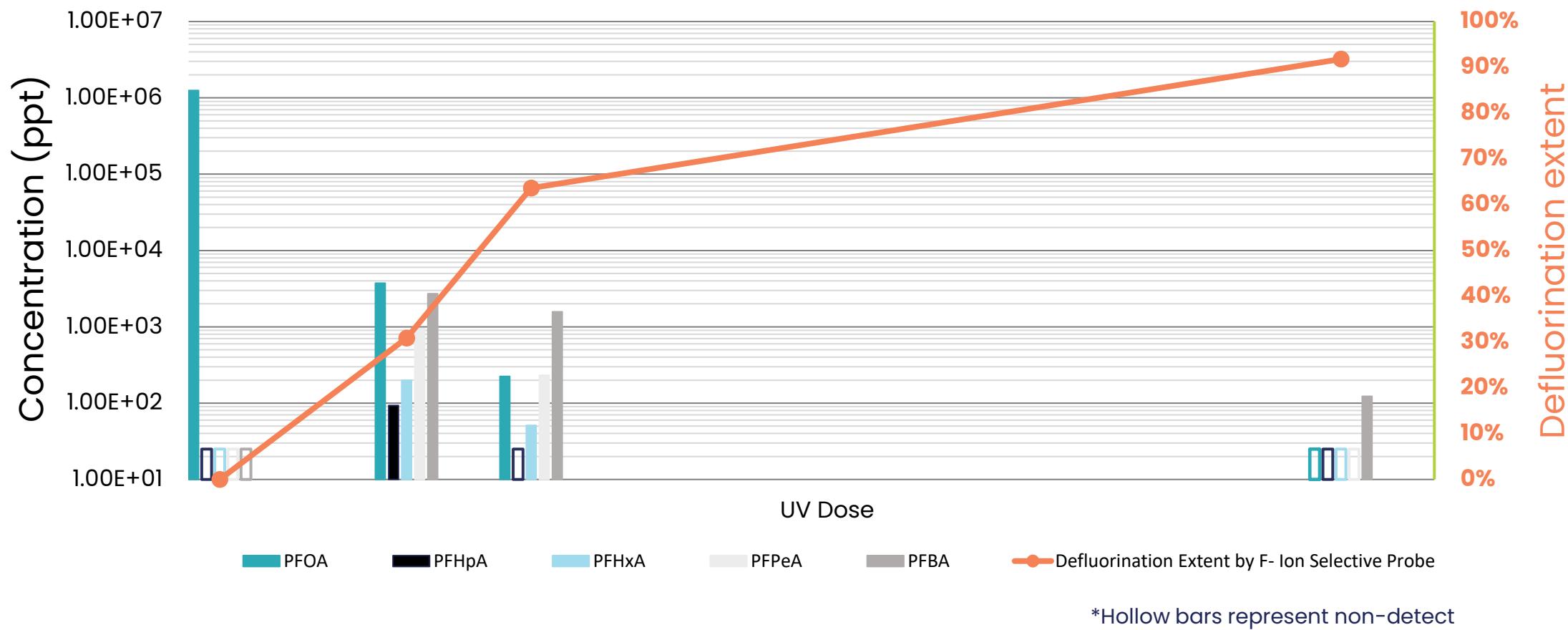
Energy
Efficiency



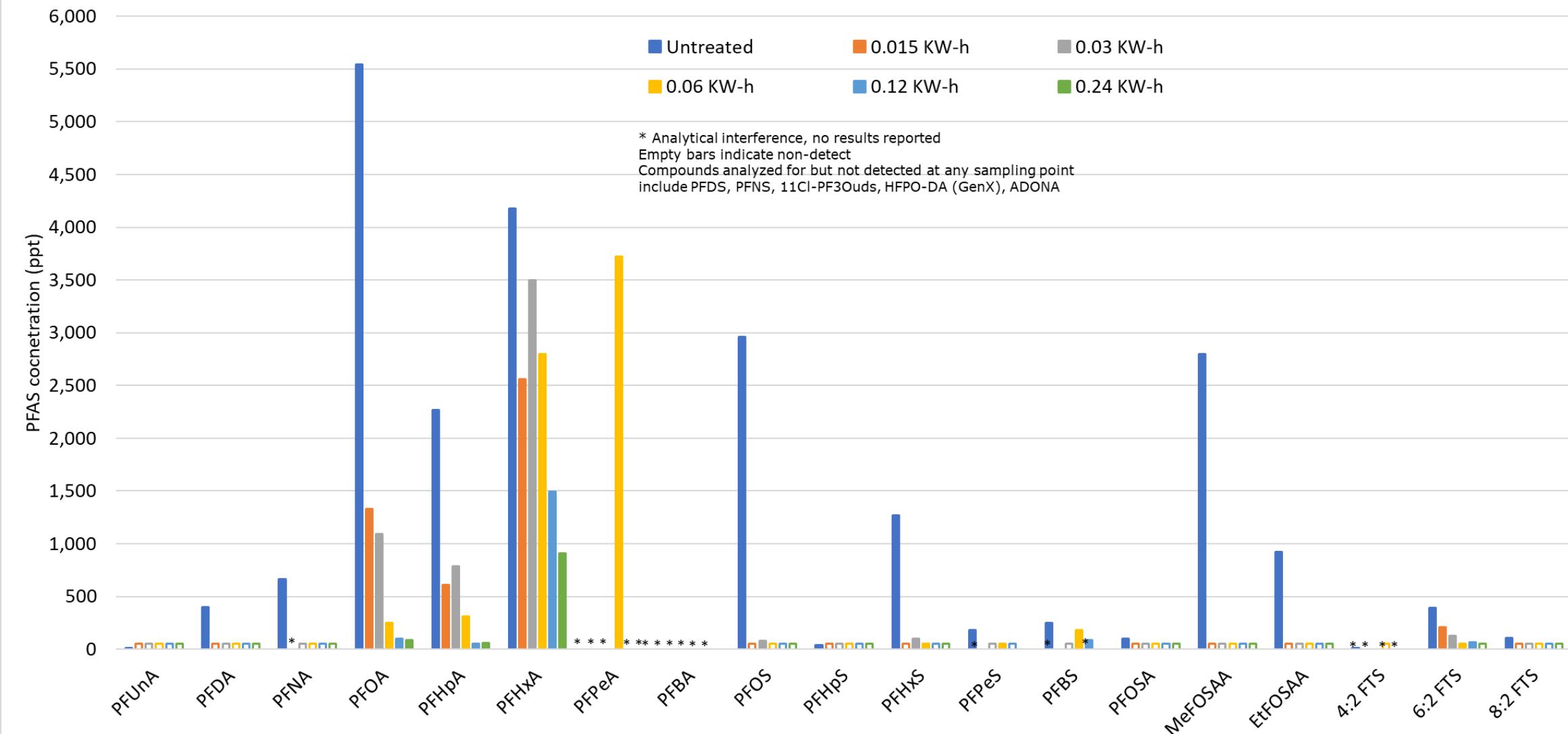
1.25 ppm PFOA Spiked DI Water Sequential Mineralization



1.25 ppm PFOA Spiked DI Water Sequential Mineralization



Destruction of PFAS in Landfill Leachate



COMMERCIAL-SCALE PFAS DESTRUCTION EQUIPMENT

PFASigator Sequencing



PFAS destruction occurs

Treated solution is discharged back to the waste treatment system

Concentrated PFAS solution
enters and reagents are mixed

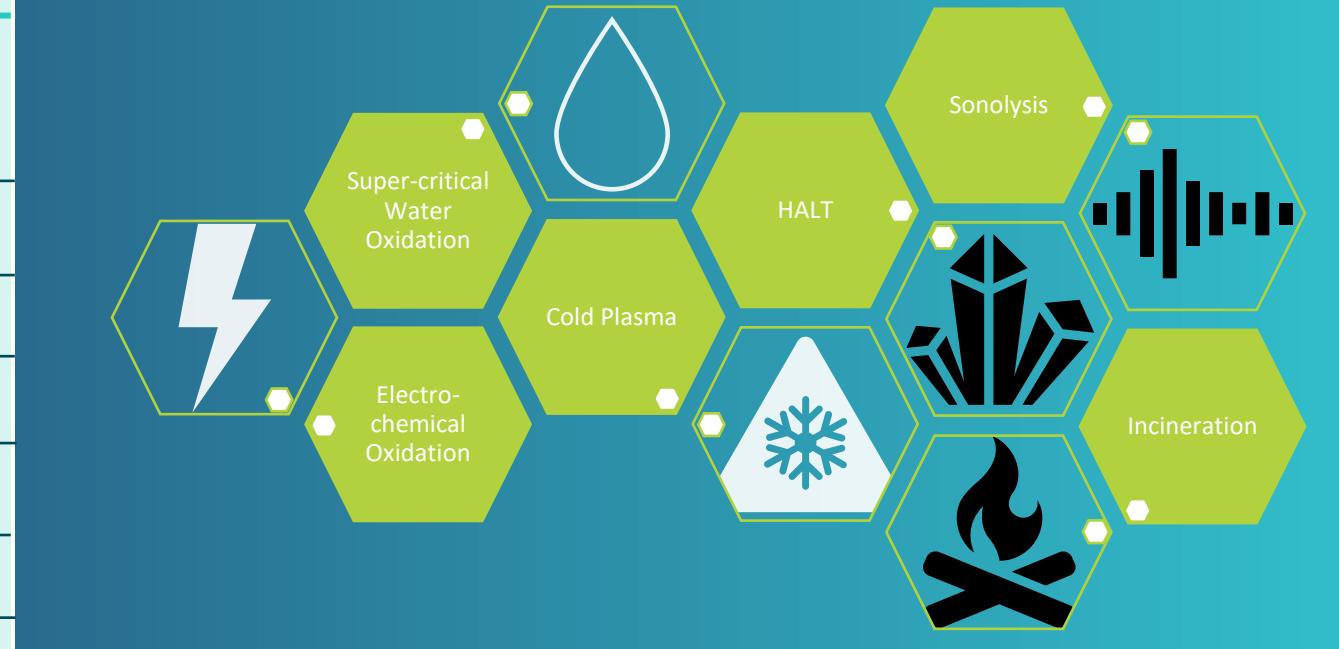
PFASigator Monitoring & Control

- Automatic batch loading & discharging
- Automatic reagent dosing
- Real-time fluoride measurement confirms PFAS mineralization
- Remote monitoring & control



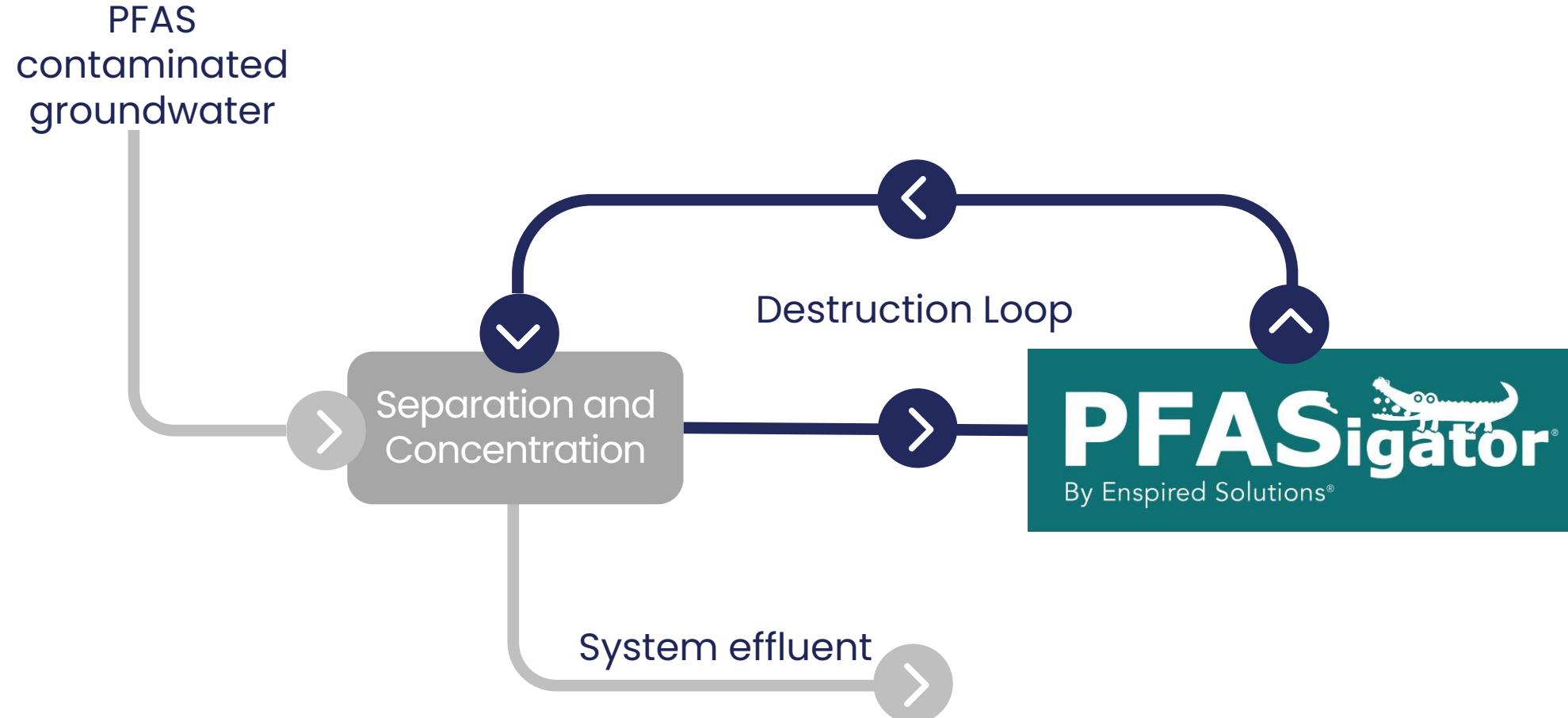
PFAS Destruction Considerations

 ENSPIRED SOLUTIONS™	
Photo-activated Reductive Defluorination	
Energy use	⚡
Safe	✓
Tunable reaction	✓
No toxic byproducts	✓
Automated	✓
At commercial scale	✓
Buy or lease	✓
Owner operated	✓



TECHNOLOGY APPLICATIONS - CASE STUDIES

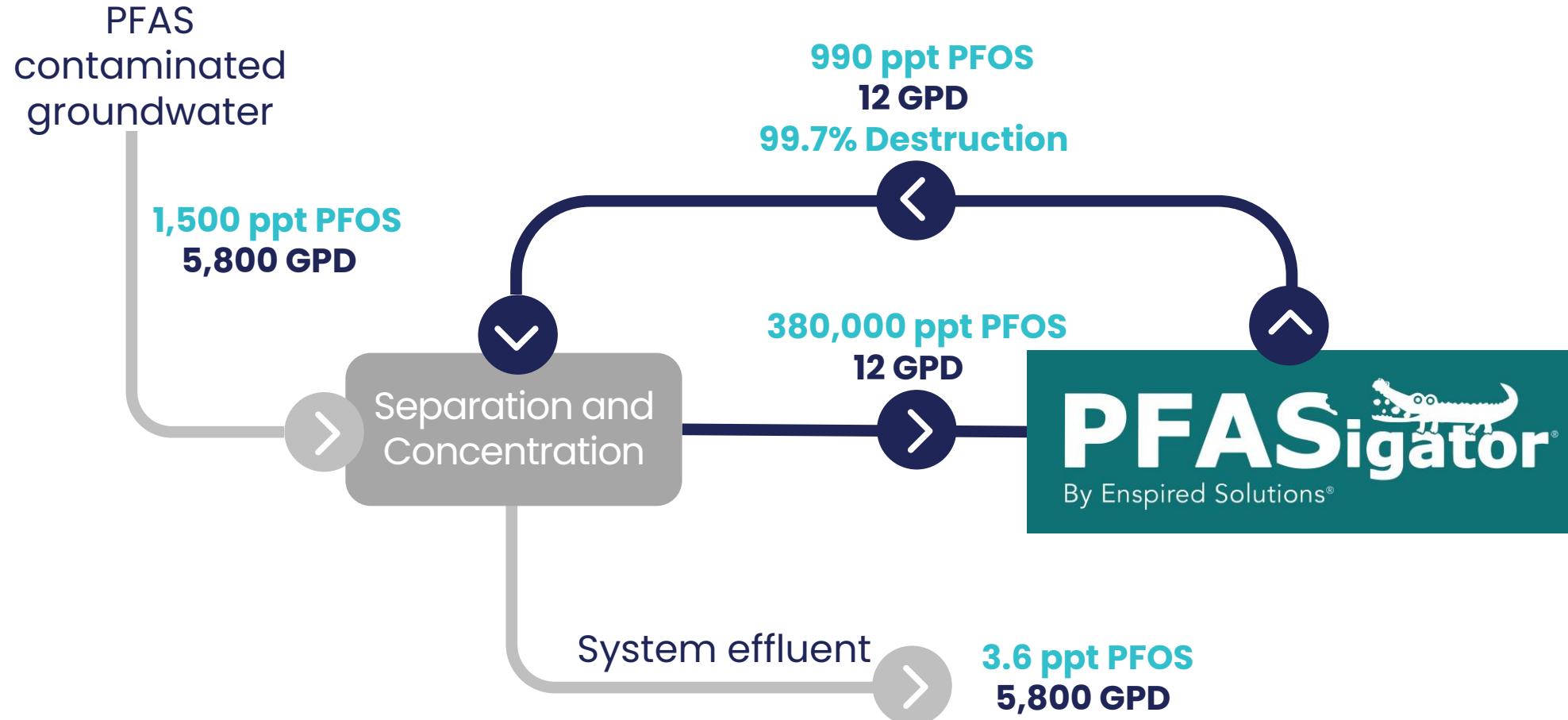
Field Pilot Recirculating Process Flow



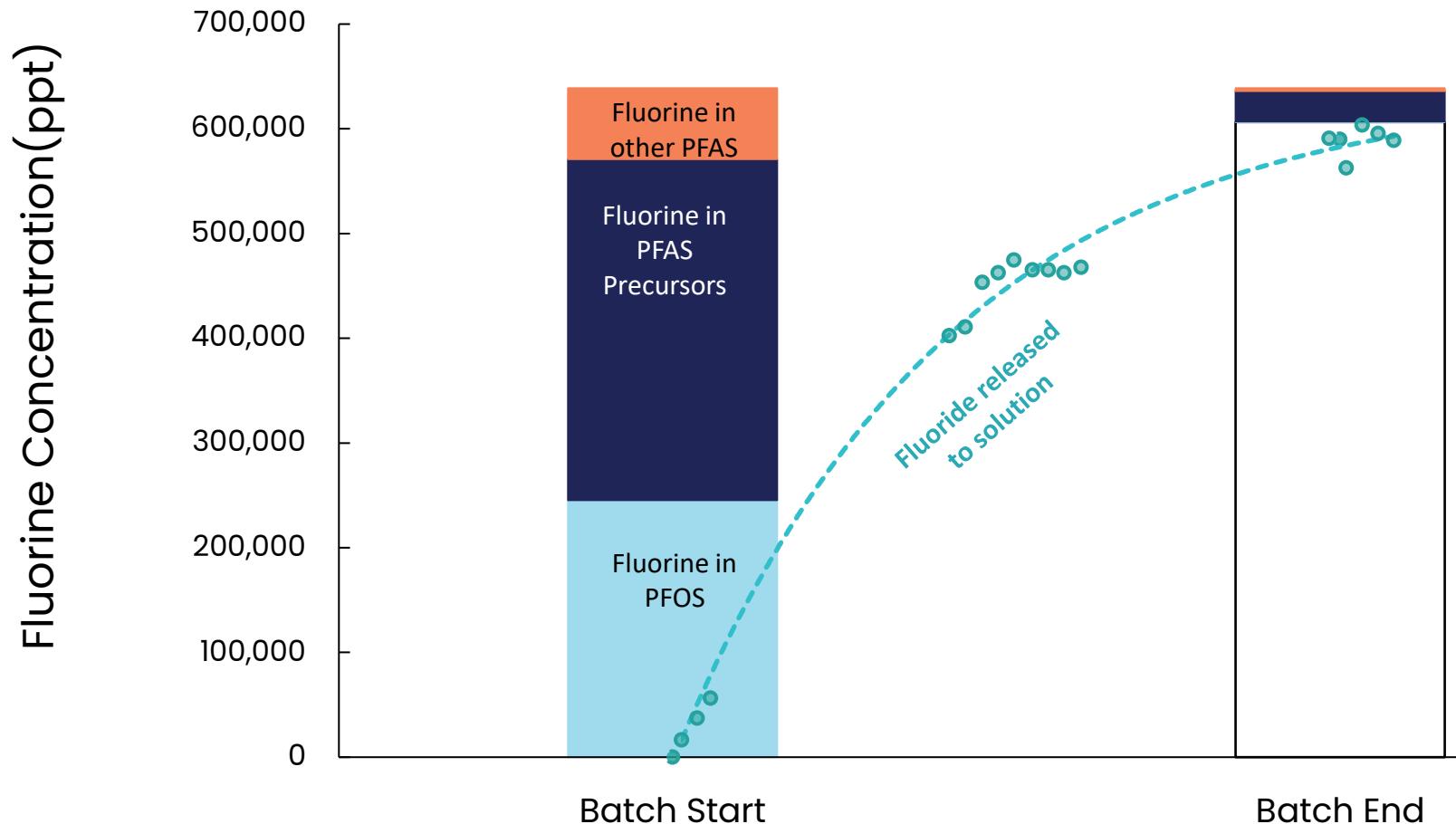
PFASig^{ator}
FOREVER CHEMICALS GONE FOREVER™
www.inspiredsolutions.com



Field Pilot PFOS Destruction Performance



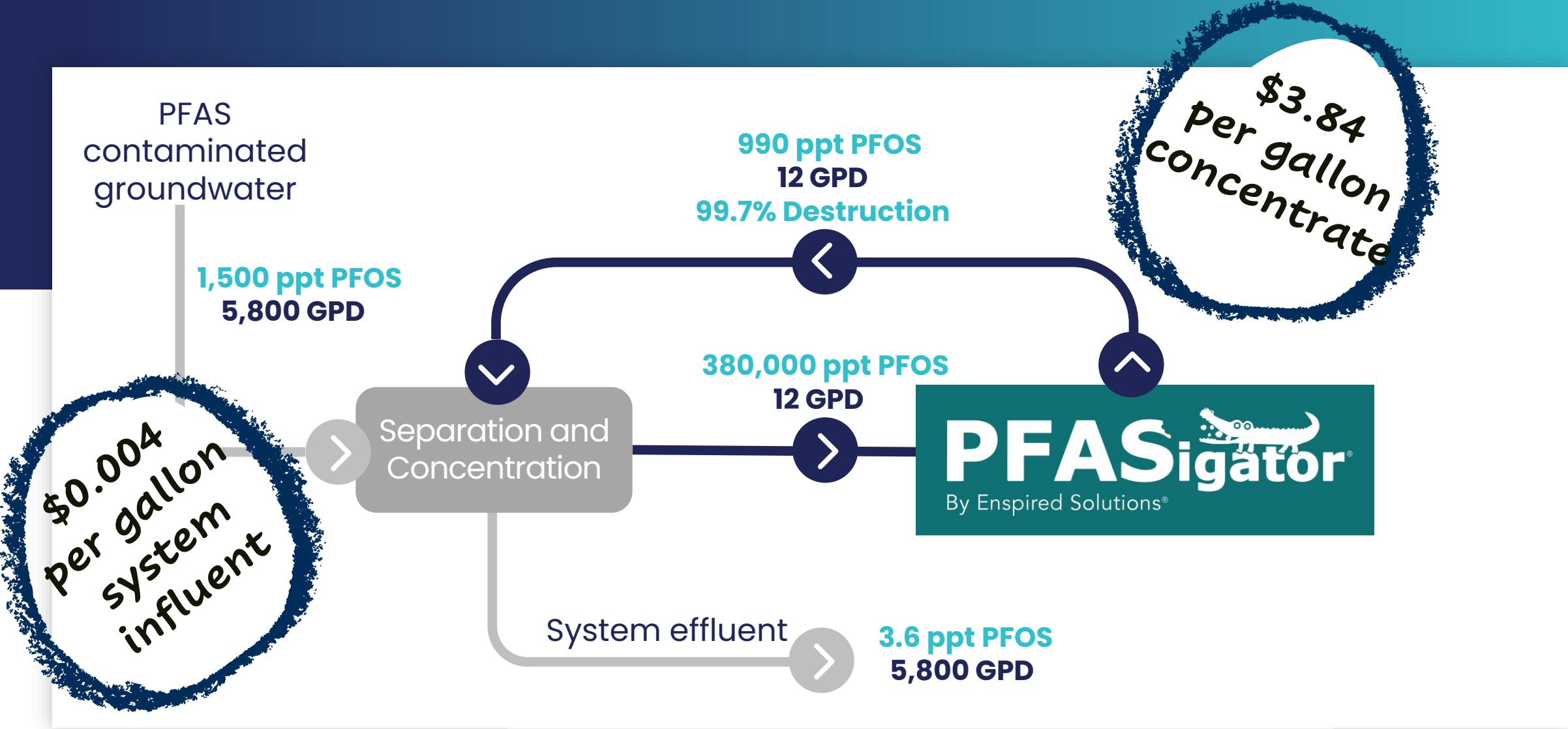
Fluoride Mass Balance



Fluorine/Fluoride Mass Balance

Fluorine - Start:	638,847 ppt
Fluorine - End:	32,517 ppt
Fluorine Decrease:	606,330 ppt
Fluoride Detected:	580,600 ppt (97%)

Field Pilot PFOS Destruction Performance



PFASigator Implementation Roadmap





Comments and Questions?

Nicholasbackman@ect2.com
920-558-7013

Meng.Wang@inspiredsolutions.com
434-825-8361



Montrose Environmental Group

