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Presentation Outline

- **Overview**
 - About Us
 - PFAS
 - Routes of Exposure
 - State Regulations
 - EPA PFAS Road Map
- **Solutions**
 - Why Carbon and Resin Work
 - PFAS Removal
 - Testing
 - Vessels
 - MitiGATOR
- **Case Studies**
- **Wrap-Up**
 - Comprehensive Portfolio
 - Next Steps

A photograph of a young girl with brown hair, wearing a pink baseball cap and a teal tank top, leaning over a stainless steel public water fountain. She is drinking water from the fountain. The background shows a paved walkway and green trees under a bright sky.

 **evoQUA**
WATER TECHNOLOGIES

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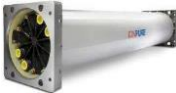
Who We Are *le-vōk-wä*

Water is a critical yet finite resource. We believe there is power and purpose in combining expertise, innovation and a commitment to maintaining this resource, now and in the future.


Evoqua Water Technologies is a leading provider of water and wastewater treatment solutions, offering a broad portfolio of products, services and expertise to support industrial, municipal and recreational customers.



Headquartered in Pittsburgh, Pennsylvania, Evoqua and our brands have over a 100-year heritage of innovation. We help more than 38,000 customers solve water challenges at over 200,000 installations worldwide and operate in more than 150 locations across ten countries. Every day, millions of people and thousands of companies rely on us as their trusted advisor to help them meet their water needs.



PRODUCTS




TECHNOLOGIES



SYSTEMS



SERVICES



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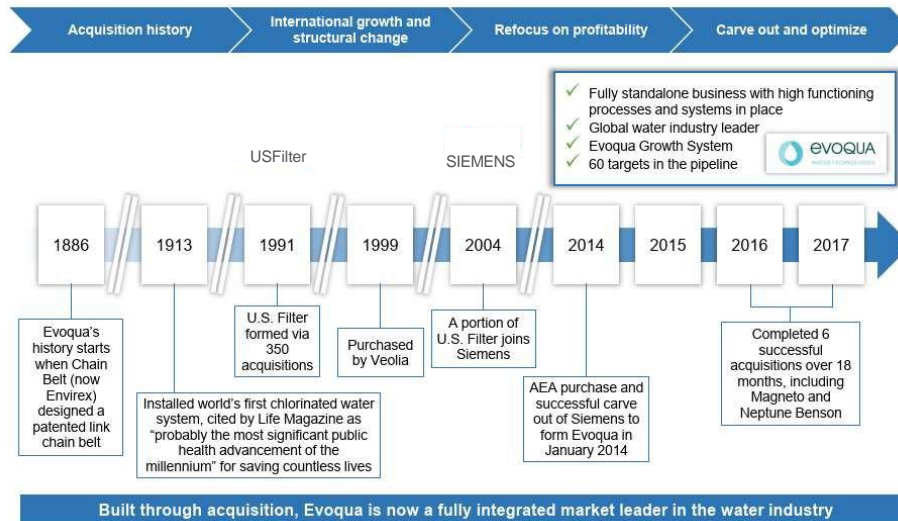
About Evoqua



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Our Company History



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Our Commitment to Safety

Our blended approach to environment, health and safety

EVOQUA SAFETY PROCESS (ESP)

ESP is a system to prevent or reduce injuries using a mobile platform of behavior-based tools along with proven management techniques. The objective is to eliminate undesirable behaviors which can lead to incidents.

The system includes:

- Pre-Job Task Review (TAKE 2)
- Standard Work Instruction
- Mobile-Based Safety Tools
- Behavior Observations
- Incident Investigations
- Organizational Engagement

ENVIRONMENT, HEALTH & SAFETY SYSTEM (EHS)

Our Evoqua EHS Management System (EMS) outlines how we integrate EHS across the organization. Our EHS programs and systems are embedded in our culture and corporate strategy.

Elements of this program include:

- Leadership Commitment
- Organizational Roles & Responsibilities
- Planning
- Communication & Participation
- Governance & Oversight



TAKE TWO

Evoqua empowers all employees to work safely and prevent injuries. The primary tool our employees utilize to ensure safe working conditions is the TAKE 2 process and STOP WORK. All employees are trained to perform a TAKE 2 which mandates that before beginning any activity, task or job each employee shall:

- Assess the Risk
- Analyze How to Reduce the Risk
- Act to Ensure Safe Operations

Every Evoqua employee has the right, authority and responsibility to stop any unsafe work without repercussion.



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Our Commitment to Sustainability

Our commitment to positively impacting human health and wellness, everyday

As the world moves towards a more circular and sustainable economy, we are well positioned to help customers achieve their sustainability goals. Our offerings are aligned with the UN Sustainable Development Goals (SDGs), allowing us to help our customers create a more sustainable future.



Use of the SDG logos or icons does not imply the endorsement of the United Nations. Learn more: <https://www.un.org/sustainabledevelopment>

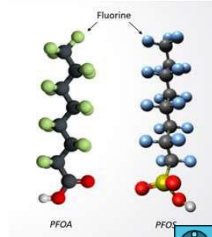
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What are Per- and Polyfluoroalkyl Substances (PFAS)?

- Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals used to make everyday products resistant to stain, heat, oil, grease, and water
- In use since the 1940s; Roy Plunkett and DuPont's discovery of Teflon
- USS Forrestal fire (1967) was a triggering event for the creation of PFAS firefighting foams **AFFF**, Navy revamped Fire Fighting Practices, Sen McCain
- Over 6,000 compounds including:
 - PFOA (perfluorooctanoic acid)
 - PFOS (perfluorooctane sulfonic acid)
- Carbon-fluorine bond is one of the strongest in chemistry... a very stable compound and **Hard to Treat!**



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Short Chain and Long Chain PFAS

PFAS

Short-chain

Long-chain

PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFTrDA, PFTeDA

PF carboxylic acids, PF sulfonic acids, PF perfluorinated acids, PF phosphonic acids, PF phosphinic acids

PFBS, PFHxS, PFHpS, PFOA, PFNA, PFDA, PFTrDA, PFTeDA

PF sulfonamides, PF sulfonamide derivatives, PF sulfonamide derivatives

PF perfluorinated acids, PF phosphonic acids, PF phosphinic acids

PF perfluorinated acids, PF phosphonic acids, PF phosphinic acids

Initial Attention

PFOS PFOA

Early Attention

PFHxS PFBS PFNA PFHpA

Recent Attention

Fluorololomers, Perfluoroethers, Perfluoropolyethers

Increasing Attention

All other PFAS

Common Analytes

UCMR3

Carboxylates

PFDA, PFTeDA, PFTrDA, PFDoA, PFUnA, PFDA, PFHxA, PFPeA, PFBA

PFDA, PFTeDA, PFTrDA, PFDoA, PFUnA, PFDA, PFHxA, PFPeA, PFBA

Thematic and not proportional. Bottom of triangle indicates additional number of compounds; not a greater quantity by mass, concentration, or frequency of detection.

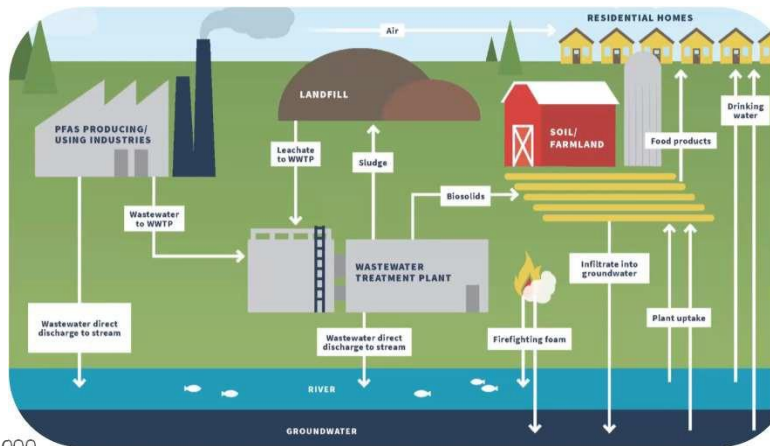
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Routes of Exposure/ Health Effects

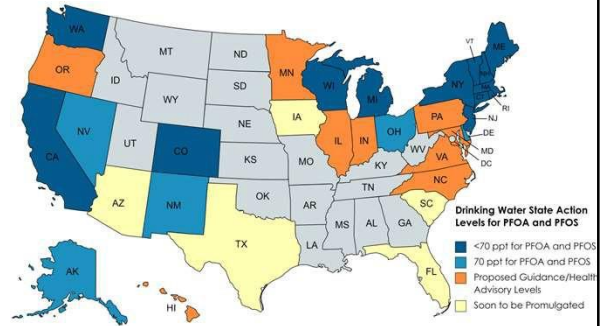
- **Sources**
 - Manufacturer (primary producers)
 - Commercial applications
 - Landfill
 - WW effluent and BioSolids
 - Firefighting foam applications
- **Exposure Routes**
 - Occupational exposure
 - Drinking water
 - Atmospheric transport; contaminated food, consumer products
- **Adverse health effects**
 - C8 Health Study 2005-2006, 6 towns, 70,000
 - CDC lab results have linked adverse healthy effect to growth, development, reproduction, and liver injury.
 - Toxicology - Low birth weight, vaccine efficacy, altered puberty, skeletal variations, liver effects



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How Does PFAS Impact DW?

- Federal Regulations
 - EPA current interim guidelines came out in Feb 2021
 - EPA drinking water lifetime health advisory limits (HAL) for PFOA and PFOS are 70 PPT set in May 2016-update 2022
- State-Based Regulations (a patchwork)
 - Effective, Proposed, Non-MCL, Guidance Levels
- Public Perception
- Brand Protection
- Cost Avoidance



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PFAS Strategic Roadmap: EPA’s Commitment to Action

- On Oct. 18th, the US EPA announced its “PFAS Strategic Roadmap: EPA’s Commitment to Action 2021-2024,” which provides the agency’s plan for regulating PFAS over the next three years. This roadmap is the product of the EPA’s Council on PFAS and includes a comprehensive program combined with expected timetables.

• Report Highlights:

EPA Action	Expected Timeline
Establish a national primary drinking water regulation for PFOA and PFOS	Proposed rule Fall 2022, Final rule Fall 2023
Propose to designate certain PFAS as CERCLA hazardous substances	Proposed rule Spring 2022, Final rule Summer 2023
Issue advance notice of proposed rulemaking on various PFAS under CERCLA	Spring 2022
Restrict PFAS discharges from industrial sources through a multi-faceted Effluent Limitations Guidelines program	2022 and Ongoing
Publish health advisories for GenX and PFBS	Spring 2022
Issue updated guidance on destroying and disposing of certain PFAS and PFAS-containing materials	<u>By</u> Fall 2023 (could be earlier)
Build the technical foundation to address PFAS air emissions	Fall 2022



Full report available at: www.epa.gov/PFAS

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EPA PFAS Roadmap Update [6.15.22]

- **[New] White House Fact Sheet Posted 6/15/22**
 - Updated Lifetime Health Advisories for PFOA, PFOS and Final Health Advisories for PFBS, and GenX
 - **\$1B in grant funding available to help small/disadvantaged communities reduce PFAS in drinking water**
 - New tools for state and local governments

• Health Advisories

Chemical	Lifetime Health Advisory Level/Value (ppt)	Minimum Reporting Level ¹ (ppt)
PFOA	0.004 (interim)	4
PFOS	0.02 (interim)	4
GenX Chemicals	10 (Final)	5
PFBS	2,000 (Final)	3

¹Unregulated Contaminant Monitoring Rule (UCMR) 5 MRL is the minimum quantitation level that, with 95 percent confidence, can be achieved by capable analysts at 75 percent or more of the laboratories using a specified analytical method. These MRLs are based on the UCMR 5 requirement to use Method 533.

• Where Does the Funding Come From?

- IJA includes **\$10 Billion** for PFAS/emerging contaminants funding:
 - **\$1 Billion** to address emerging contaminants in wastewater through the Clean Water SRF
 - **\$4 Billion** to address PFAS in drinking water through the Drinking Water SRF
 - **\$5 Billion** for small and disadvantaged communities to address emerging contaminants



State of New York



New York State has been developing drinking water standards, also called contaminant levels (MCLs) to address these contaminants, starting with the two most common PFAS: perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).

Public drinking water with PFOA or PFOS above the MCLs must be treated to reduce the levels below the MCL. New York's drinking water standards for emerging contaminants are among the most protective in the country.

In 2020, NYS set maximum contaminant levels (MCLs) of 10 parts per trillion (10 ppt) each for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), and 1 part per billion (1 ppb) for 1,4-dioxane.

New York was the first state to develop an MCL for 1,4-dioxane. New York is working to pass even more drinking water standards and notification levels for up to 23 PFAS. New York State DOH continues to review the evolving science around health risks associated



State MCLs for PFAS								
Specific PFAS	NHDES	NIDEP	VT DEP	MI DHHS	MA DEP	NY DOH	RIDEM	WI DNR
PFOA	12	13	20* combined	8	20* combined	10	20* combined	70 combined
PFOS	15	14	*	16	*	10	*	*
PFHxS	18		*	51	*		*	
PFNA	11	13	*	6	*		*	
PFHpA			*		*		*	
PFDA					*		*	
GenX				370				
PFBS				420				
PFHxA				400,000				

All units are in part-per-trillion

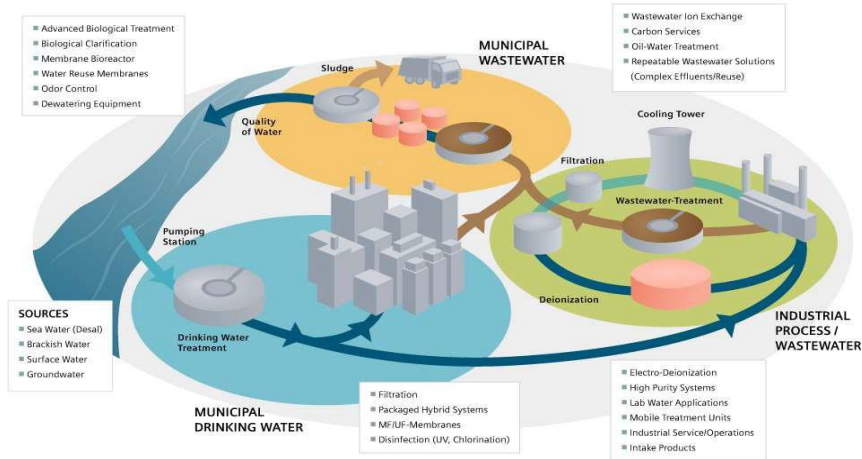


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Water and Wastewater Treatment needs



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Environmental Solutions Division

Equipment, media and services group, keeping customers safe, sustainable, and in compliance, by removing organic and inorganic contaminants from water and vapor streams.



Key Contaminants:

- PFAS
- TCE/PCE
- MTBE
- 1,4-Dioxane
- Arsenic
- Iron / Manganese
- Perchlorate
- Nitrate
- Chrome VI
- ...And Many More



Key Evoqua Products:

- Granular Activated Carbon (GAC) and Reactivation Services
- Ion Exchange and Regeneration Service
- Advanced Oxidation Process (AOP)
- Emergency, mobile, and permanent solutions
- Zeolites, Organoclays, Fluorosorb



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PFAS Removal Solutions: Each Water Is Unique



Granular Activated Carbon

- Most proven technology
- Reduces liability
- Removes other organic contaminants
- Minimal maintenance

Effective Products:

AquaCarb® CX Carbon
UltraCarb® 1240AW Carbon



Single Pass Ion Exchange

- Lower EBCT / Higher flowrate
- Small footprint
- High throughput
- No chemicals or liquid waste
- Minimal maintenance

Effective Products:

PSR2 Plus
APR1 and APR2



Membranes

- Highly effective
- Removes dissolved solids

Effective Products:

Vantage® Product Line

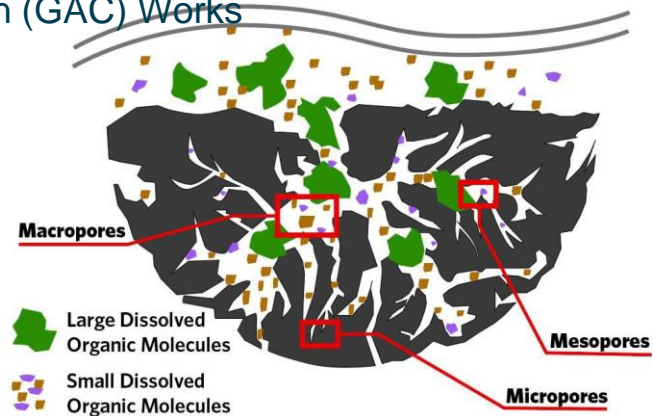


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Why Granular Activated Carbon (GAC) Works

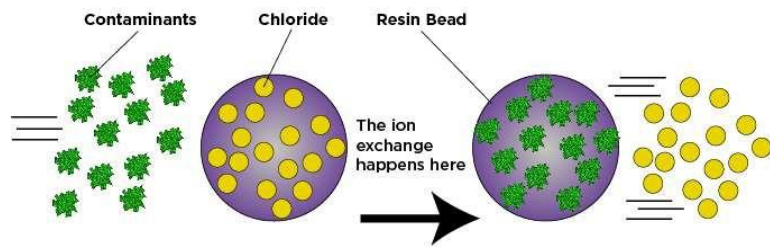
- GAC is a highly porous media with large surface area for contaminant adsorption.
- All carbon is not created equal.
- Performance determined by porosity and surface chemistry.
- Evoqua helps to match the user with the best performing GAC for their application.



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Why Ion Exchange (IX) Resin Works

- Ion Exchange is based on the principle of exchanging a harmless ion for the contaminant.
- Smaller system footprint if space is an issue.
- Lifecycle costs are easier to predict.
- Spent resin can be incinerated.



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RSSCT (ASTM D6586)

- Prediction of contaminant adsorption on GAC
- Test method outlined and approved by ASTM D28 Activated Carbon Test Methods Committee
- Can simulate months to years of full-scale operation within days to weeks of lab-scale time
- Good comparative method with some predictive ability



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Pilot Scale Performance Testing

- Pilot scale can be used to test the effectiveness of the technology for contaminant removal before a full-scale system is installed for community's drinking water.
- Uses small diameter (3" to 6") columns to simulate operating conditions of full scale adsorber.
- Matching hydraulic loading rate and shortening bed depth (e.g. 0.5 full scale) can decrease time to reaching conclusions.
- Requires more time and labor, however pilot studies provide more accurate predictions of bed life in full-scale applications

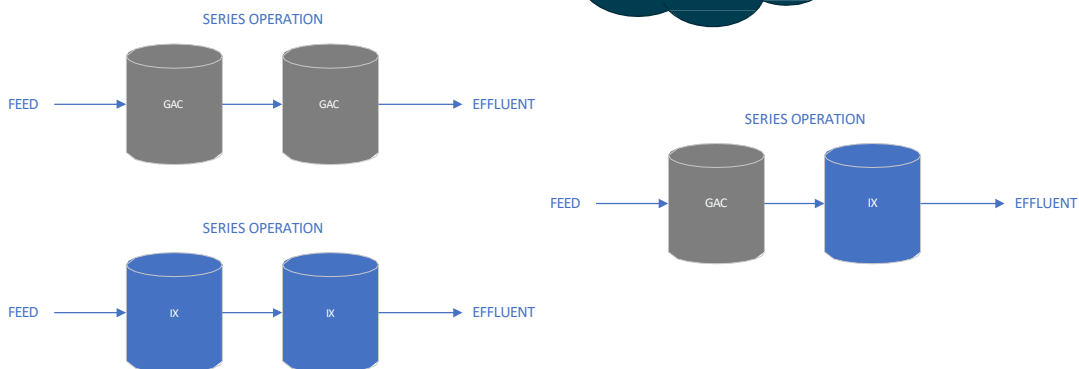


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Standard Operation

Flexibility in design allows flexibility in operation

Parallel operation
also possible



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PV-Series High Pressure Liquid Phase Adsorption Systems

Models

PV-500, PV-1000, PV-2000, PV-5000,
PV-10000, PV-30-SYS, PV-48-SYS

- Durable, lined carbon steel vessels
- 500-10,000 lb. GAC media per adsorber
- Suitable for higher pressure (<75 psig) applications
- Flow rates from 25-500 GPM per adsorber
- Applications: groundwater remediation, wastewater treatment, pilot testing, UST cleanup, drinking water and spill cleanup



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HP® Series Liquid Phase Adsorption Systems (ASME code)

Models

HP-810, HP-1020, HP-1220, HP1230, HP1240,
HP1560, HP-2000, HP2000SS, IX-48

- Durable, lined carbon steel vessels, ASME Code
- Dual stage system with interconnecting piping
- 10,000 – 60,000 lb. GAC media per adsorber
- 8', 10', 12' and 15' diameter vessels
- Rated to 125 psig (IX-48 rated 100 psig)
- Flow rates from 500 - 1500 GPM per adsorber
- Applications: drinking water, groundwater remediation, food and beverage



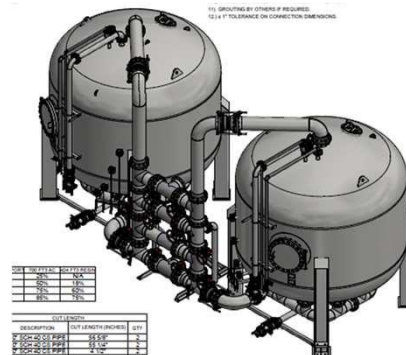
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HP CIX Systems Designs

Designed for Emerging Contaminant Treatment

- Designed for ease of lifetime operations & flexibility for future configurations
- Flexible design allows for use of multiple types of medias
- Allows pre-purchase of equipment while piloting GAC/IX/Novel sorbents
- Allows for overall lifetime cost optimization as more products become approved/available
- Patent-Pending Design
- “System” includes two vessels + manifold



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HP® Series | Septa Underdrain Design

- Lower overall height
- Lower pressure drop through nozzles and screens
- Less chance of mechanical failure to the underdrain
- No vessel entry required for installation or servicing of underdrain
- Longer life expected for internal coating
- Fewer obstacles preventing carbon removal
- Greater utilization of carbon
- Underdrain repair can be accomplished without removal of GAC or vessel entry



Flexibility
between Carbon
and Resin!



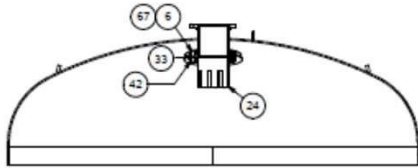
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Inlet Distributors

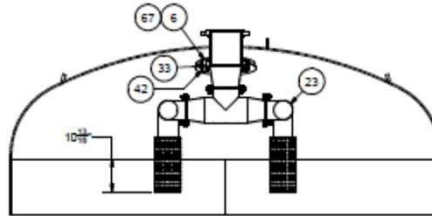
Can be swapped out on location

GAC - "TOP HAT"



SINGLE POINT CARBON DISTRIBUTION
SECTION G-G

IX - FOUR POINT



4 POINT RESIN DISTRIBUTION
SECTION G-G



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Inlet Distributors

Can be swapped out on location

GAC - "TOP HAT"



IX - FOUR POINT



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HPCIX Price Comparison for GAC vs. IX

Evoqua HPCIX design Overview: GAC vs IX

PFAS- GAC = 10 min EBCT (also applies to TCP treatment with GAC - change out costs will be slightly less)

Equipment Model	Max flow in series	Capital Cost	CF media per vessel	Initial Fill Cost	Change out cost
HP810SYSCIX	250	\$ 375,000.00	350	\$ 37,000.00	\$ 30,000.00
HP1020SYSCIX	500	\$ 400,000.00	700	\$ 74,000.00	\$ 60,000.00
HP1220SYS CIX	500	\$ 425,000.00	700	\$ 74,000.00	\$ 60,000.00

PFAS- IX = 2 min EBCT

Equipment Model	Max flow in series	Capital Cost	CF media per vessel	Initial Fill Cost	Change out cost
HP810SYSCIX	900	\$ 375,000.00	247	\$ 165,490.00	\$ 101,270.00
HP1020SYSCIX	1200	\$ 400,000.00	353	\$ 236,510.00	\$ 144,730.00
HP1220SYS CIX	1800	\$ 425,000.00	495	\$ 331,650.00	\$ 202,950.00

*SYS = 2 vessels with connecting piping/valve manifold

**Initial fill = filling (2) vessels in system

***Change out = changeout media in (1) lead vessel



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Mobile Units

When your operation cannot be interrupted

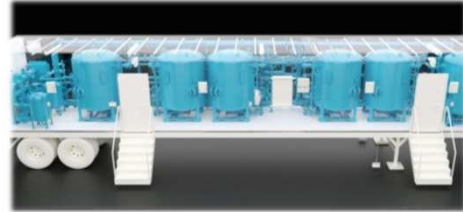
- Rapid or emergency response
- Temporary or semi-permanent installation
- More than drinking water applications ...
 - Construction site water treatment (50-2000+ gpm)
 - Industrial process water
 - Industrial wastewater
- Footprint: variable / skid-mounted and tailored to site constraints



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MitiGATOR Product Overview

- Potable trailer with NSF61 wetted components
- Maximum flow rate 1000 GPM (designed for 200-1000 GPM)
- 2 Bag filters for pre-filtration
- 6 x 60in custom vessels
- Carbon and or Resin



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Leading Service Provider

- Our priorities are community and environmental safety
- Provide quick response to ensure clean, safe water.
- National coverage – large cities and small towns
- We have easy financing options for your community or application:
 - Lease to Own
 - Rental
 - Capital Purchase
 - Build/Own/Operate



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GAC Installation

Prep at the Evoqua Branch

- The slurry truck is sterilized
- DDW Approved and Accepted Procedures are followed
 - Plants maintains SOP Procedures
 - Controlled Indoor Environment
- The carbon is loaded into the transport truck and taken to the site



Fill at LADWP:

- GAC is slurried in through the slurry inlet
- GAC soaks overnight
- Backwash the following morning
- Forward flush to drain for 15 minutes then sample for BacT's and plate count
- The vessel remains in low flow forward flush until the samples come back good
- The vessel is put back into service by LADWP



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Goals of Proper Bed Startup

- **Proper startup procedures will eliminate ~90% of potential operational problems with carbon bed during operation!**
 - Maximize utilization of the carbon's surface area
 - Remove air and fines to minimize pressure drop
 - Stratify bed if the adsorber will be subsequently backwashed during operation
- **Startup Processes**
 - Deaeration
 - Backwashing



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GAC Vessel Change Out

- Vessels are scheduled for change out
- Spent GAC is slurried out of the slurry out line
- Inspection and vessel entry if necessary
- Fill procedure is then initiated.
- The lead bed is put in the lag position, and the lag becomes the new lead -The freshest GAC is always in the “polish” position.
- Spent carbon disposal via reactivation



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Kennebunk, Kennebunkport & Wells Water District (KKWWD), Maine

Proactive, Tested Many Carbon Systems

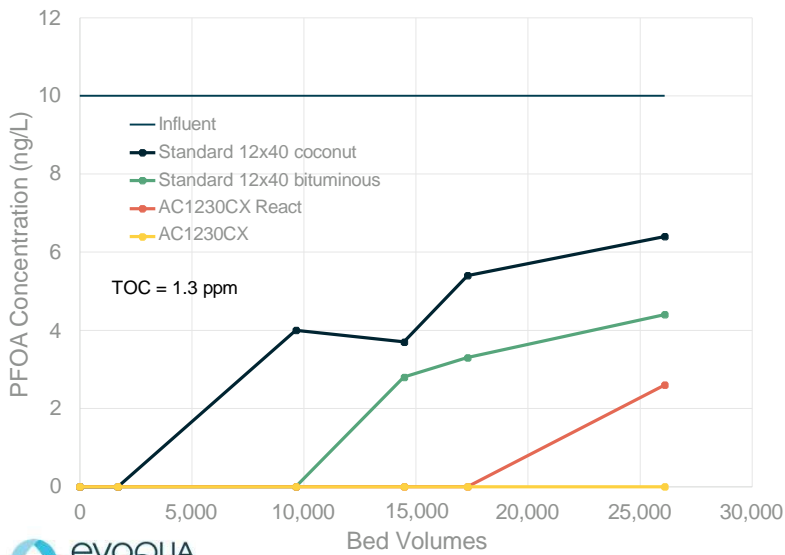
- Evoqua advised KKWWD to pilot test several types of carbon to determine which performed best given their local water chemistry.
- The results showed that the Evoqua’s carbon made from coconut provided an additional 3 months of full scale run time, versus other carbons.
- KKWWD installed a full-scale high pressure vessel system to remove PFAS from the water.



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KKWWD: GAC Pilot Investigation



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KKWWD: GAC Installed Solution

- Single 12' sand filter vessel
- One lead/lag GAC system
- 12' diameter vessels
- 34,700 lbs. AquaCarb®1230 CX media
- 10-minute EBCT design/8 min EBCT actual
- Outdoor installation
- Custom-Segregated React and Return can save 30% on carbon rebeds
- Septa design allows for built in flexibility



Right: Interior lining of GAC vessel with Septa underdrain design



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KKWWD – Online In Time For Tourists With Minimal Impact to Ratepayers

- “Our goal now is to continuously produce drinking water with non-detect levels,” says KKWWD, Superintendent. **“With Evoqua’s lead-lag system we should have no problem.”**
- **The impact to ratepayers is roughly three to four cents per day**, according to Labbe, and they won’t see the increase for several years.
- “It’s still cheaper than buying water from an outside water utility, and **it keeps us independent.**”

<https://www.seacoastonline.com/news/20180118/kkwwd-shuts-down-well-due-to-pfc-levels>



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Portfolio | Comprehensive Solutions

Unbiased technology, start to finish

- Temporary mobile assets for rapid deployment providing treatment today
- Treatability Studies | Identifying the optimal technology train for each customer
- Permanent solution
- Servicing Network | 85% of the US population within 2 hours
- Reactivation Services | Disposal know-how



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Next Steps

1. Assess risk
 - Regulatory requirements (geographical, temporal, activity type)
 - Brand protection concerns
2. PFAS sampling and analysis
 - SOPs, NELAP/DOD QSM, MDLs vs MRLs
3. Remedial alternatives
 - Lifecycle costs, destructive technology vs concentration methods, disposal methods
4. Testing methodologies
 - Pilot, RSSCT, Lifecycle costs, destructive technology vs concentration methods, disposal methods



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Summary: Your Water Is Unique

A Customized Solution Just For Your Community Based On Local Water Conditions



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And Now....Time For Your Questions

Reach out to us:

Geoff Pellechia

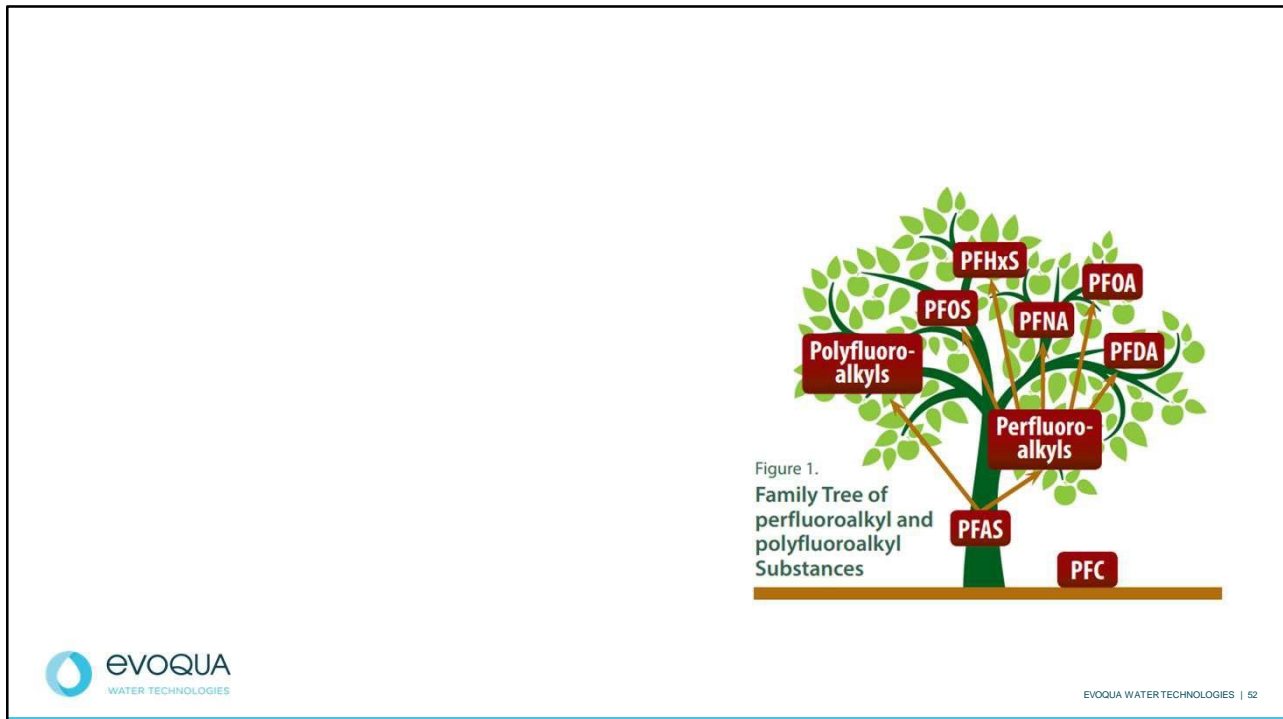
Geoffrey.Pellechia@evoqua.com

(207) 272-7118

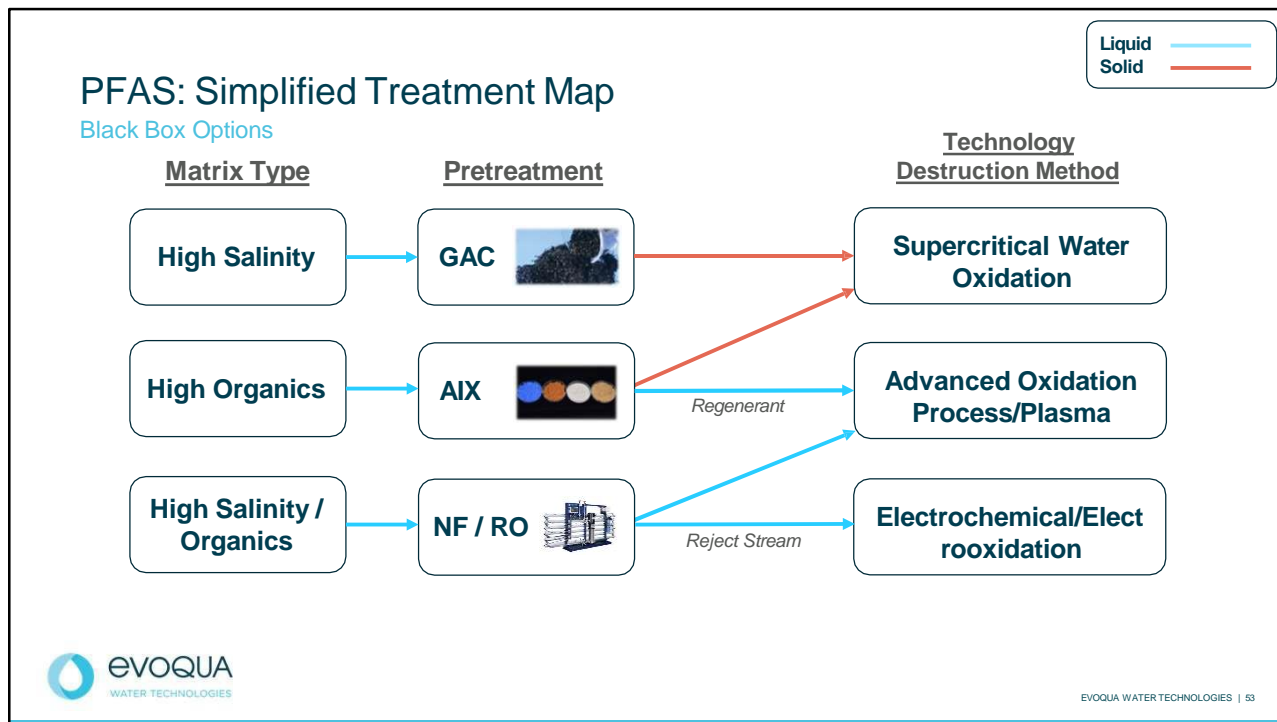




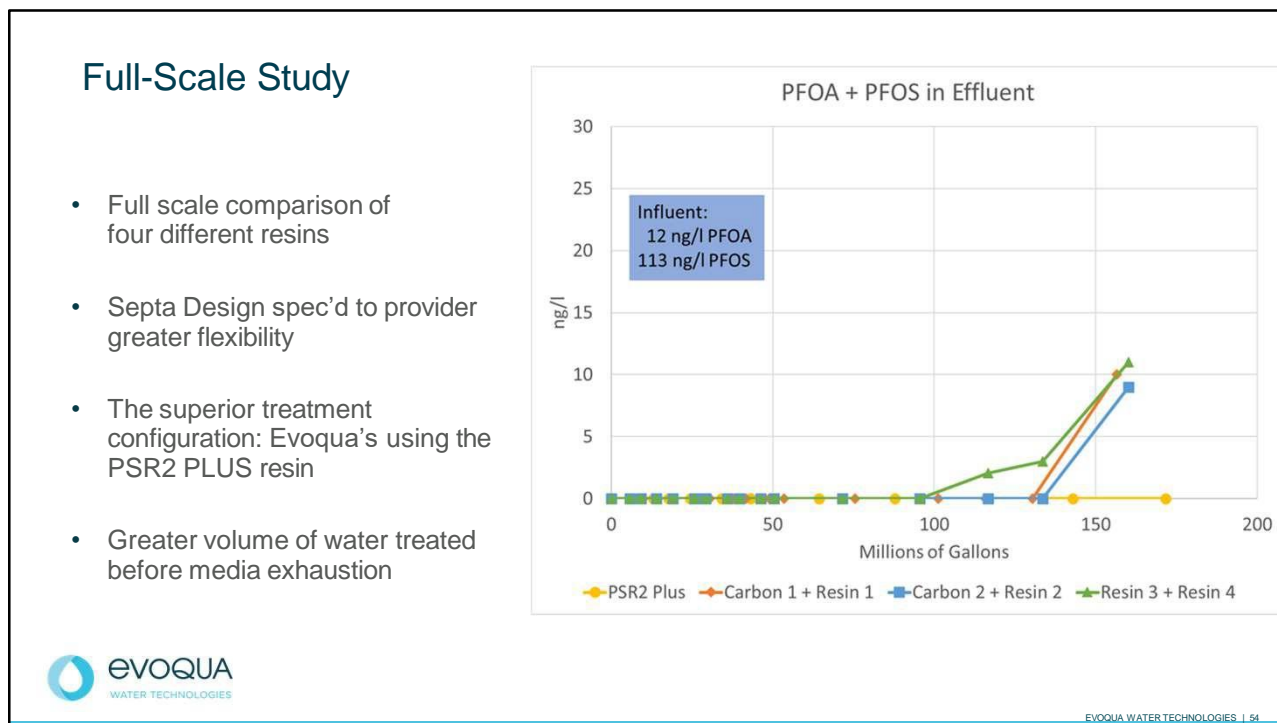
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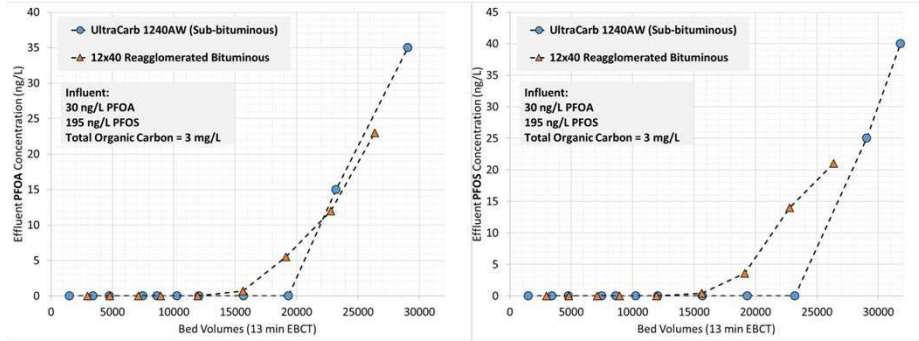


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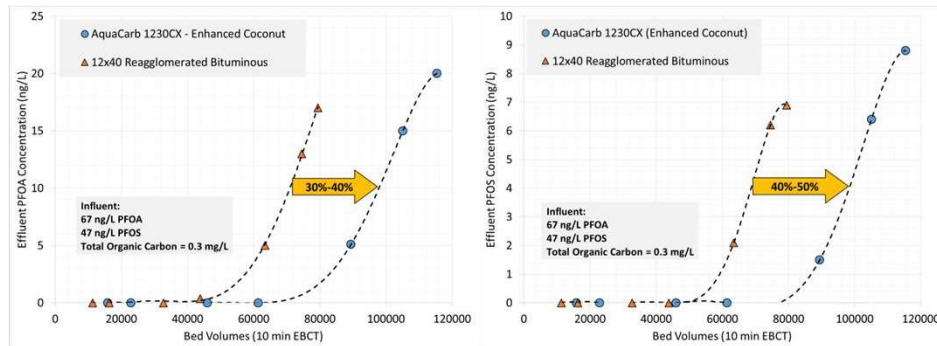
UltraCarb® 1240AW Carbon is Effective at Removing PFOA/PFOS in Surface Water



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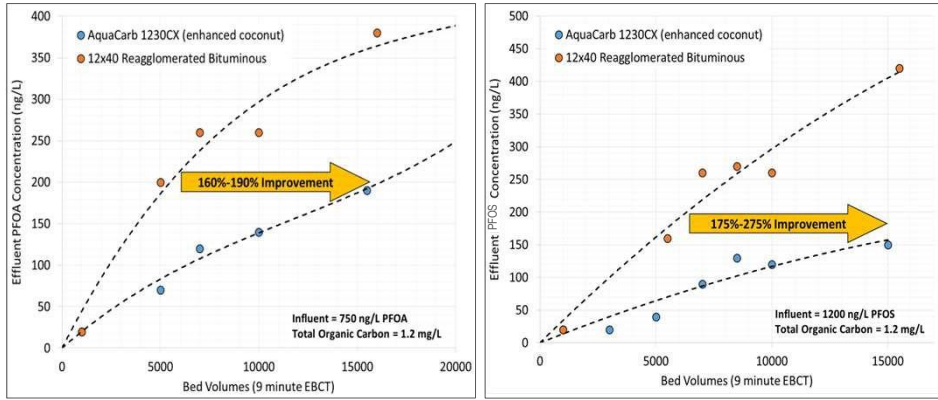
AquaCarb® CX Carbon Can Deliver 30-50% PFOA/PFOS Performance Improvement



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AquaCarb® CX Carbon Can Deliver >150% Performance Improvements in Remediation Applications

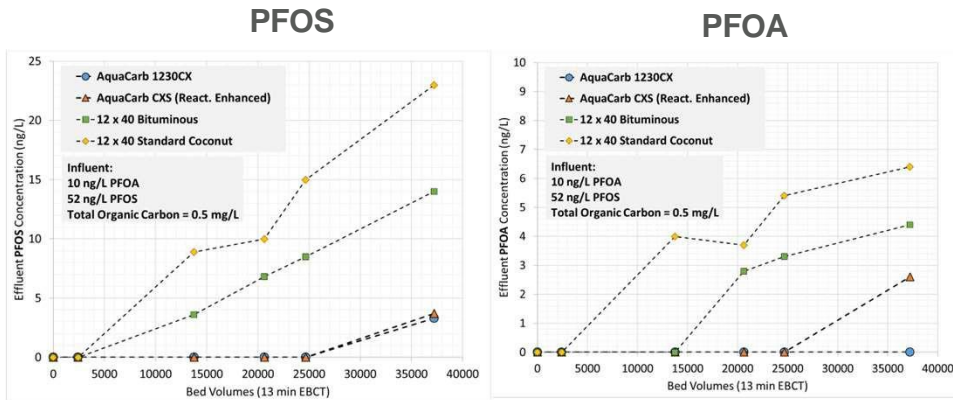


Data from Engineering Performance Solutions, Report No. 164.01.0316



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Reactivated AquaCarb® 1230CX can surpass or match virgin carbons.



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Resin Full Scale Data



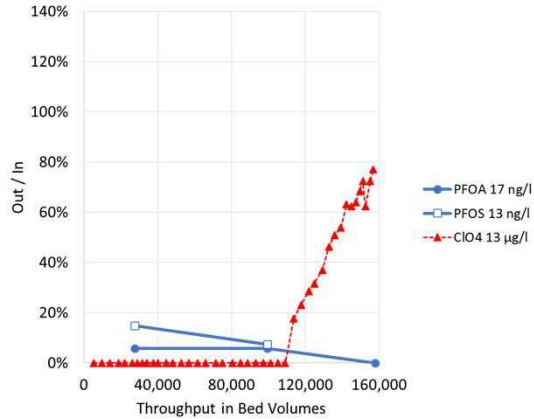
Full Scale Perchlorate system shown to remove PFOS and PFOA well

Perchlorate broke through before PFAS

PFAS analytical methods have improved since 2008

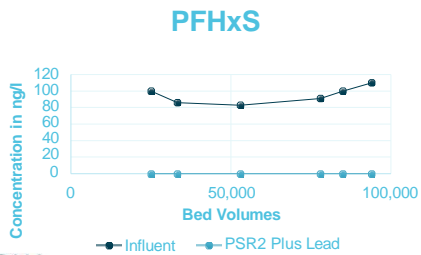
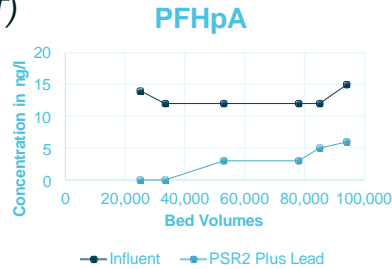
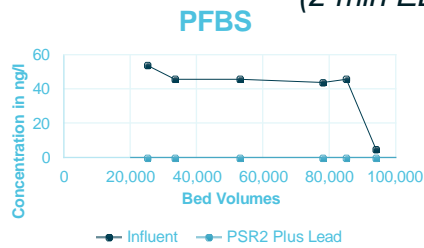
Four additional sites have shown PFOA/PFOS at non-detect more recently when treating perchlorate full scale

Southern California 1000 gpm Perchlorate-Removal System
2008 Data



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Dowex® PSR2 Plus is Effective for Short Chain PFAS: Groundwater (2 min EBCT)



- PSR2 Plus takes up both long and short chains PFAS
- Sulfonics are absorbed better than non-sulfonics
- After 100,000 BV, ran out of time for pilot and moved forward with full scale system



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Ongoing Pilot with Typical Groundwater



Low TDS
 Low TOC
 Excellent removal with resin
 9 months into an 18 month pilot
 Site has full-scale perchlorate-removal system that has no PFOA or PFOS in effluent.

