PFAS Today, Tomorrow, and Forever

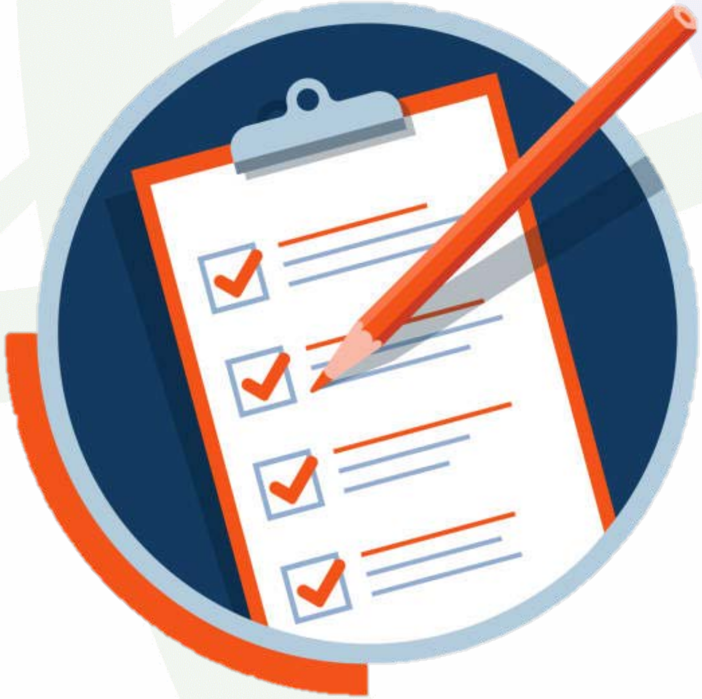
Effective Treatment of "Forever Chemicals"

Will Shaffer, PE

April 9, 2024

Agenda

- Introduction
- Regulatory Overview
- PFAS Treatment – Drinking Water
- Drinking Water Treatment Costs
- PFAS Treatment – Wastewater
- PFAS Waste Destruction



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Introduction

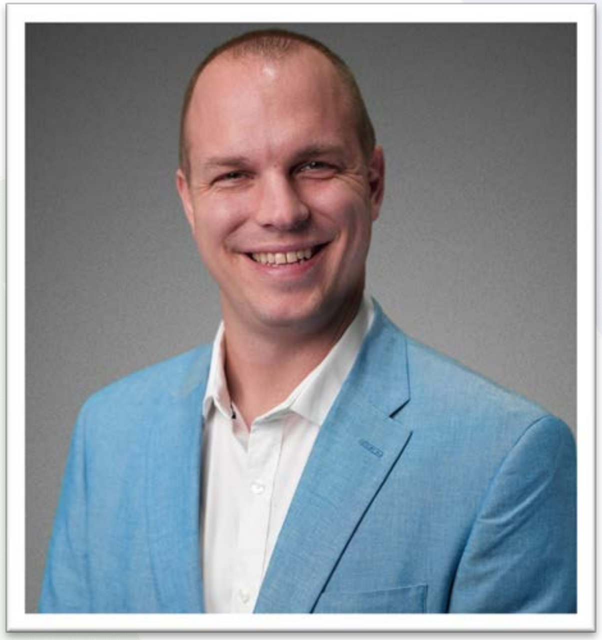
Introduction

EEC Environmental

- National environmental engineering consultant
- Chemists, engineers, geologists, hydrogeologists, regulatory and compliance specialists
- PFAS treatment experts

PFAS Services

- Site assessment and remediation
- PFAS characterization and planning
- Treatment system design
- Owner's representative consultant



Will Shaffer, PE
Project Engineer

Webinar Series

1. **November 14, 2023** – PFAS Today, Tomorrow, and Forever
2. **February 6, 2024** - MCLs are Coming…Very Soon!
3. **March 5, 2024** - How Do I Know if I Have a PFAS Problem?
4. **April 9, 2024** – Effective Treatment of “Forever Chemicals”
5. **May 7, 2024** – How to Destroy PFAS for Good

PFAS 101

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- <u>Broad class</u> of manufactured chemicals used to make products that resist heat, oils, grease, stains, & water
- Teflon™ coated cookware, carpets, clothing, paper packaging for food, fire retardants, AFFF
- Over 5,000 PFAS constituents (terminal and precursors)
- Extremely stable in environment and can be found in soil, air, surface water, groundwater, wastewater plant effluent, sewage sludge and landfills **"Forever Chemicals"**

PFAS 101- Treatment Terminology

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Treatment

General term

Removal

General term

Separation

Separate PFAS from a specific medium or process stream

e.g., GAC/IX/RO

Concentration

Concentrate PFAS within a specific medium

e.g., foam fractionation

Destruction

Terminal destruction by breaking C-F bond

e.g., thermal destruction

Pretreatment

Industrial: on-site treatment at point discharge

POTW: general treatment at central plant

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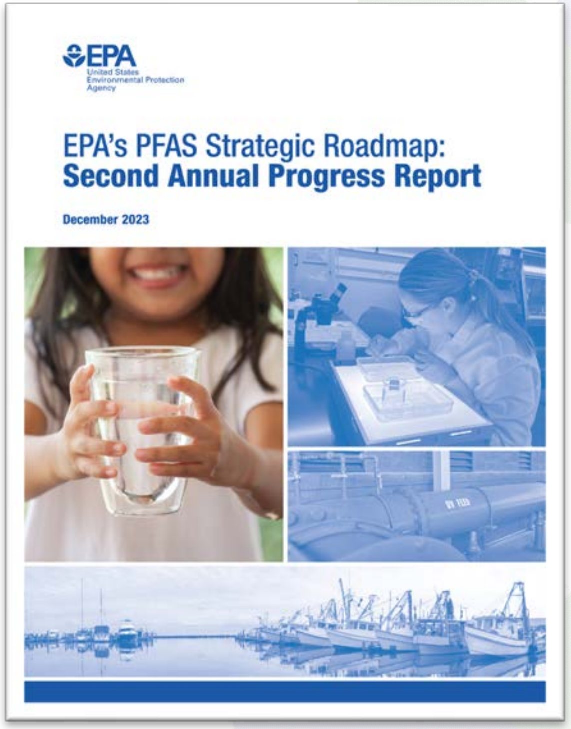
Regulatory Overview

EPA PFAS Strategic Roadmap

Research — Restrict — Remediate



- Biosolids
- Drinking Water
- Chemical Manu. and Use
- Contaminated Sites
- Wastewater
- Surface Water
- Analytical Methods
- Air

https://www.epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024

EPA PFAS Strategic Roadmap Key Actions

Research — Restrict — Remediate

Fall 2021
Nationwide monitoring (UCMR5)

March 2023
Propose PFAS MCLs for six constituents [1]

February 2024
Propose nine PFAS as RCRA hazardous constituents [2]

Early 2024
Finalize PFAS MCLs for six constituents [1]

Early 2024
Finalize PFOS and PFOA (at a minimum) as hazardous substances (CERCLA) [2]

Summer 2024
Adopt Effluent Limitation Guidelines (ELGs) for nine industrial categories and landfills.

Winter 2024
Finalize risk assessment for PFOA and PFOS in biosolids to determine whether regulation is appropriate

[1] PFOA, PFOS, PFNA, PFHxA, PFBS, HFPO-DA (GenX)
[2] PFOA, PFOS, PFBS, PFHxS, PFNA, GenX, PFBA, PFHxA, PFDA & precursors (advanced notice)

Drinking Water with PFAS > Proposed MCLs

As of January 2024

	0-10,000 customers Small PWS	10,000+ customers Large PWS
Number of PWS Sampled	1,950	1,851
Number of PWS Total	17,194*	4,589
PFOA > Proposed MCLs	152 (7.9%)	277 (15.4%)
PFOS > Proposed MCLs	185 (9.6%)	292 (16.3%)
GenX > Proposed MCLs	0	1
Exceedance Percentage	**11.9%**	**19.9%**

*UCMR5 only applies to Non-Transient non-community systems

Of those systems tested so far

1 in 5 Large PWS & 1 in 10 Small PWS nationally currently exceed proposed PFAS MCLs

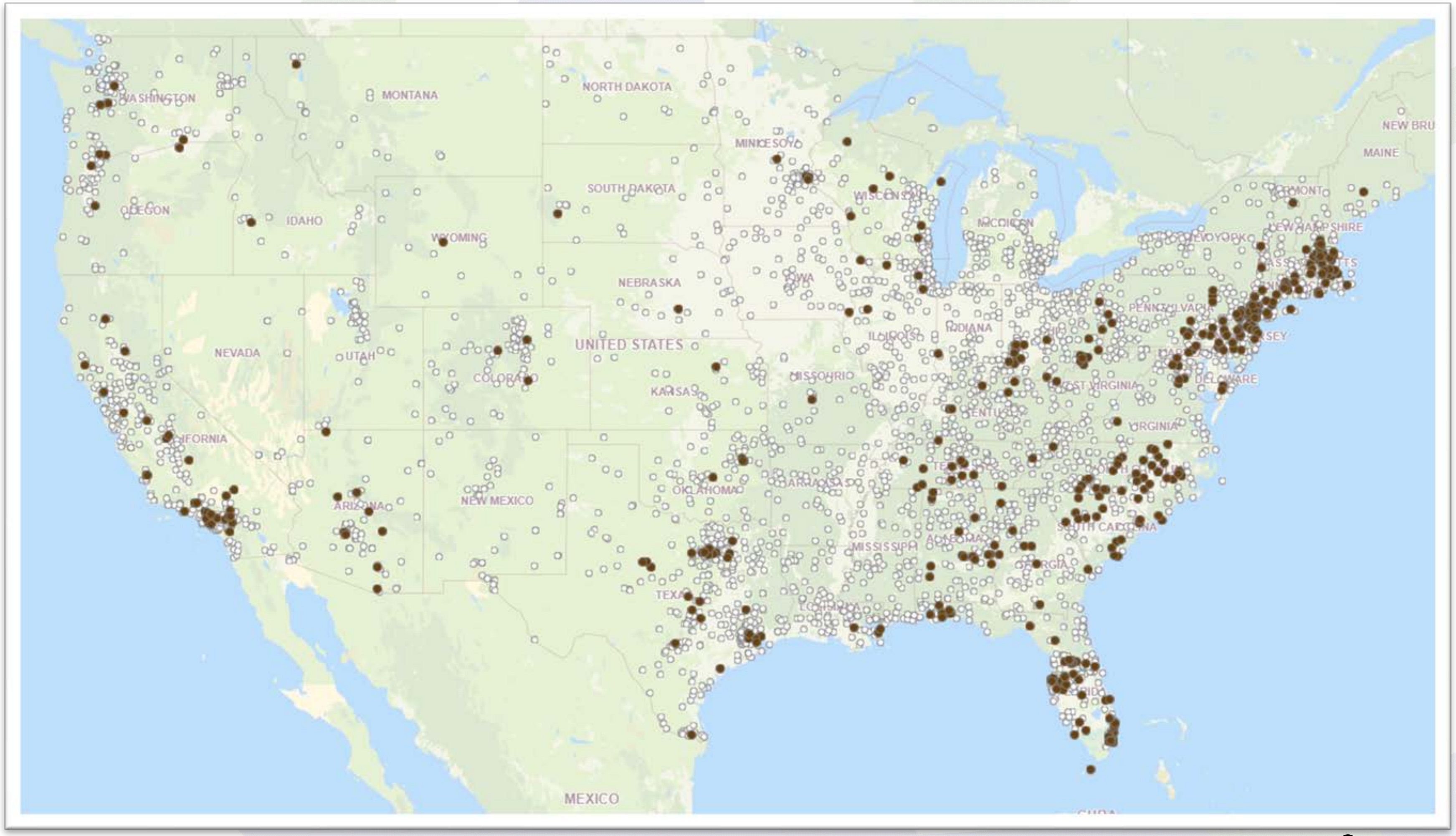
or

15.8% of all PWS tested nationally currently exceed proposed PFAS MCLs

https://www.epa.gov/dwucmr/fifth-unregulated-contaminant-monitoring-rule-data-finder

Drinking Water with PFAS > Proposed MCLs

As of January 2024



Source: PFAS Analytic Tools

RECAP

Strategic Roadmap	Impact	Imminent
Whole of government approach	10-20% of PWS nationally Ubiquitous	Key regulations finalizing soon

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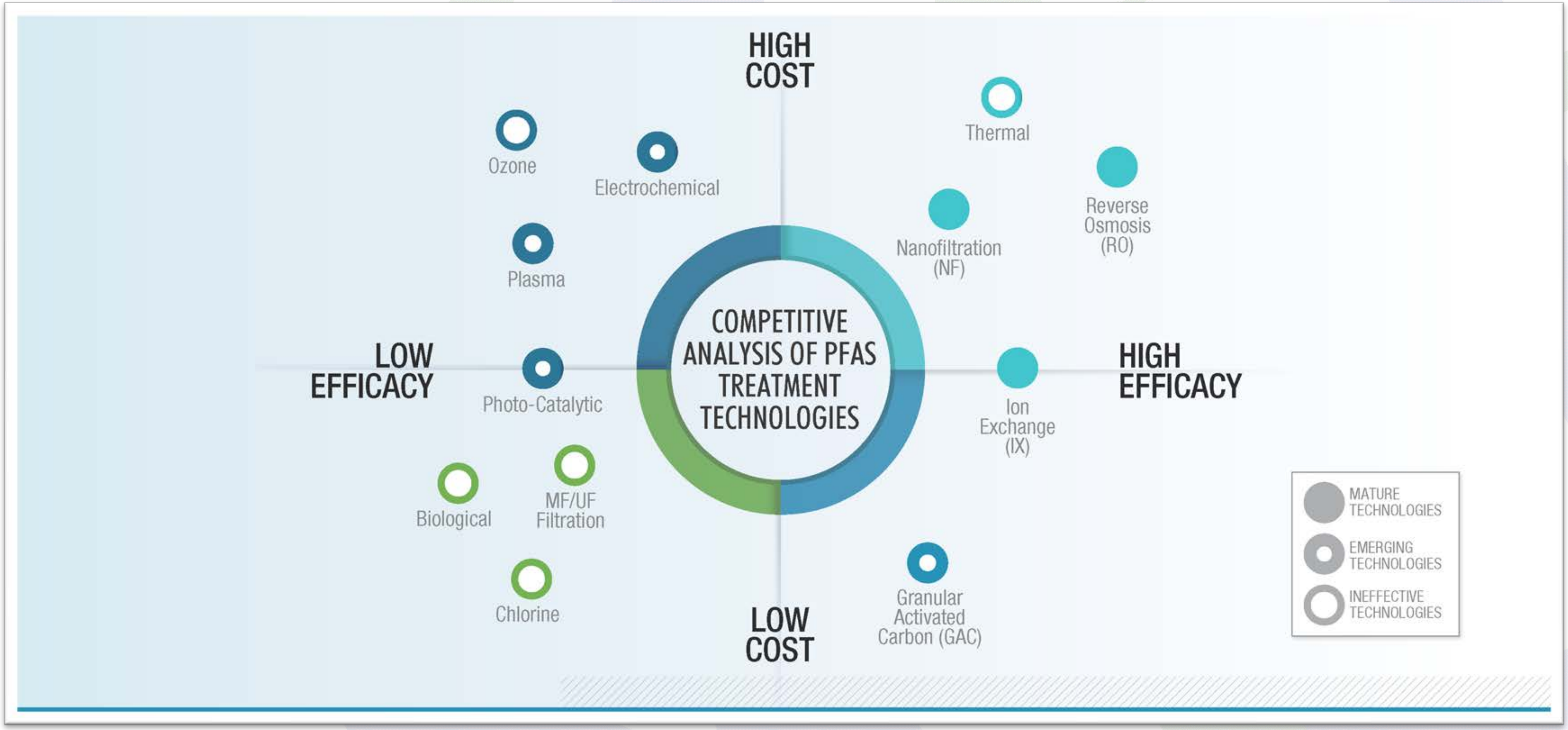
PFAS Treatment – Drinking Water

Best Available Treatment Technologies



Source: Carollo

Best Available Treatment Technologies

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Technology	Removal Efficiency	Pros	Cons
Granular Activated Carbon (GAC)	• Effective for long-chain PFAS and strongly adsorbing compounds	• Well understood technology • Simple operation • Robust market	• Large footprint • Disposal/reactivation of large volumes of carbon
Ion Exchange Resin (IX)	• Excellent removal of certain PFAS (anions)	• Efficient single-step technology • Small footprint	• Non-regenerable in most cases • Smaller market subject to higher inflation
Membrane Processes (RO/NF)	• Effective for PFAS removal, both long- and short-chain • Removes other CECs	• Efficient process if properly operated and maintained	• High CAPEX • Complex operation • Concentrate treatment/disposal

Adsorption Technologies (GAC/IX/Novel)

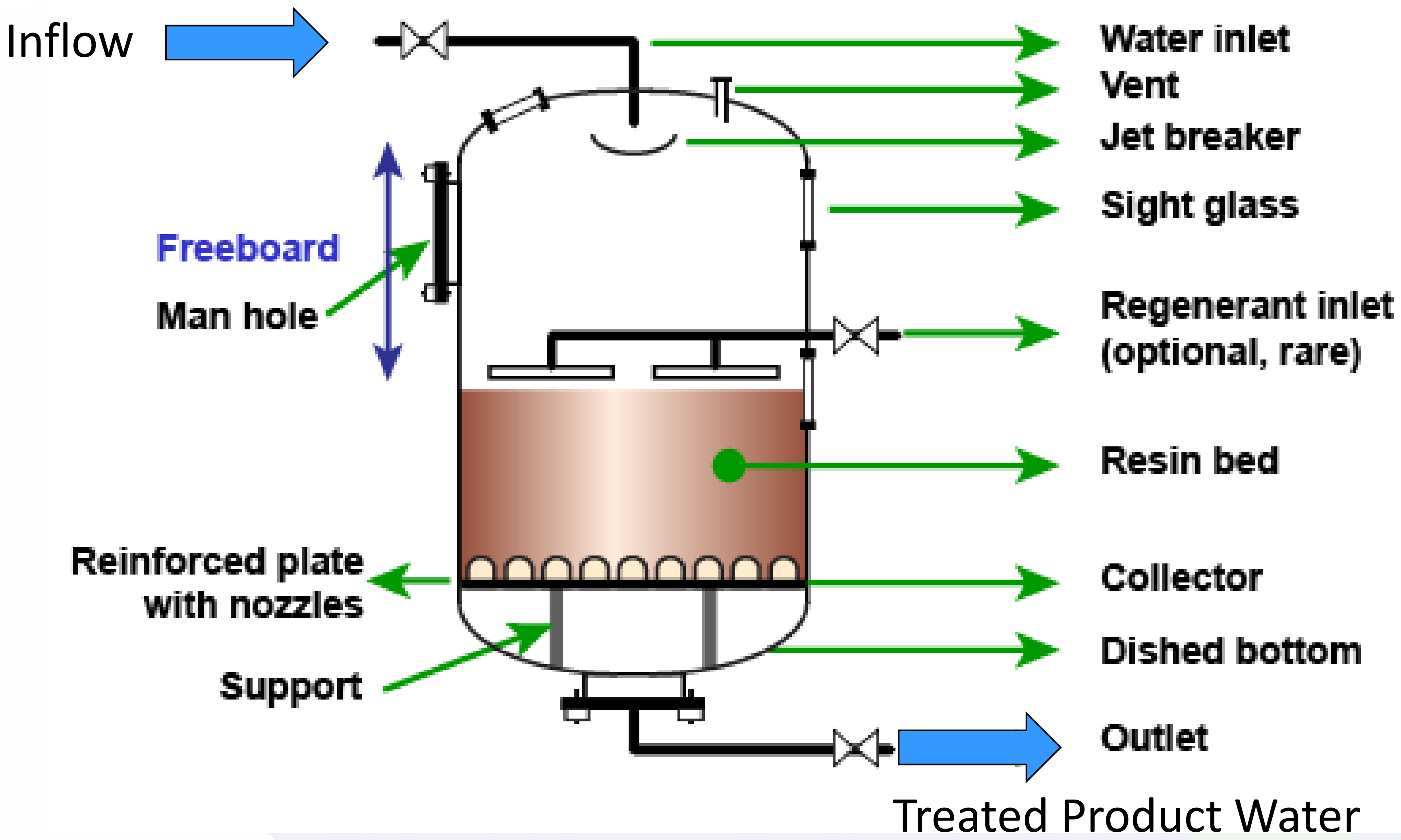
Granulated Activated Carbon (GAC)

Ion Exchange (IX) Resin

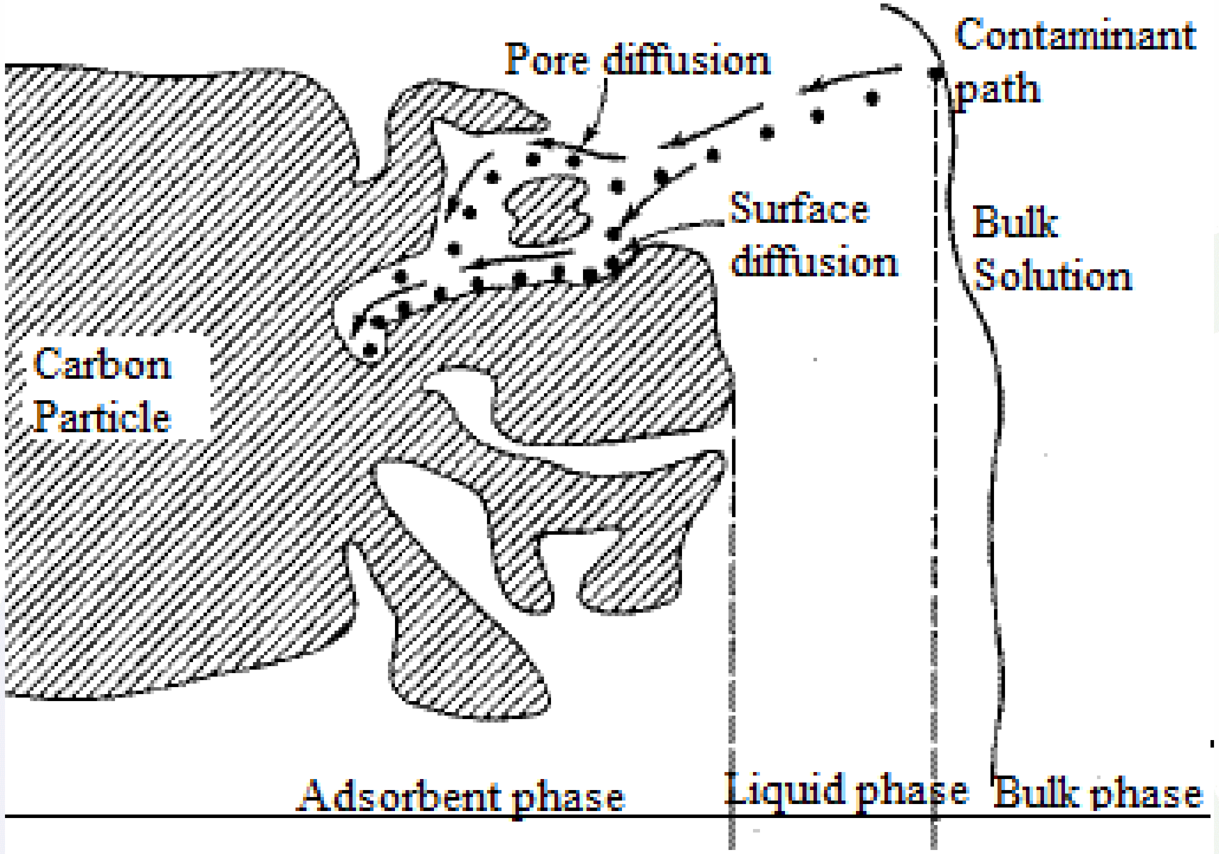
Novel Adsorbent

Adsorption Technologies (GAC/IX/Novel)

Adsorption Technologies (GAC/IX/Novel)

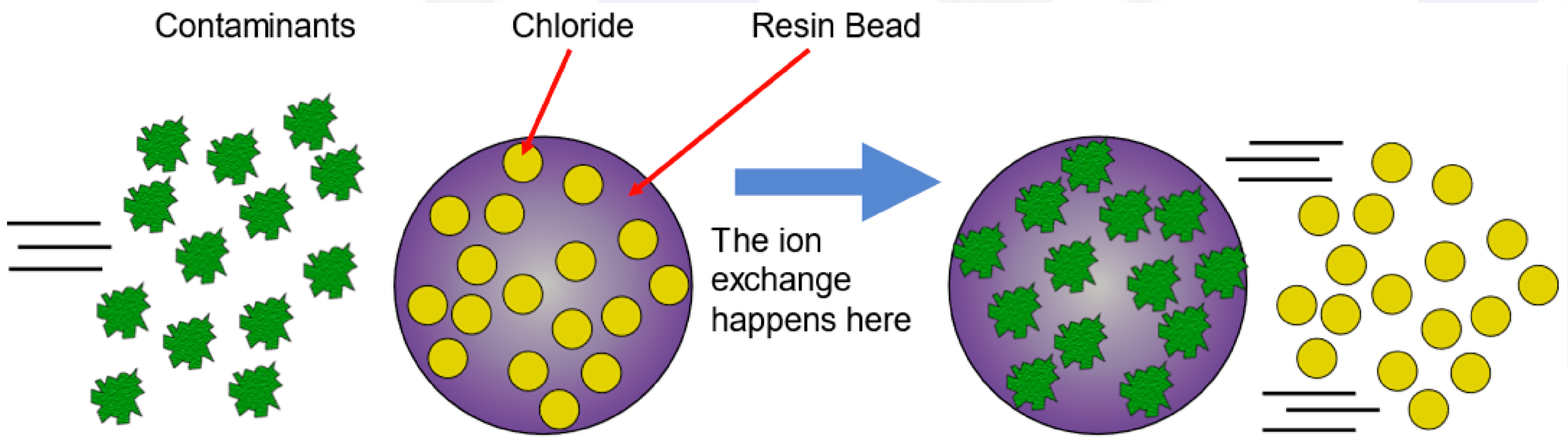


GAC Adsorption



Granulated Activated Carbon (GAC) has a high surface area due to pore structure. Contaminants adsorb to oleophilic (oil loving) surface and are held by molecular forces

Ion Exchange Process



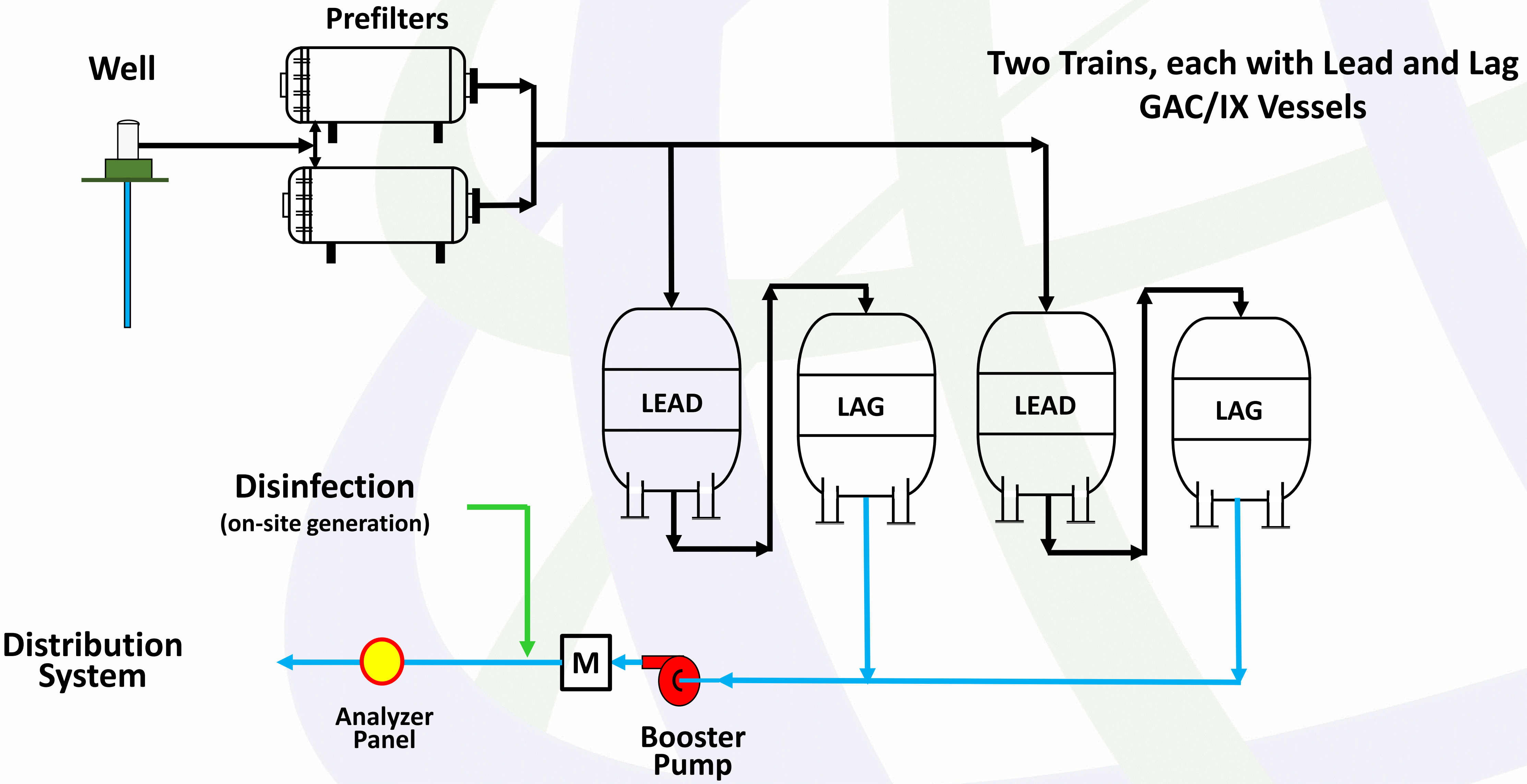
Ion Exchange (IX) is based on **exchanging** a harmless ion for the contaminant

Novel Adsorbents

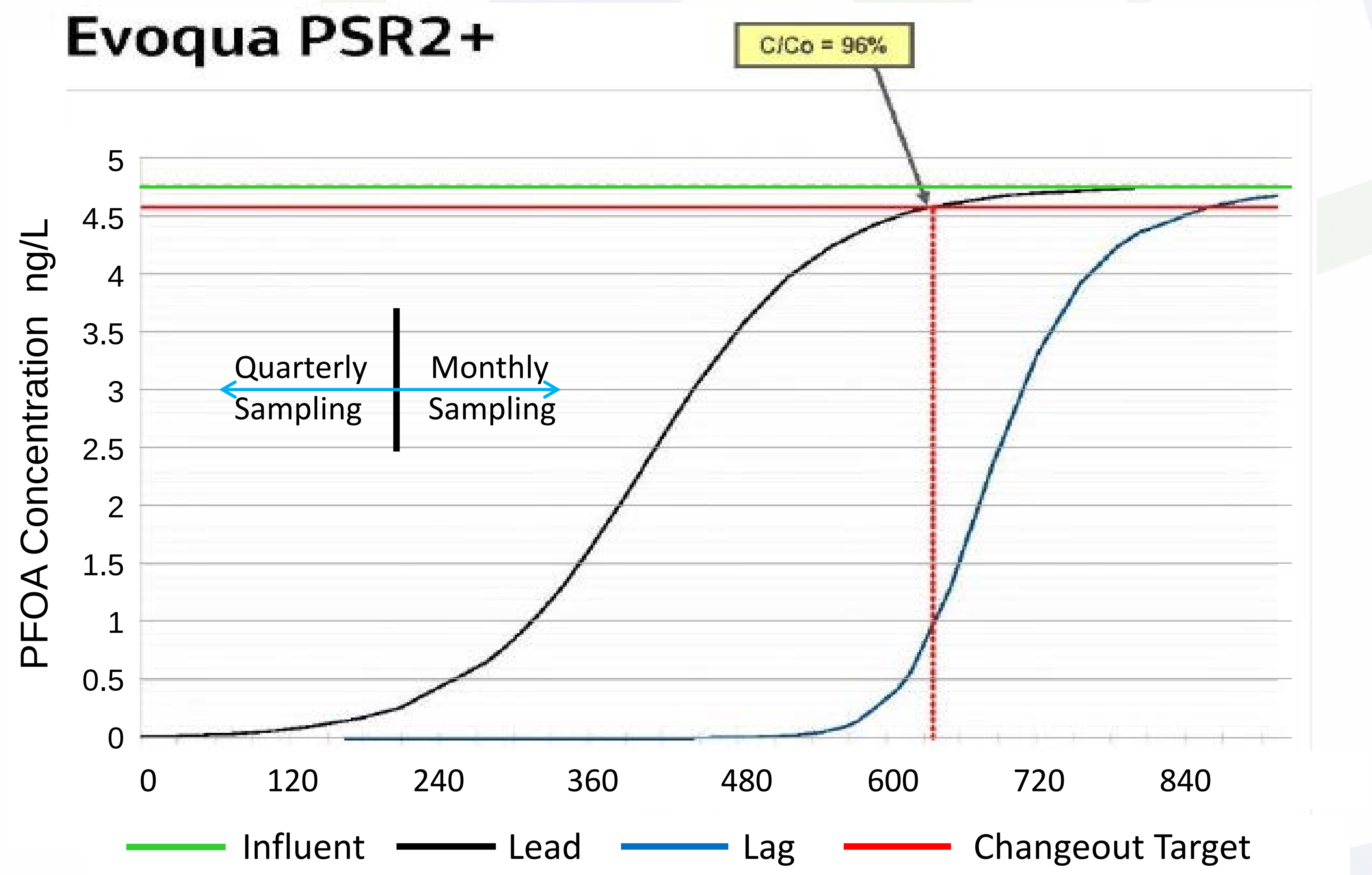
Novel adsorbents demonstrate similar kinetics to IX, but provide greater selectivity

Source: Cyclopure

Typical Pressure Vessel Treatment System



Media Life Determined by Monitoring



Source: Modified from OCWD

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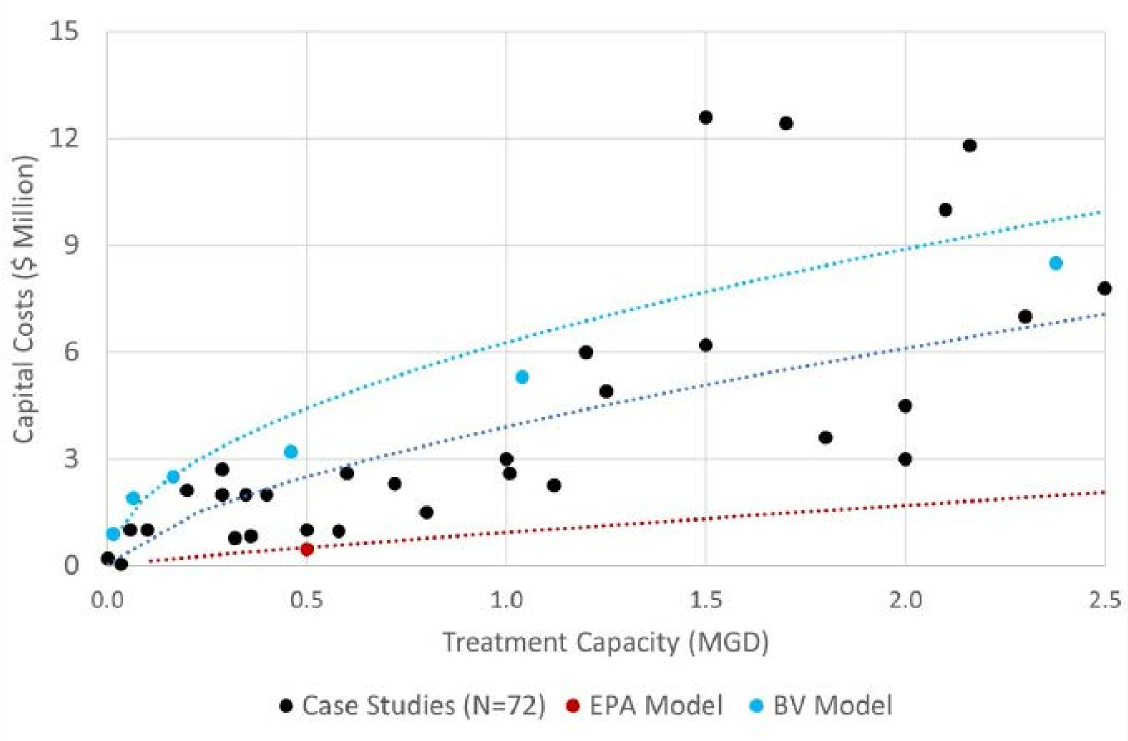
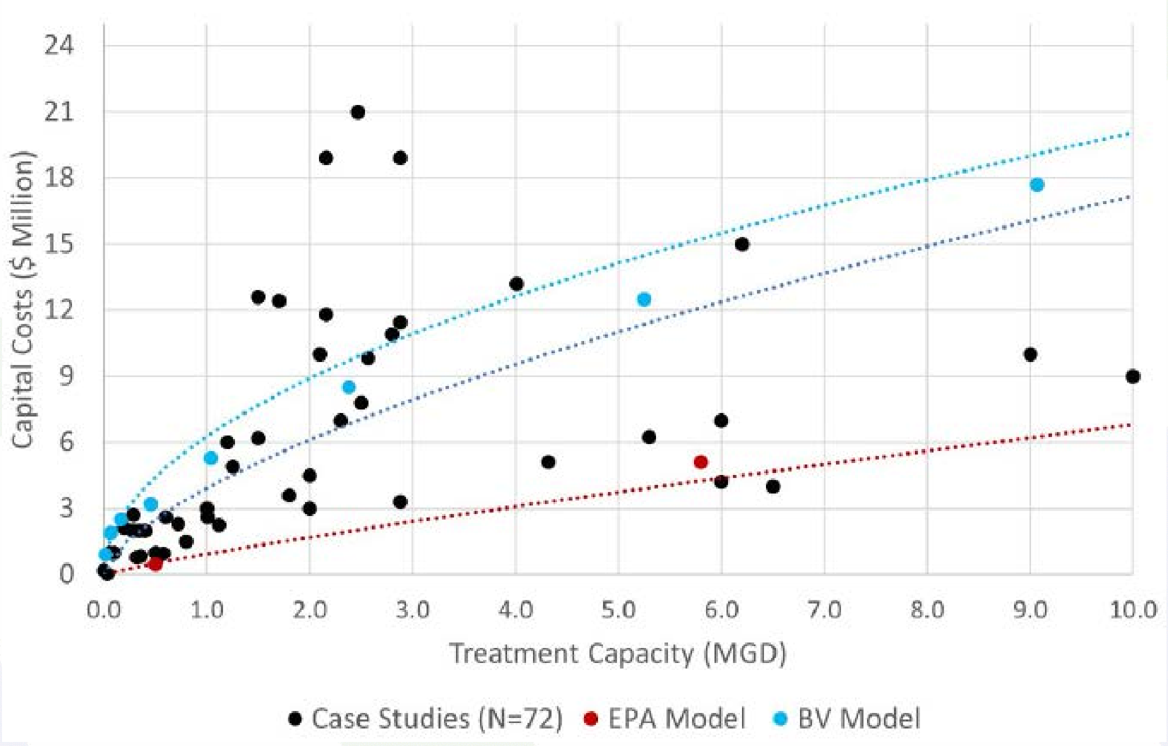
Drinking Water Treatment Costs

Treatment Costs - GAC



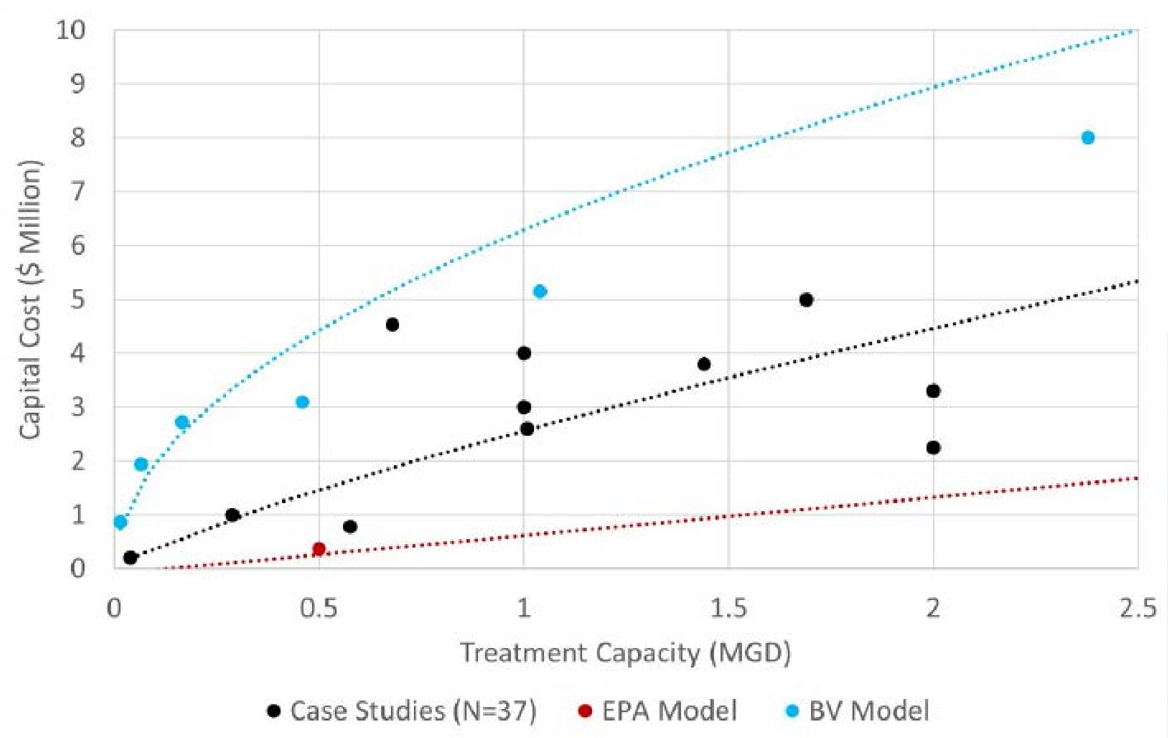
Comparison of GAC Capital Costs for Small Systems (<2.5MGD)



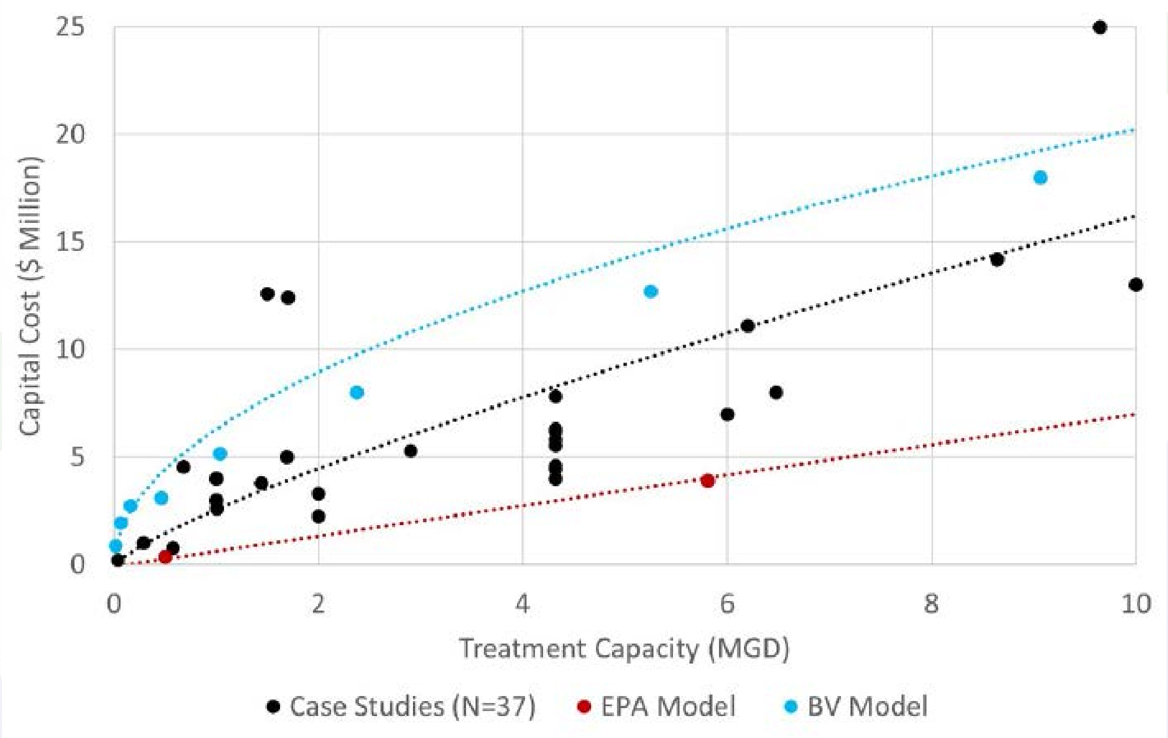
Comparison of GAC Capital Costs for Medium Systems (<10MGD)

Source: https://www.reginfo.gov/public/do/eoDownloadDocument?pubId=&eodoc=true&documentID=328592

Treatment Costs - IX



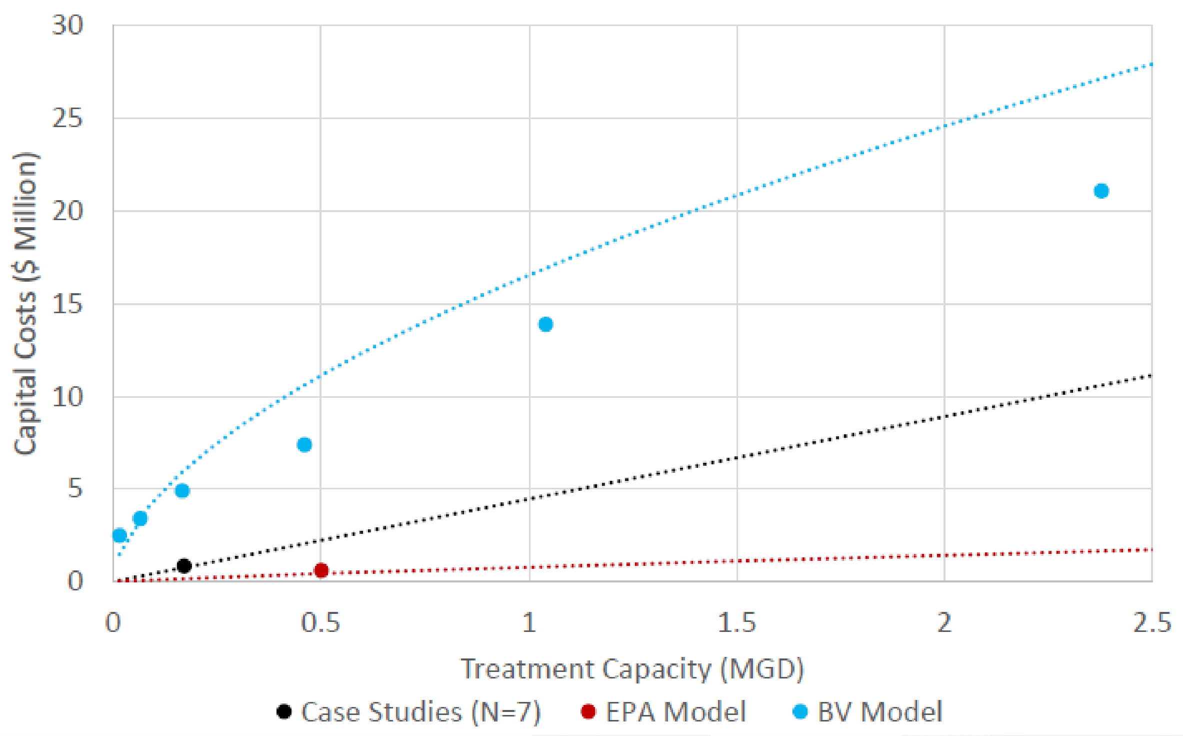
Comparison of IX Capital Costs for Small Systems (<2.5MGD)



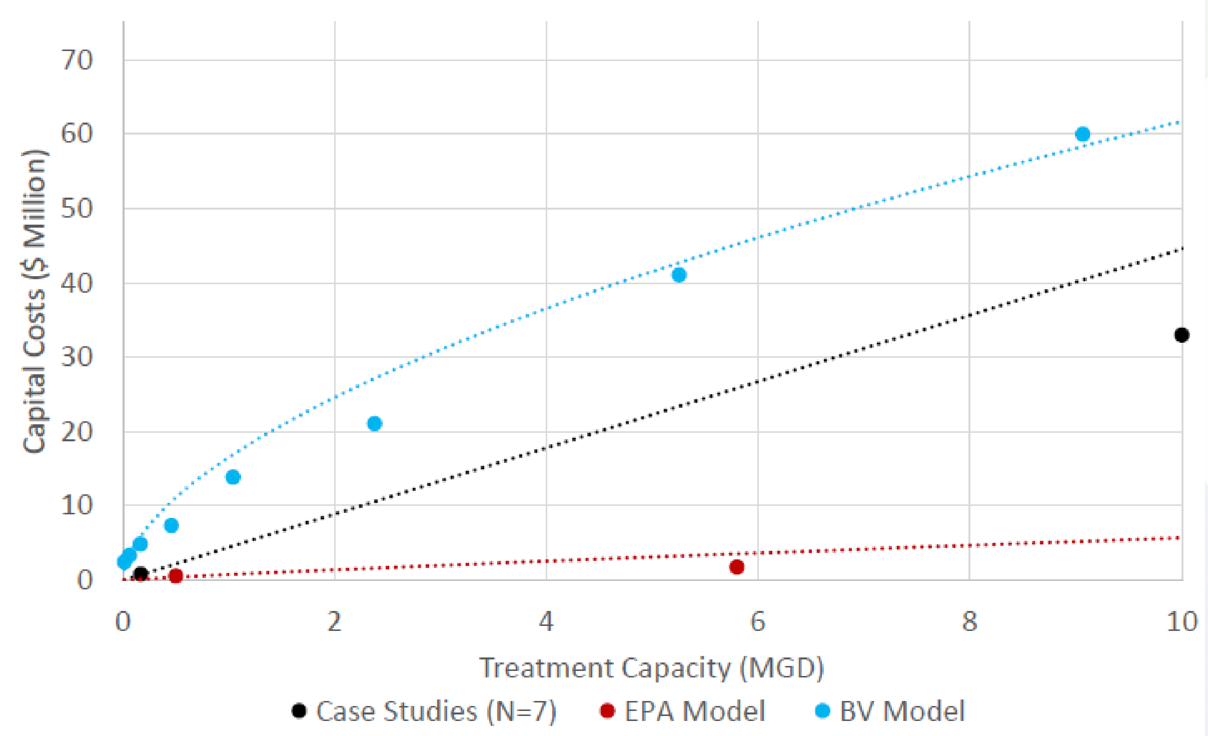
Comparison of IX Capital Costs for Medium Systems (<10MGD)

Source: https://www.reginfo.gov/public/do/eoDownloadDocument?pubId=&eodoc=true&documentID=328592

Treatment Costs - RO



Comparison of RO Capital Costs for Small Systems (<2.5MGD)



Comparison of RO Capital Costs for Medium Systems (<10MGD)

Source: https://www.reginfo.gov/public/do/eoDownloadDocument?pubId=&eodoc=true&documentID=328592

RECAP

Reliable	Efficient	Plan
Mature technologies exist for effective treatment	Lead/lag configuration allows for full exhaustion	Detailed alternatives analysis and sampling/ piloting

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PFAS Treatment - Wastewater

Wastewater Local Limit Scenario

EPA Drinking Water Health Advisory Levels (HAL)	
PFOA: 0.004 ppt	PFOS: 0.02 ppt

↓

Drinking Water Maximum Contaminant Levels (MCL)	
PFOA: 4 ppt (proposed)	PFOS: 4 ppt (proposed)

↓

State Water Quality Standards (WQS)	
PFOA: 66 ppt (MI)	PFOS: 11 ppt (MI)

↓

National Pollutant Discharge Elimination System (NPDES) Effluent Limit	
PFOA: 66 ppt (MI)	PFOS: 11 ppt (MI)

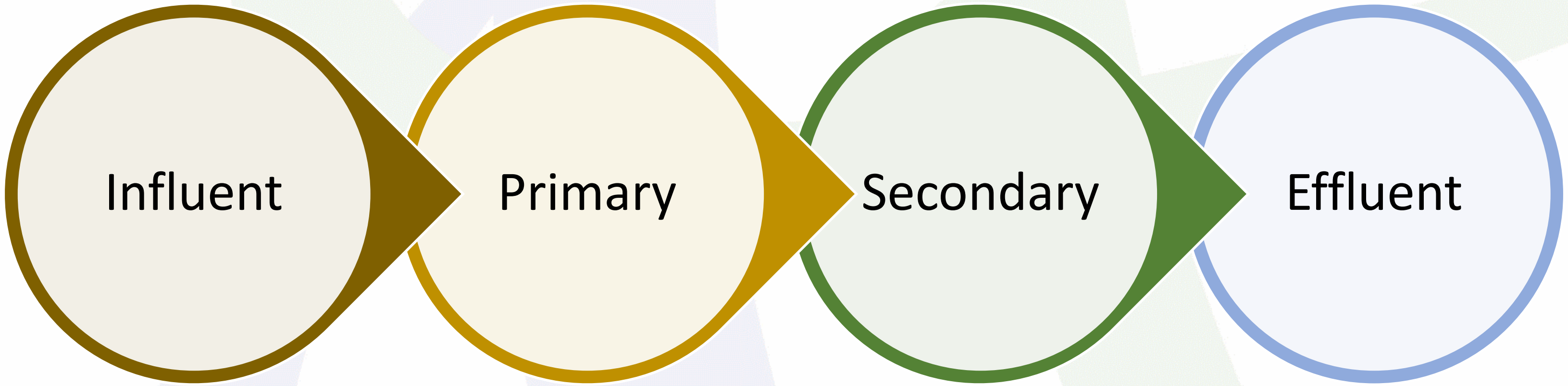
↓

POTW Local Limits (Industry Permit Limits)	
Total PFAS: 7,000 ppt (GLWA, not adopted)	PFOS: 65 ppt (GLWA)

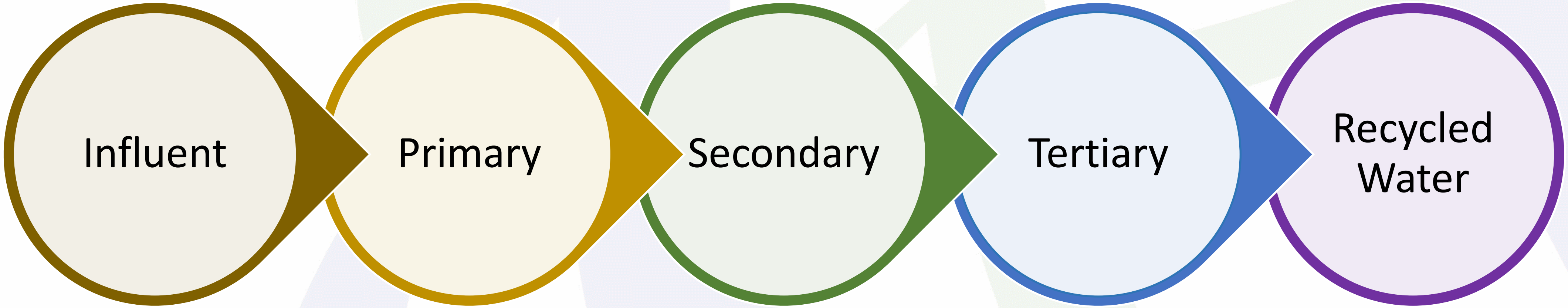
Industrial Pretreatment or POTW Treatment?

Sources: Shinonome Studio, Adobe Stock; iStock

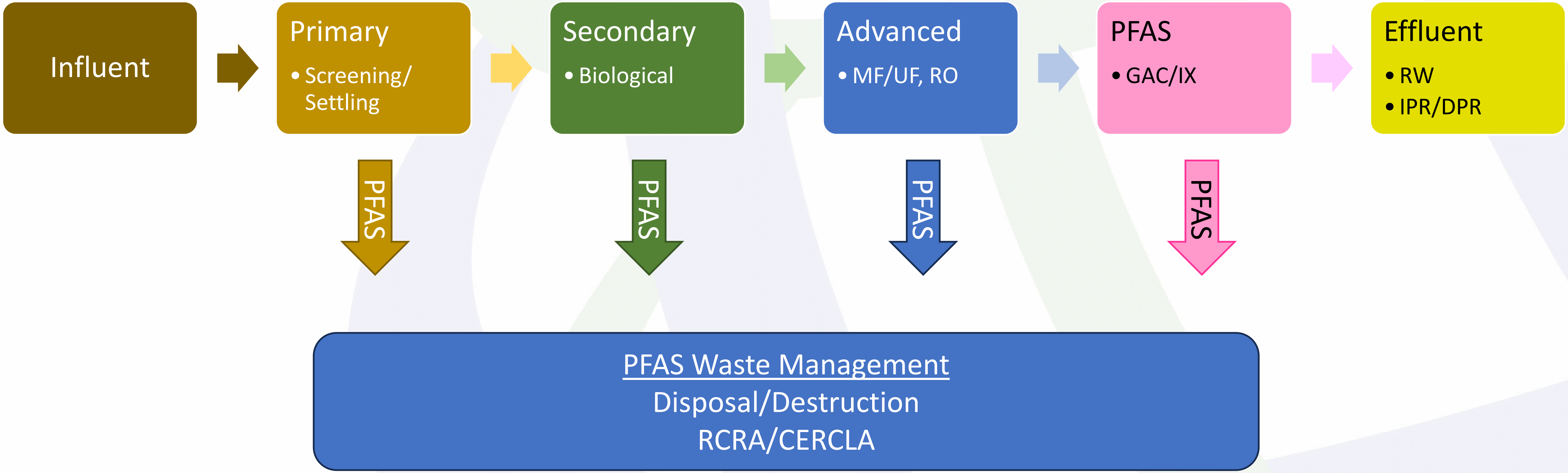
POTW Treatment



POTW Treatment



POTW Treatment



RECAP

Pending	Sources	Treatment
Wastewater regulations are in the near-future (mostly)	Source identification is critical for all systems	POTW-level PFAS treatment will be challenging

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PFAS Waste Destruction

PFAS Destruction

Treatment (separation/concentration) requires waste disposal or destruction

Illinois and Department of Defense (DoD) have banned incineration of PFAS-laden waste (April/June 2022)

- EPA Office of Research and Development (ORD) with DoD studying fate of PFAS during incineration
- Incineration could result in Products of Incomplete Combustion (PIC)

DoD temporary incineration ban (April 2022) modified with issuance of destruction guidance (July 2023)

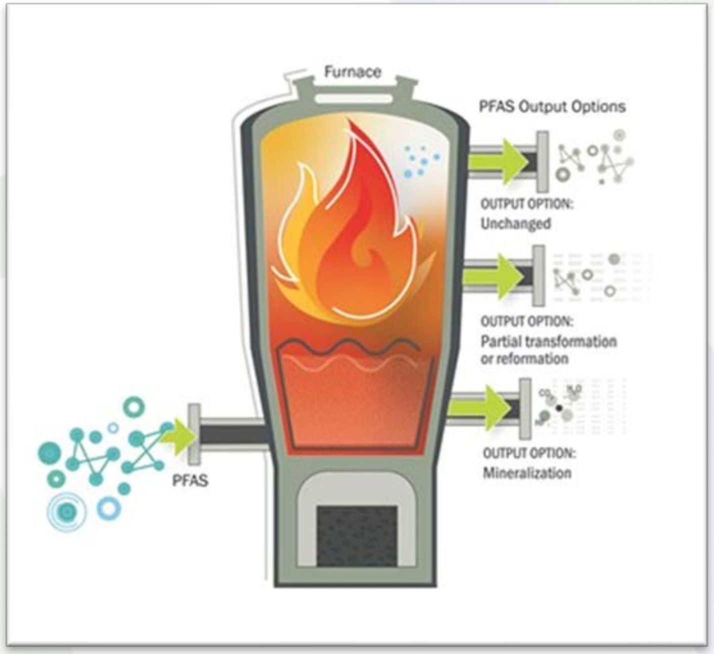


Image source: Brown and Caldwell

PFAS Destruction

Supercritical Water Oxidation (SCWO)

Hydrothermal Alkaline Treatment (HALT)

Electrochemical Oxidation

Laboratory or pilot scale

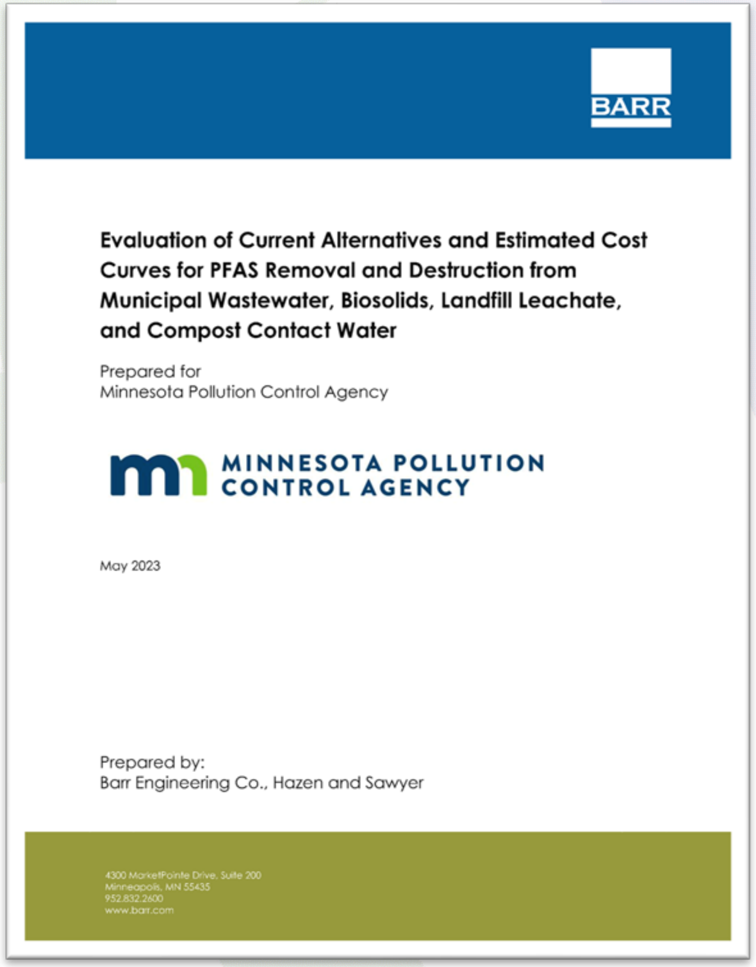
Low flow, high concentration

Emerging technologies

Sources:
1 Duke University
2 Aquagga
3 Axine Water Technologies

PFAS Destruction

- High Demand
- Strict Regulatory Environment
- Demonstrated Efficiency
- Scalability?
- Regional PFAS Management Facilities


BARR

Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water

Prepared for
Minnesota Pollution Control Agency

MINNESOTA POLLUTION CONTROL AGENCY

May 2023

Prepared by:
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Source: https://www.pca.state.mn.us/sites/default/files/c-pfc1-26.pdf

RECAP

Impact	Water Treatment	Wastewater Treatment	EFCN
10-20% of PWS nationally Ubiquitous	Mature technologies exist for effective treatment	Source identification is critical for all systems	Leverage your local EFCN chapter

Questions?

Speaker Contact Information

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Thank you!

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