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PFAS Enhanced Retention Using Colloidal Activated Carbon:

Proven, low-cost remediation of groundwater and soil

Scott Wilson | REGENESIS

June 18, 2026

REGENESIS:

- Colloidal Activated Carbon (CAC) technology developer and provider
  - Project feasibility, application design, performance evaluation
- 12 years of commercial CAC remediation
  - 595 sites, 15 countries
- 10 years of CAC PFAS remediation
  - 63 sites, 9 countries

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This Presentation:

- Summary description of CAC technology
- Statistics and window of usage to date for PFAS
- PFAS removal or retention in place?
  - Three arguments for *in situ* retention

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Technology

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PlumeStop®

Superfine Activated Carbon < ***2.0 µm in diameter***

- Size of a red blood cell
- Proprietary suspension polymers
- Distribution agents

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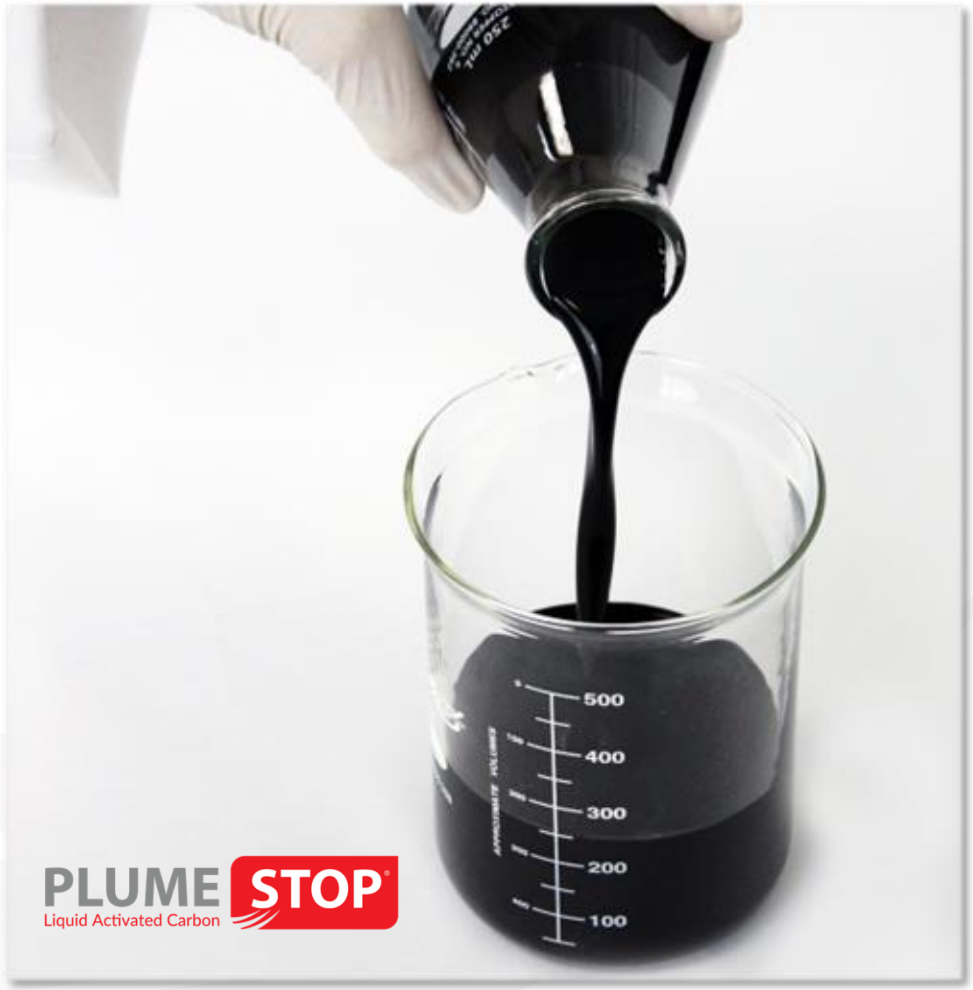
PlumeStop®

- Think of it as an **activated carbon ink**

it flows but sticks

- The coating it leaves is **micron-thin**

it doesn't interfere with groundwater flow



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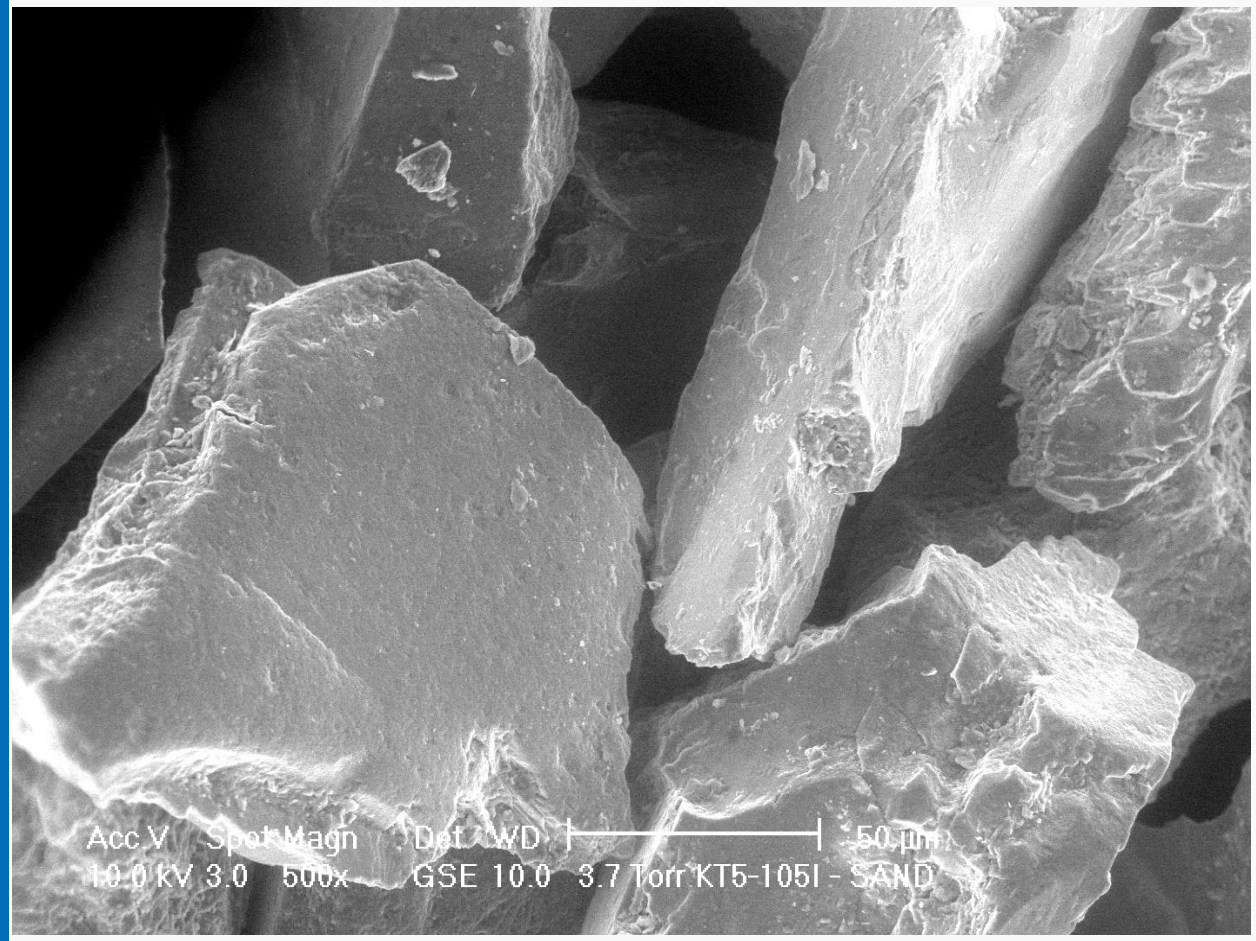
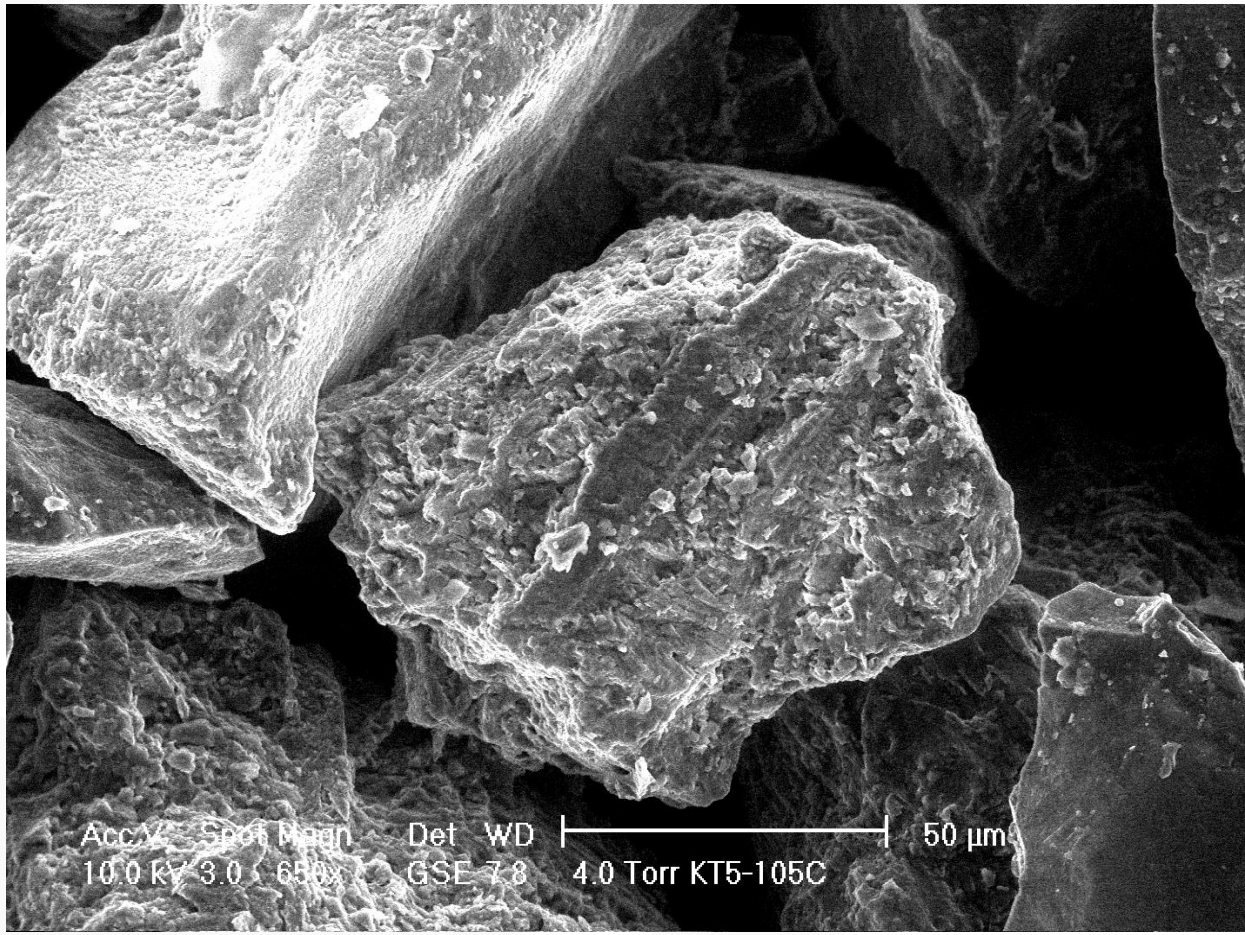
PlumeStop®



Before PlumeStop



After PlumeStop

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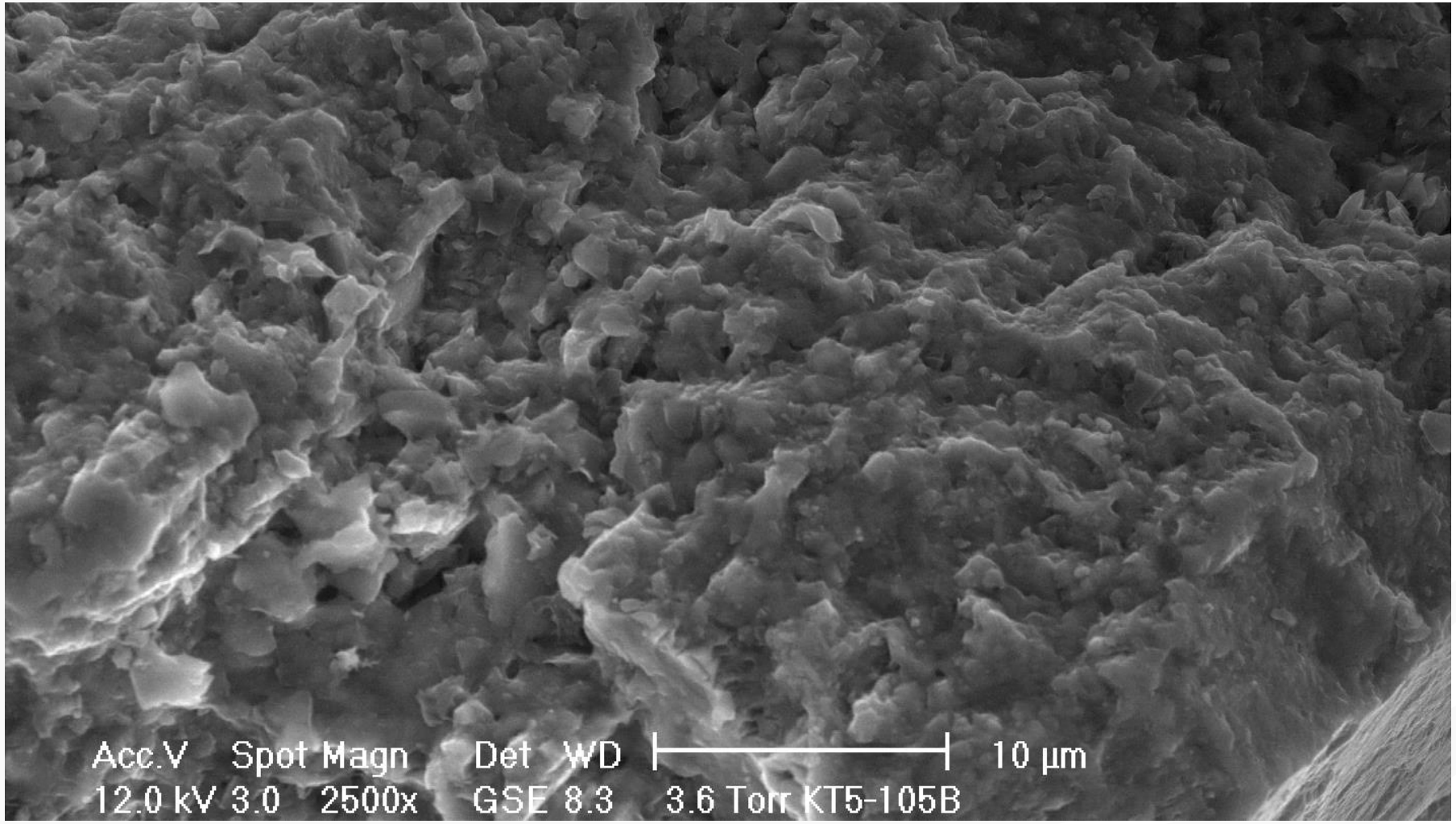
PlumeStop®



Close Up

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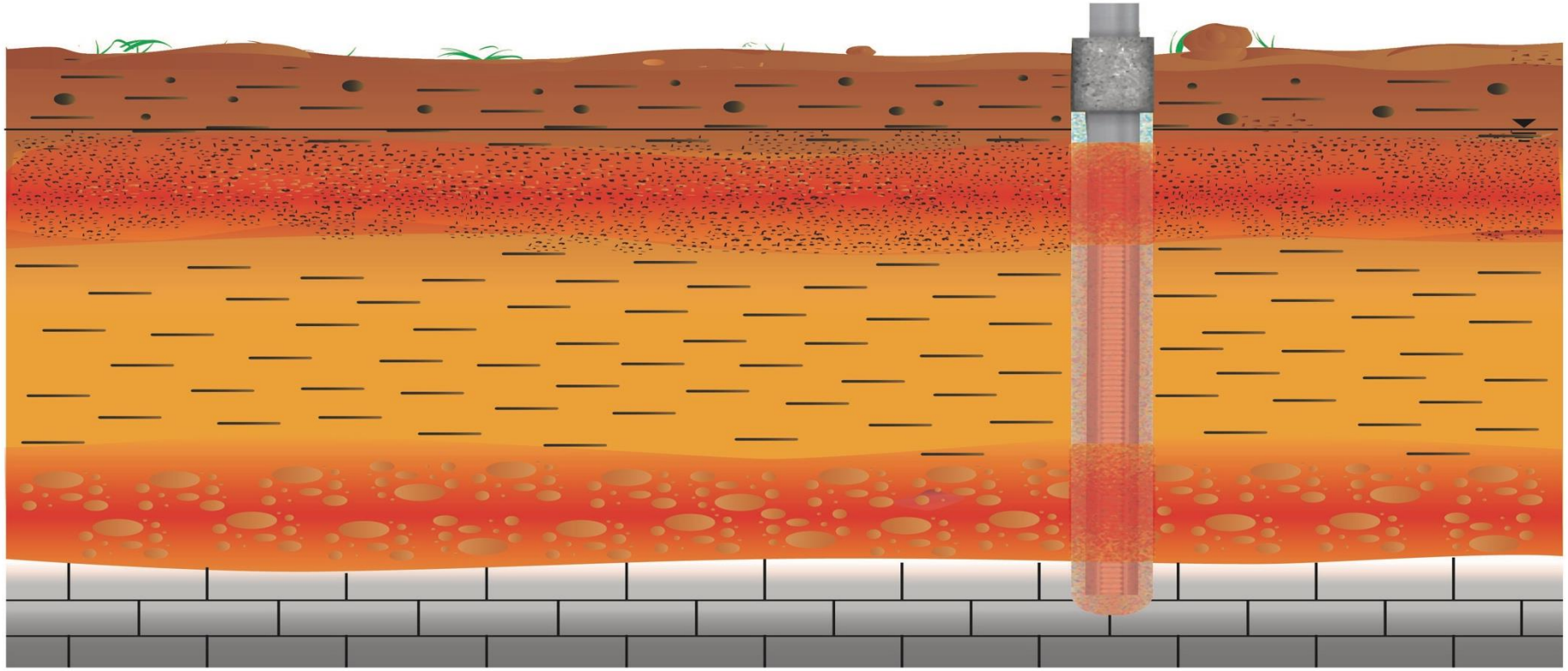
Converts Polluted Aquifer to Purifying Filter



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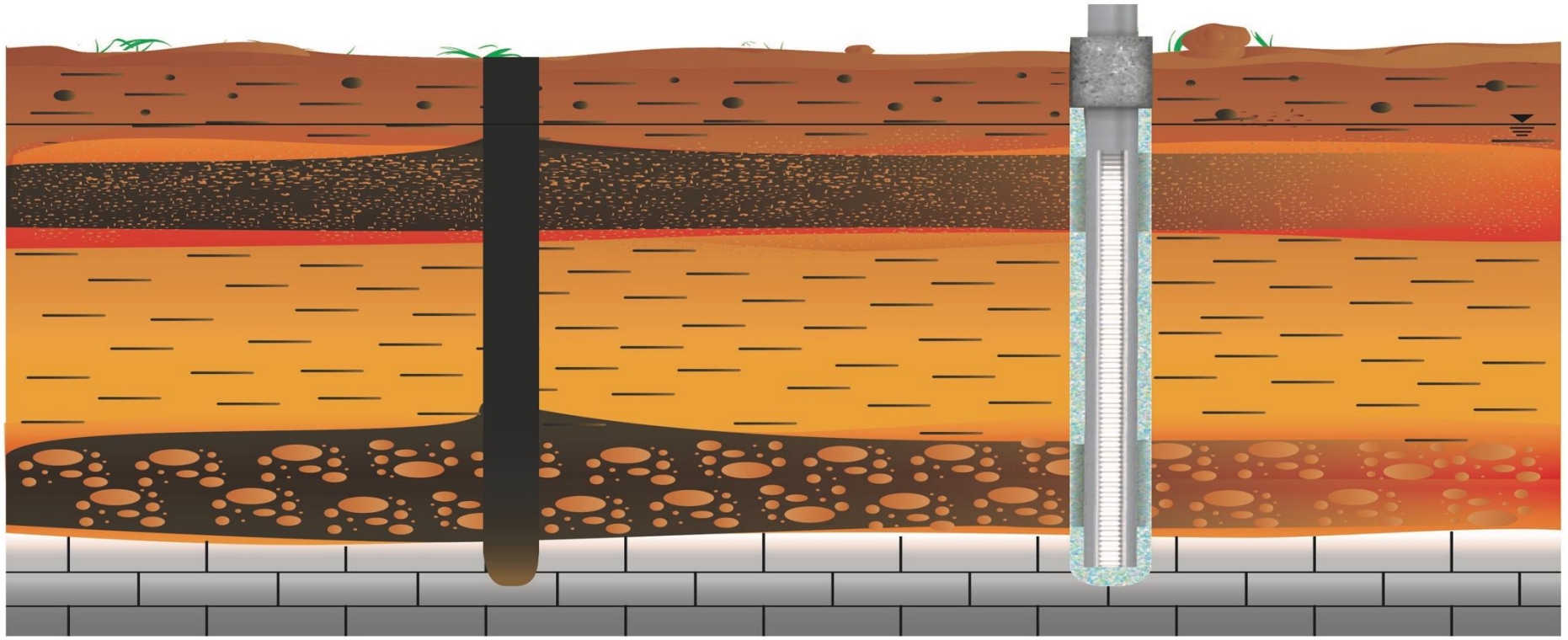

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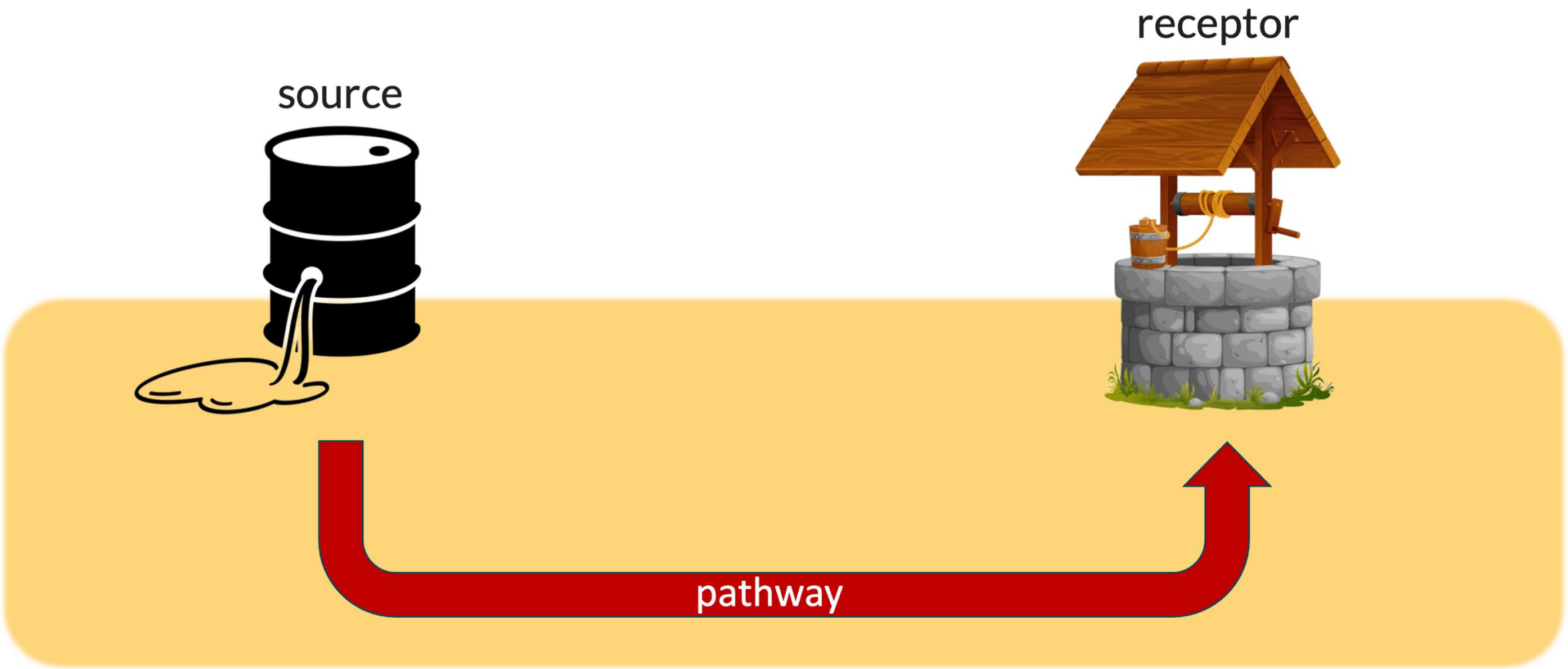
Pollutant linkage



Usage Statistics

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PFAS PlumeStop® CAC Projects 2016-2026

9 Countries

Canada, USA, Australia, UK, Italy, Belgium, Sweden, Norway, Saudi Arabia

63 completed applications

179 sites in design and review phase

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PFAS PlumeStop® CAC Projects 2016-2026

- **PFAS C-range** (specified target species)
  - C_4 – C_{10}
- **Pre-treatment concentrations of specified target species** (examples)
  - PFOA 63 – **2,000,000 ng/L**
  - PFOS 16 – **392,000 ng/L**
  - PFBS 2,400 – **16,000 ng/L**
- **Groundwater Velocity**
  - 11 – **1,148 ft/year** (3.4 – 350 m/year)
- **Pre-treatment PFAS flux**
  - 0.022 – **21.6 mg/m^2/day** (∑PFOA, PFOS, PFBS)
- **Barrier Length**
  - 30 ft (pilots) – **1,640 ft** (full scale) (9 m – 500 m)
- **Barrier Depth**
  - 8 ft – **150 ft** (alluvium to fractured rock) (2.4 – 46 m)

Still growing and testing limits

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Performance

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PFAS PlumeStop® CAC Projects 2016-2025

Performance statistics

	Before Treatment PFAS Conc.			After Treatment PFAS Conc.			% Reduction			OoM Reduction		
	PFOS	PFOA	PFHxS	PFOS	PFOA	PFHxS	PFOS	PFOA	PFHxS	PFOS	PFOA	PFHxS
	ng/L	*ng/L*	*ng/L*	*ng/L*	*ng/L*	*ng/L*	*%*	*%*	*%*	-	-	-
Minumum	5.0	5.0	82	0.5	0.1	0.3	45%	53%	39%	0.3	0.3	0.2
25th Percentile	123	49	262	1.8	1.6	1.5	95%	93%	97%	1.3	1.1	1.7
Median	**319**	**670**	**460**	**2.0**	**2.0**	**3.1**	**99%**	**99%**	**99.2%**	**2.0**	**1.8**	**2.1**
75th Percentile	2,114	1,500	1,238	14	15	49	99.6%	99.5%	99.7%	2.4	2.3	2.5
Max	392,000	260,000	7,900	2,800	88	632	99.999%	99.999%	99.917%	5.0	4.9	3.1
n	36	37	8	36	37	8	36	37	8	36	37	8

- **Multiple orders of magnitude reductions are commonly achieved.**
- Lower concentration post-treatment concentration reductions biased low by reporting to quantitation limits.
- CAC barrier post-treatment concentrations are compressed into a much narrower band than pre-treatment concs.
  - Pre-treatment concs span ≈5 orders of magnitude – post-treatment concs span ≈3 orders of magnitude.

Newell et al (2025). Remediation Journal, 2025; 35:e70017 | https://doi.org/10.1002/rem.70017

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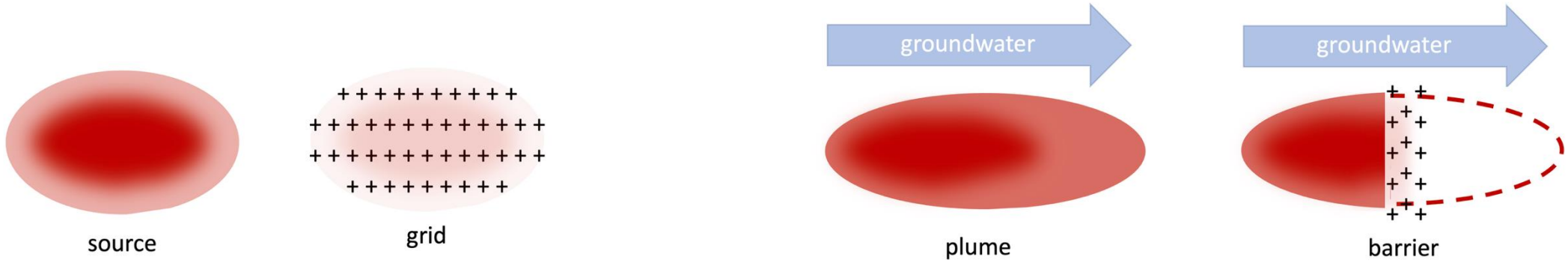
Performance

- **Source / grid treatment** (batch study lab analog)
  - Principal dose-response variable is **equilibrium concentration**

- **Plume / barrier treatment** (column study lab analog)
  - Principal dose-response variable is **longevity** (time to breakthrough)



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Longevity

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Longevity?

SERDP ESTCP

ER21-1130 (Werth) ER24-8200 (Newell)

Remediation Journal

WILEY

RESEARCH ARTICLE OPEN ACCESS

Tool and Database for Estimating Potential Longevity of Colloidal Activated Carbon Barriers for PFAS in Groundwater

Charles J. Newell[1] | Wade B. Smith[1] | Kade Kearney[2] | Sage Clay[2] | Hassan Javed[1] | Grant R. Carey[3,4] | Stephen D. Richardson[2] | Charles J. Werth[5]

*"Application of the tool to **17 field sites** yields barrier longevities ranging from **4** to over **100,000 years**, with median values of **870, 150,** and **180 years** for **PFOS, PFOA,** and **PFHxS**, respectively."*

April 2025

Newell et al (2025). Remediation Journal, 2025; 35:e70017 | https://doi.org/10.1002/rem.70017

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But the PFAS stay in the ground …

… isn’t it better to remove them?

Remove or Retain in Place?

1. Practicality – feasibility and time.
2. Cost – financial and resource.
3. Liability – reduction or expansion?

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Remove or Retain in Place?

1. **Practicality – feasibility and time.**
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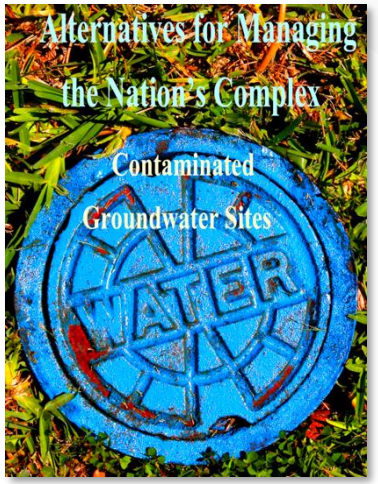
Removal – practicality



Can we free an aquifer of PFAS?

- How many aquifers have we freed from solvent contamination?
- Is it easier or harder for PFAS?

NRC (2013) (solvents and hydrocarbons)

- **126,000 US sites** with residual contamination preventing closure
- MCL-level restoration unachievable for many within **50 – 100 years**

PFAS vs. VOCs

- No bio / ISCO / ISCR - reduced toolkit, persistence
- Orders of magnitude lower clean-up targets
- Stronger natural aquifer retention

NRC (2013) - Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites.

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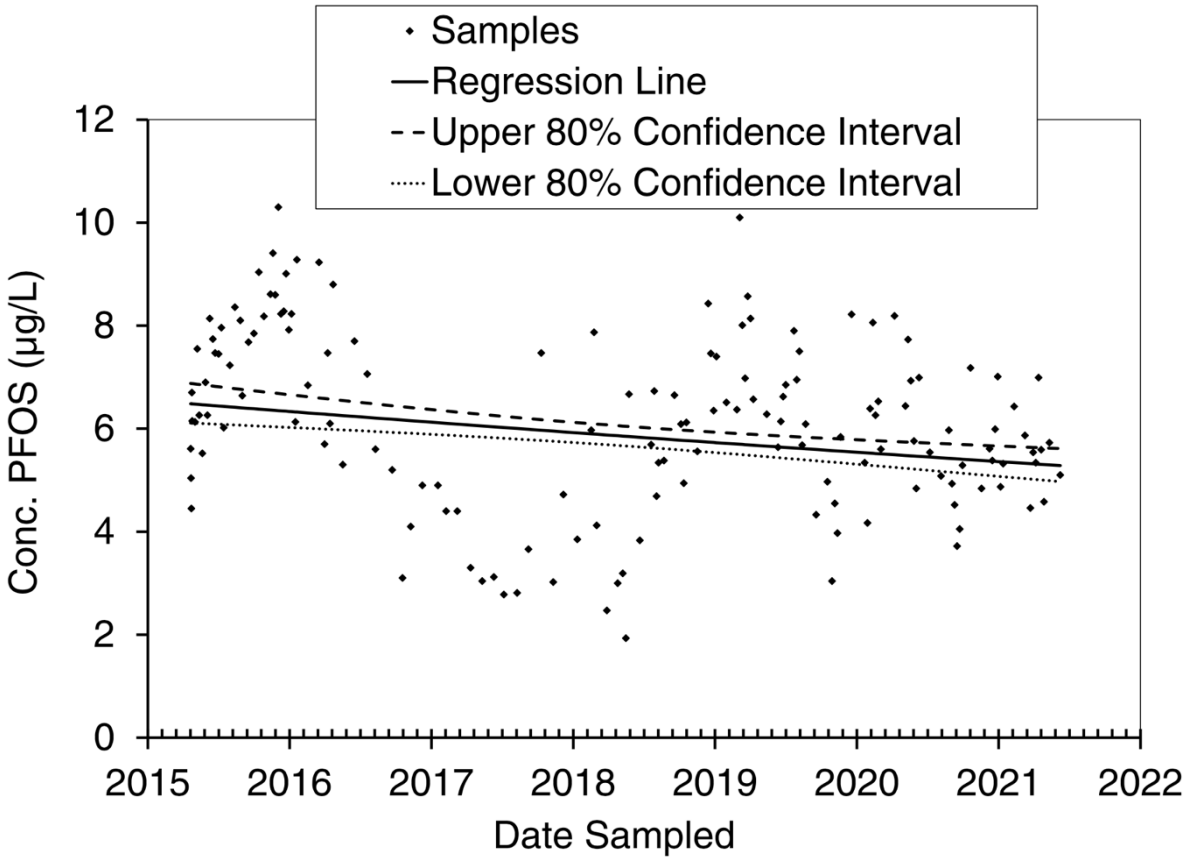
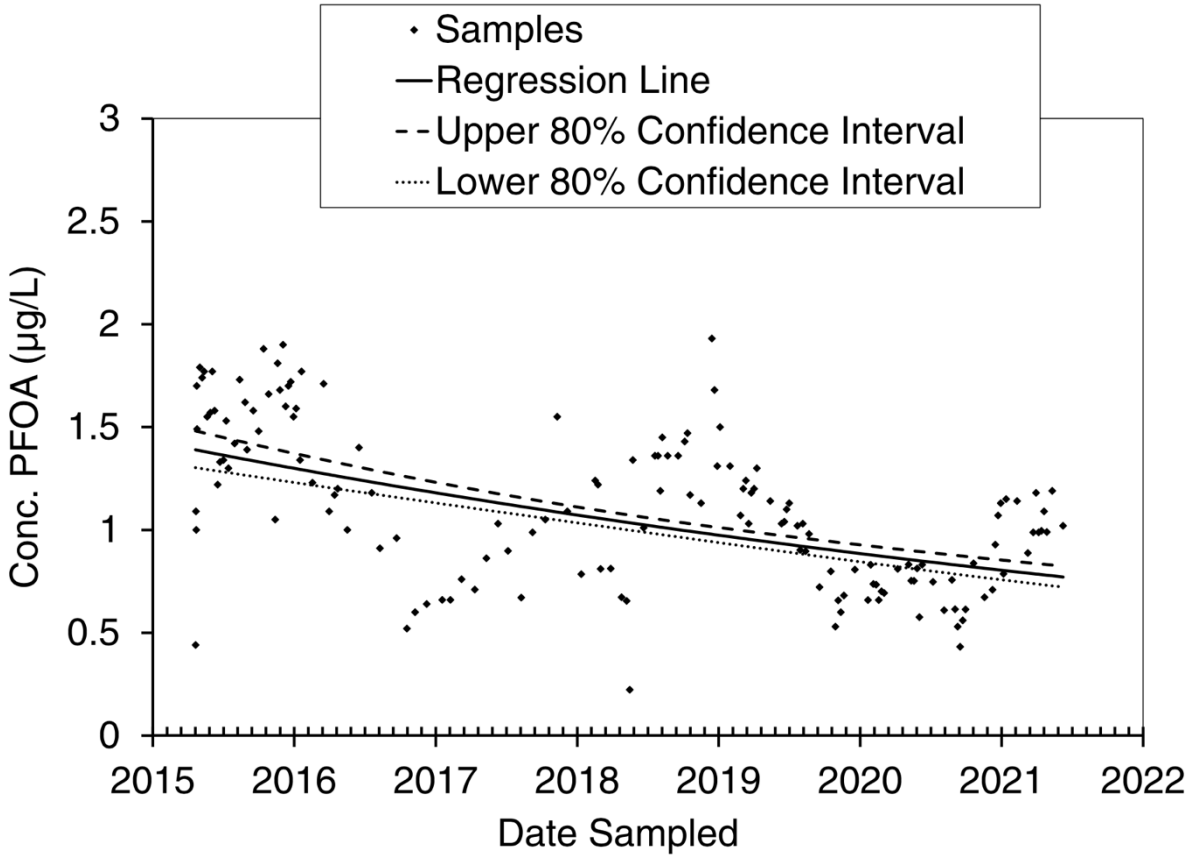
Wurtsmith Air Force Base P&T – the first 6 years



PFOS



PFOA

Birnstingl and Wilson (2024). Remediation Journal **35**(1). https://doi.org/10.1002/rem.70005

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P&T extrapolated time to target

TABLE 2 | Projected time to reach the clean-up goals for PFOS and PFOA. The minimum and maximum times are projections of the 80% confidence band on the regression line (Figures 4 and 5).

Species	Target	Min time to target (years)	Year target reached	Mean time to target (years)	Year target reached	Max time to target (years)	Year target reached
PFOS	20 (ng/L)	119	2134	175	2190	335	2350
PFOA	40 (ng/L)	32	2047	37	2052	52	2067
PFOS	4 (ng/L)	150	2165	222	2237	433	2448
PFOA	4 (ng/L)	52	2067	61	2076	74	2089

Note: There is an 80% probability that the stated clean-up goal will be reached between the maximum and minimum time to target. The probability of the stated clean-up goal being reached in a shorter time than the minimum or a longer time than the maximum will therefore be 10% in either case. The mean time to target represents the best-fit regression.

Implication: *"…**centuries may be required** to secure (P&T) clean-up."*

Birnstingl and Wilson (2024). Remediation Journal **35**(1). https://doi.org/10.1002/rem.70005

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Remove or Retain in Place?

1. Practicality – feasibility and time.
2. **Cost – financial and resource.**
3. Liability – reduction or expansion?

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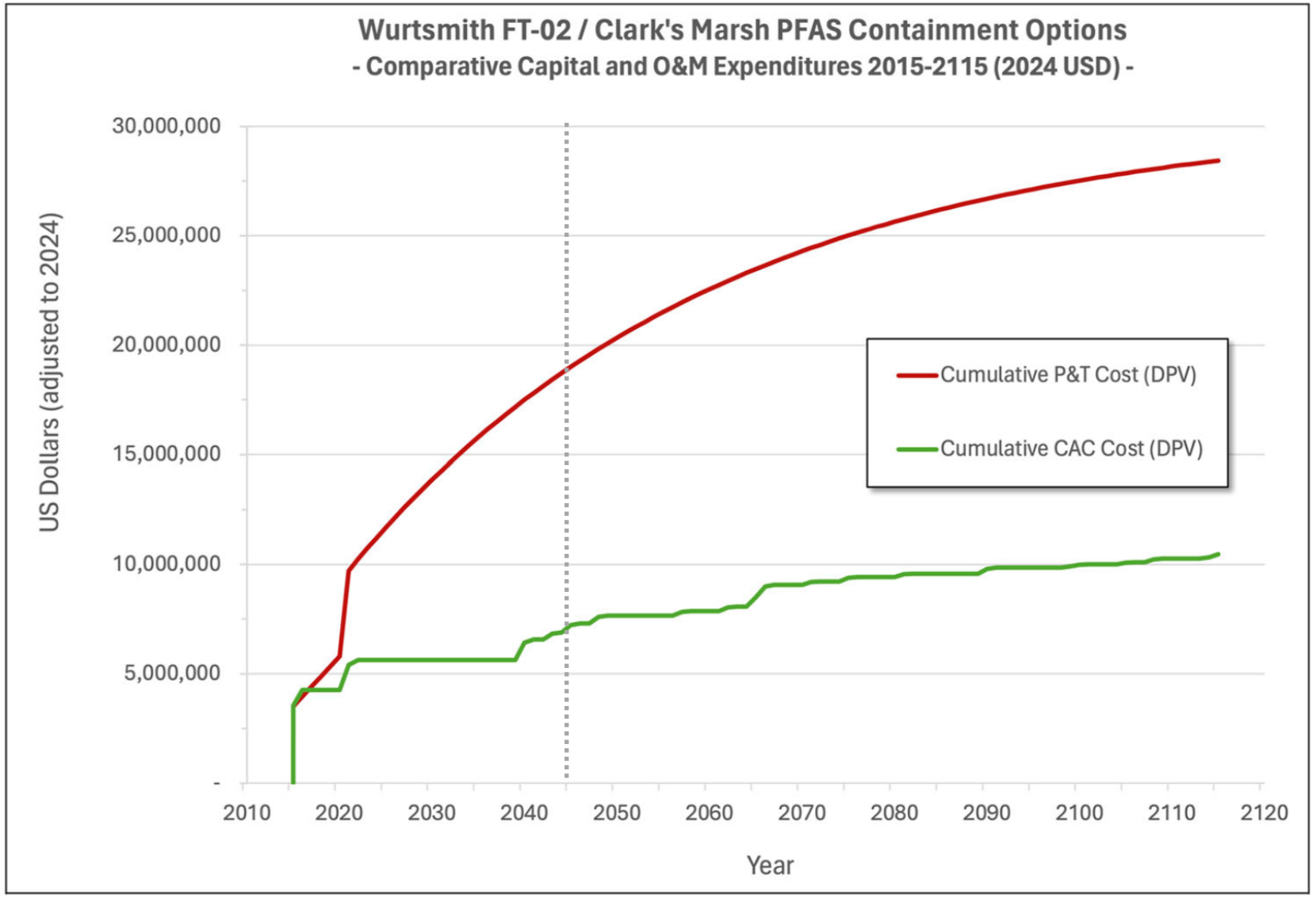
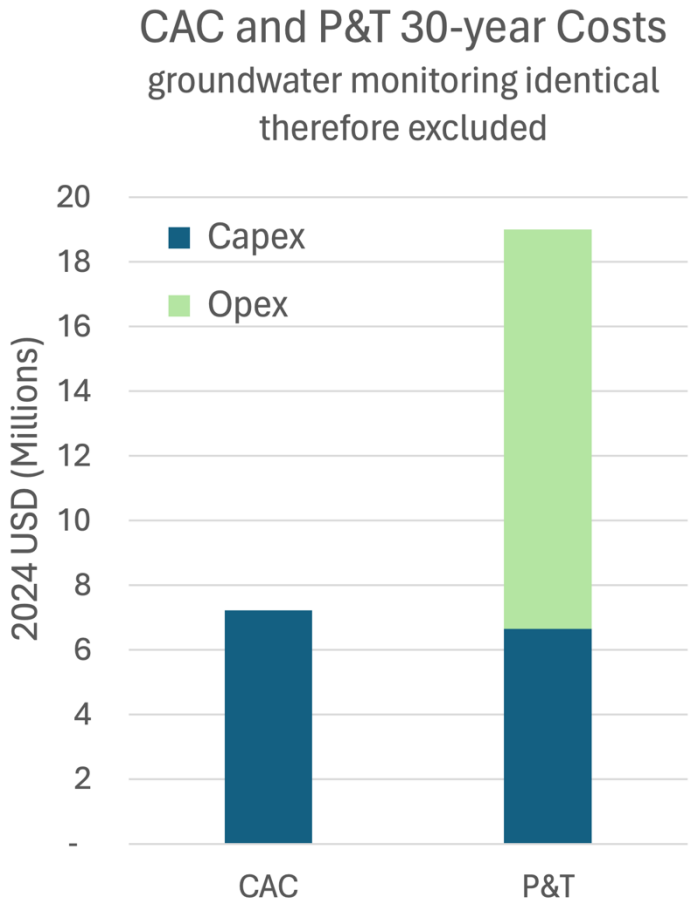
Comparative Cumulative Costs – first 100 years

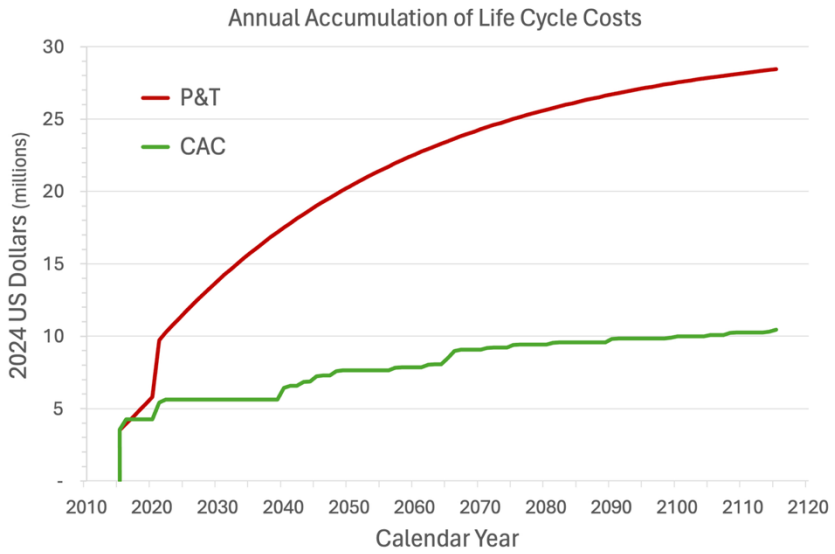


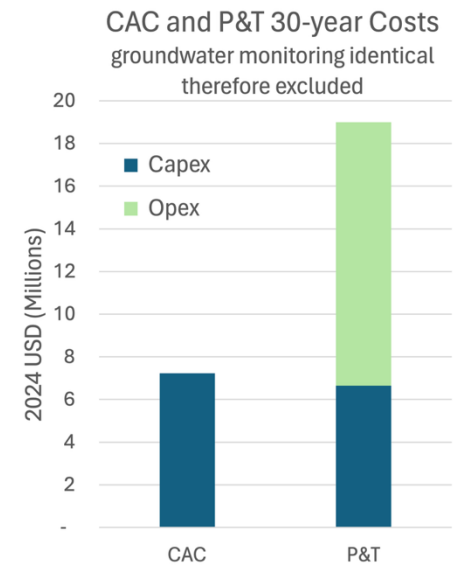


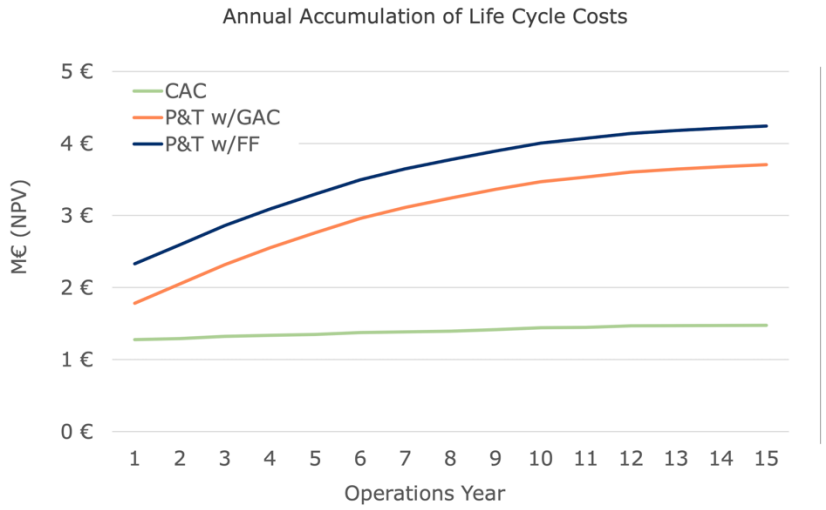
Birnstingl and Wilson (2024). Remediation Journal **35**(1). https://doi.org/10.1002/rem.70005

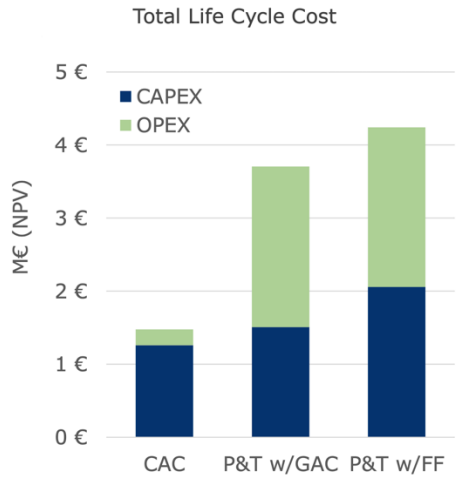
How Representative?

- **Wurtsmith AFB**
  - Installed P&T
  - Calculated CAC
  - CAC 62% lower cost
- **UK Airport ***
  - Installed CAC
  - Calculated P&T
  - CAC 60 – 65% lower cost





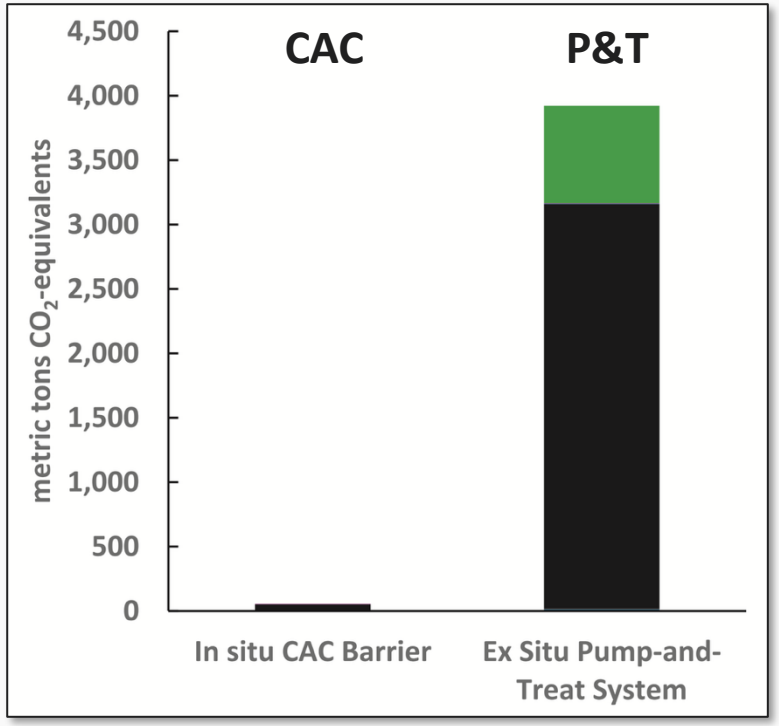


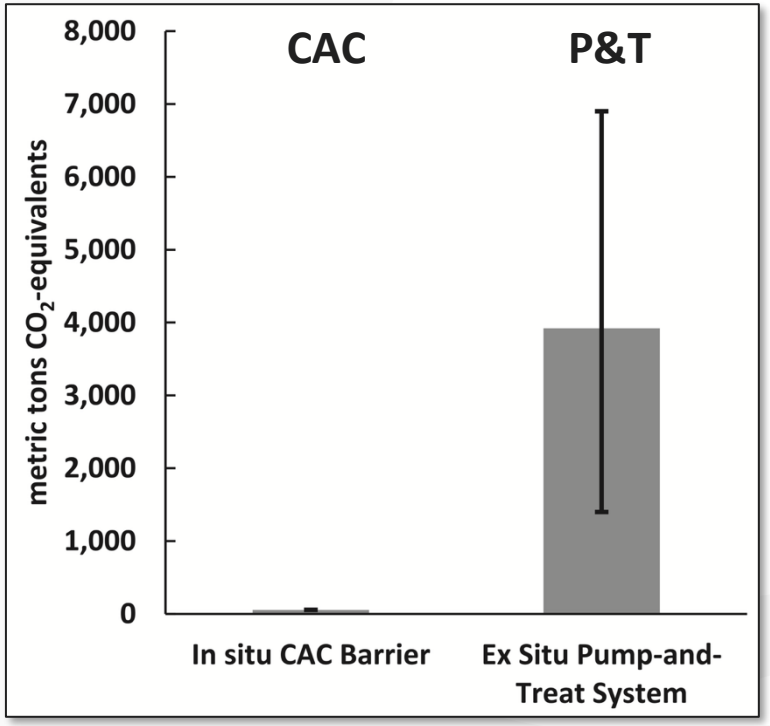


* Mallat et al. 2023. Sustainability Assessment of In Situ and Ex Situ Remediation of PFAS Contaminated Groundwater. (Report No. 1510073703). Ramboll.

Remove or Retain in Place?

Relative Greenhouse Gas (GHG) Emissions – in situ CAC vs P&T





- UK airport
- PFAS plume
- Technology comparison
  - CAC actual
  - P&T hypothetical

- **CAC 98% lower GHG**
  - CAC: 15 t CO_2-eq
  - P&T: 3,922 t CO_2-eq
  - 15-year projections

Black – operation
Green – waste management
Error bars – sensitivity analysis for different GAC usage rates for P&T

Thoreson et al. (2025). Remediation Journal **35**(4). https://doi.org/10.1002/rem.70034

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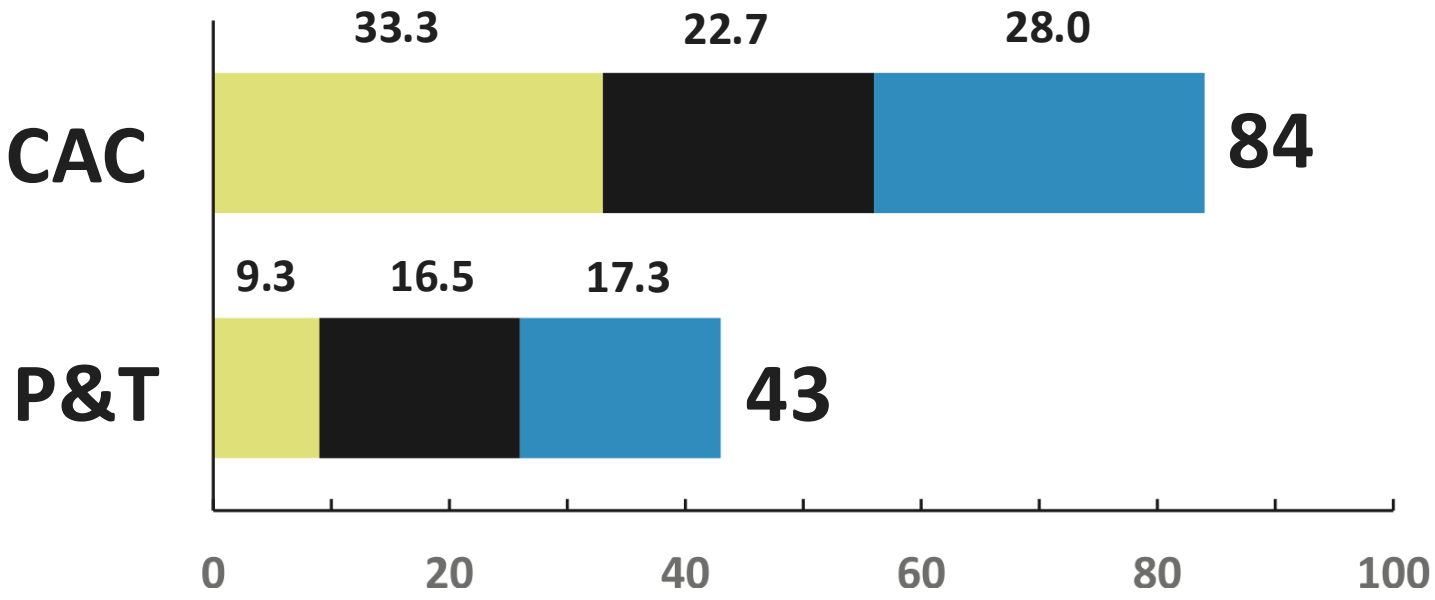
Remove or Retain in Place?

Sustainability Score
(Ramboll *SURE*, ISO 18504)



- CAC scores **higher** across all domains
- CAC attains the **maximum** possible score on 'environment'
- CAC scores are more **balanced** across all domains

Max possible category score is 33.3
Max possible overall score is 100

Environment
Society
Economy

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Thoreson et al. (2025). Remediation Journal **35**(4). https://doi.org/10.1002/rem.70034

Remove or Retain in Place?

1. Practicality – feasibility and time.
2. Cost – financial and resource.
3. **Liability – reduction or expansion?**

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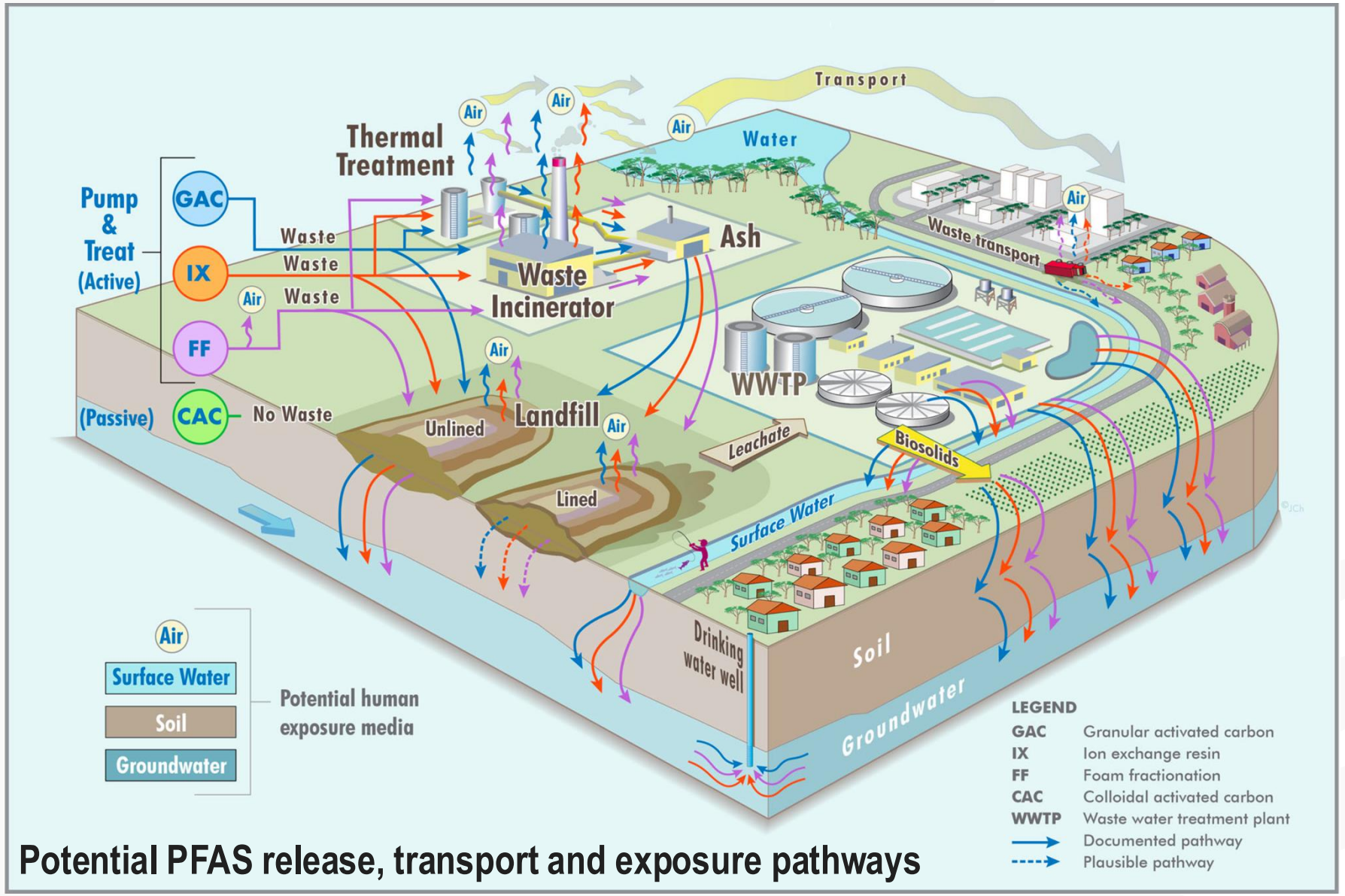
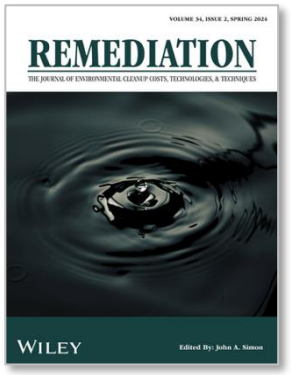
Waste Lifecycle – potential exposure liabilities



Potential PFAS release, transport and exposure pathways



Volume 34, Issue 2
Spring 2024
e21775

Hall, Birnstingl, Wilson (2024)
Pandora's PFAS Box

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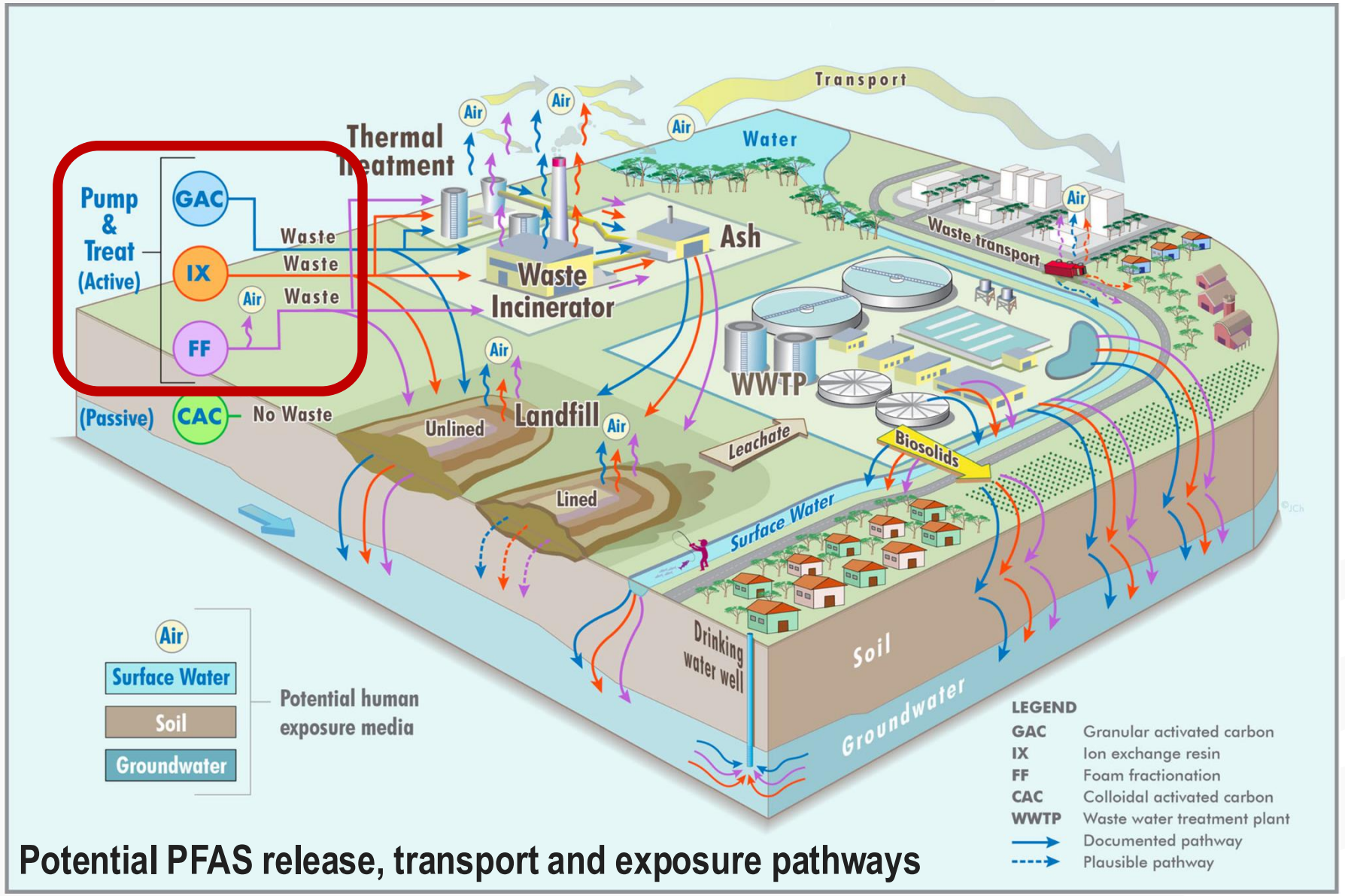
Waste Lifecycle – potential exposure liabilities



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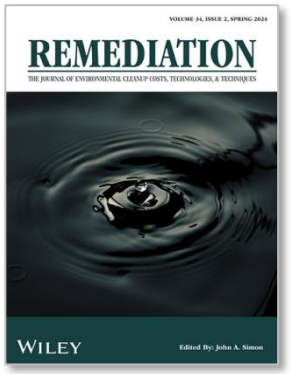

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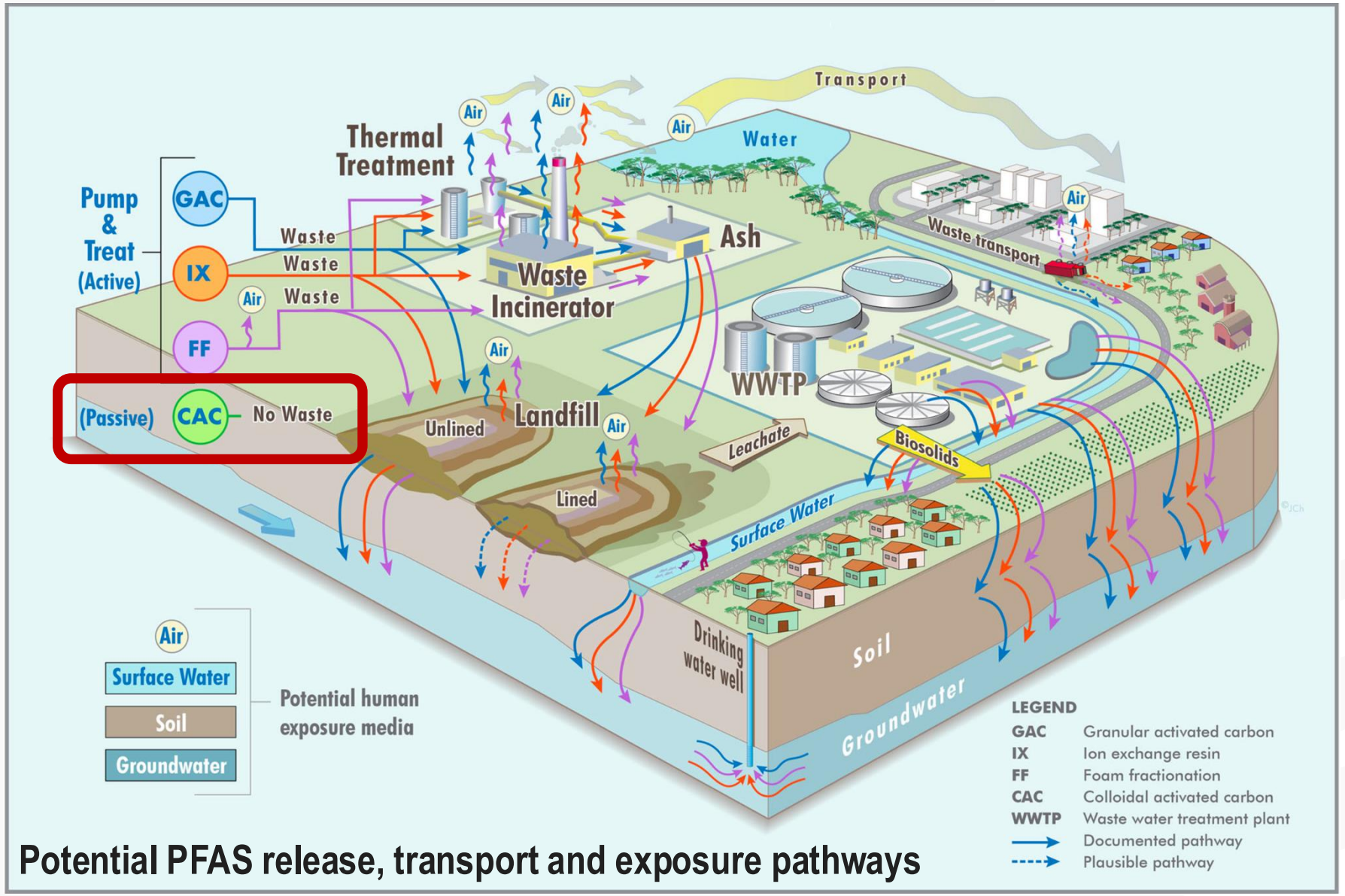

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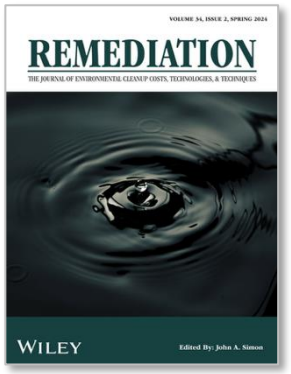

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Hazardous Substance Liabilities

- PFAS designated **'Hazardous Substances'** under CERCLA (July 2024) [1]
  - Presently applies to PFOS and PFOA
- Introduces strict implications relating to stewardship and liability
- Unintentional releases or public exposure take on a new significance

[1] US Federal Register / Vol. 89, No. 90, 39124. Wednesday, May 8, 2024.

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Will it happen?

Who can say?

- We're only just starting
- The track record is still to be written
- But documented precedents for PFAS already exist

- **Probability**
  - P&T: extraction and disposal will be ongoing for many years
  - Possibility that a release will have occurred will grow
  - **Over a century, a 'once-in-a-hundred-years' event becomes a certainty**

Remove or Retain in Place?

Summary

1. **Practicality** – feasibility and time
   - Mass depletion is very slow
   - Removal to MCL is unrealistic
   - The aquifer remains contaminated

2. **Cost** – financial and resource
   - CAC 60% less expensive than P&T
   - CAC 98% lower GHC contribution than P&T
   - CAC 95% higher sustainability score than P&T

3. **Liability** – reduction or expansion?
   - PFAS removal generates PFAS wastes
   - Waste lifecycle introduces potential new exposure pathways and liabilities
   - *In situ* retention generates no wastes, no new exposure routes, no new liabilities

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Questions?

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