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Sustainable PFAS Remediation: Comparing the Environmental Impact of Enhanced Attenuation using Colloidal Activated Carbon to Pump and Treat

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Overview

Purpose

- Goal of groundwater remediation is environmental clean-up
- Logical to think about the sustainability of *how* we remediate

Background

- PFAS Contamination in Groundwater
- Remediation Approaches for PFAS
  - In situ passive barrier
  - Ex situ pump and treat

Life Cycle Assessment Comparative Case Study

- PFAS Contaminated airport site in the UK
- Approach of LCA
- Results of in situ and ex situ methods

PFAS Contamination in Groundwater

What is PFAS?

- Per- and polyfluoroalkyl substances
- Man-made, widely used in industrial, commercial, and household applications.

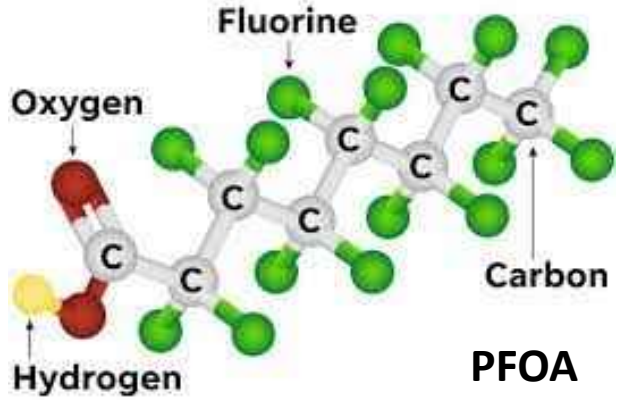
Accumulation

- Recalcitrant nature
- Accumulates in the environment, contaminates soil and groundwater.

Exposure to PFAS

- Linked to adverse health effects
  - part per trillion concentrations
- Developmental, reproductive, and immune system effects

PFAS contamination is a growing concern worldwide, and there is a need for effective and sustainable strategies to manage and remediate contaminated sites.



PFOA

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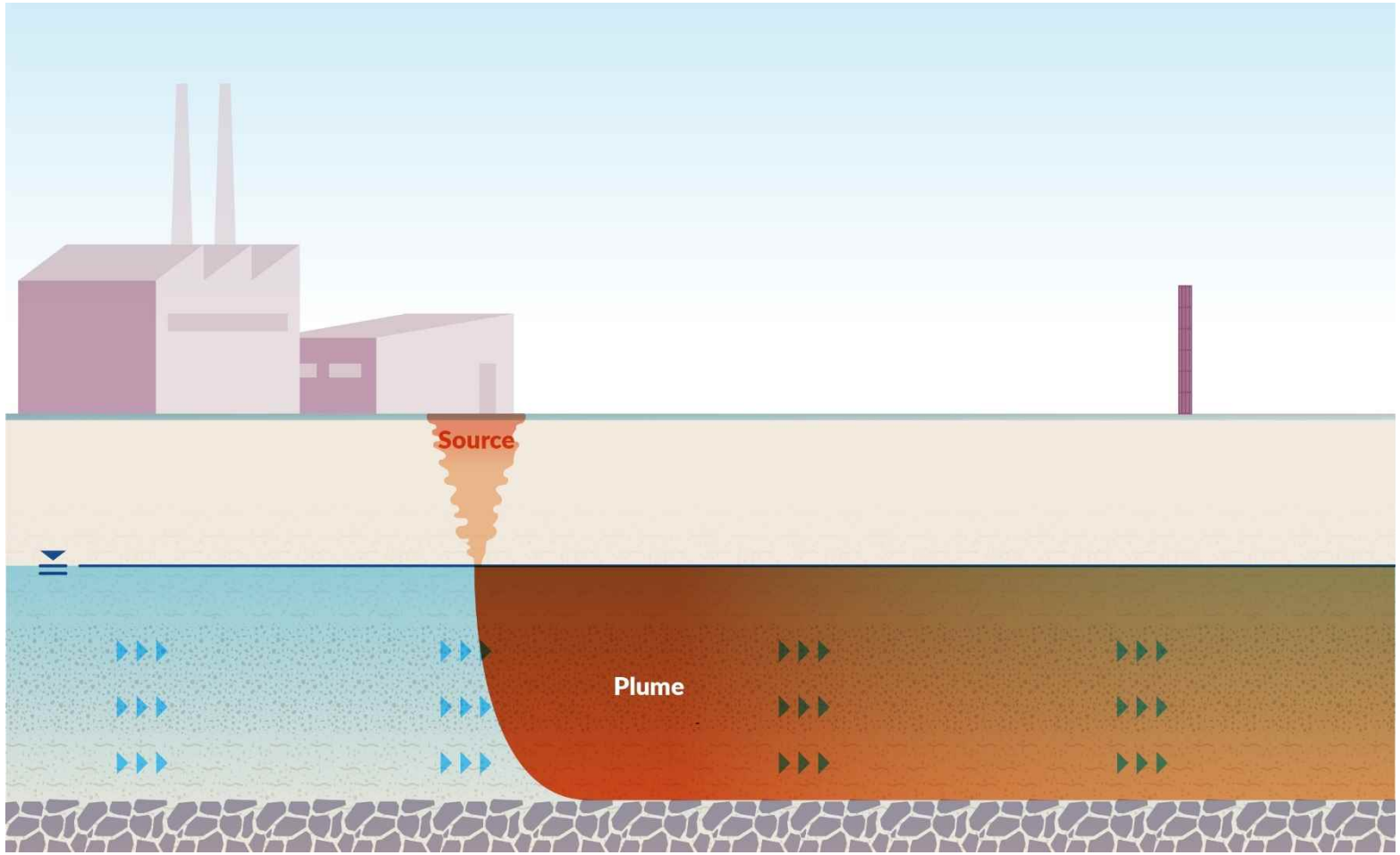
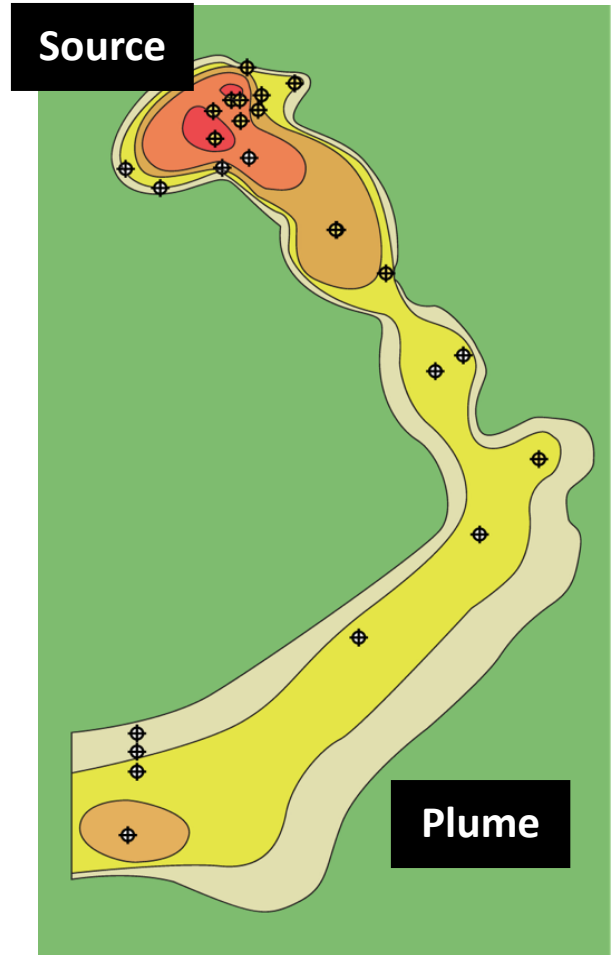
Groundwater Contamination





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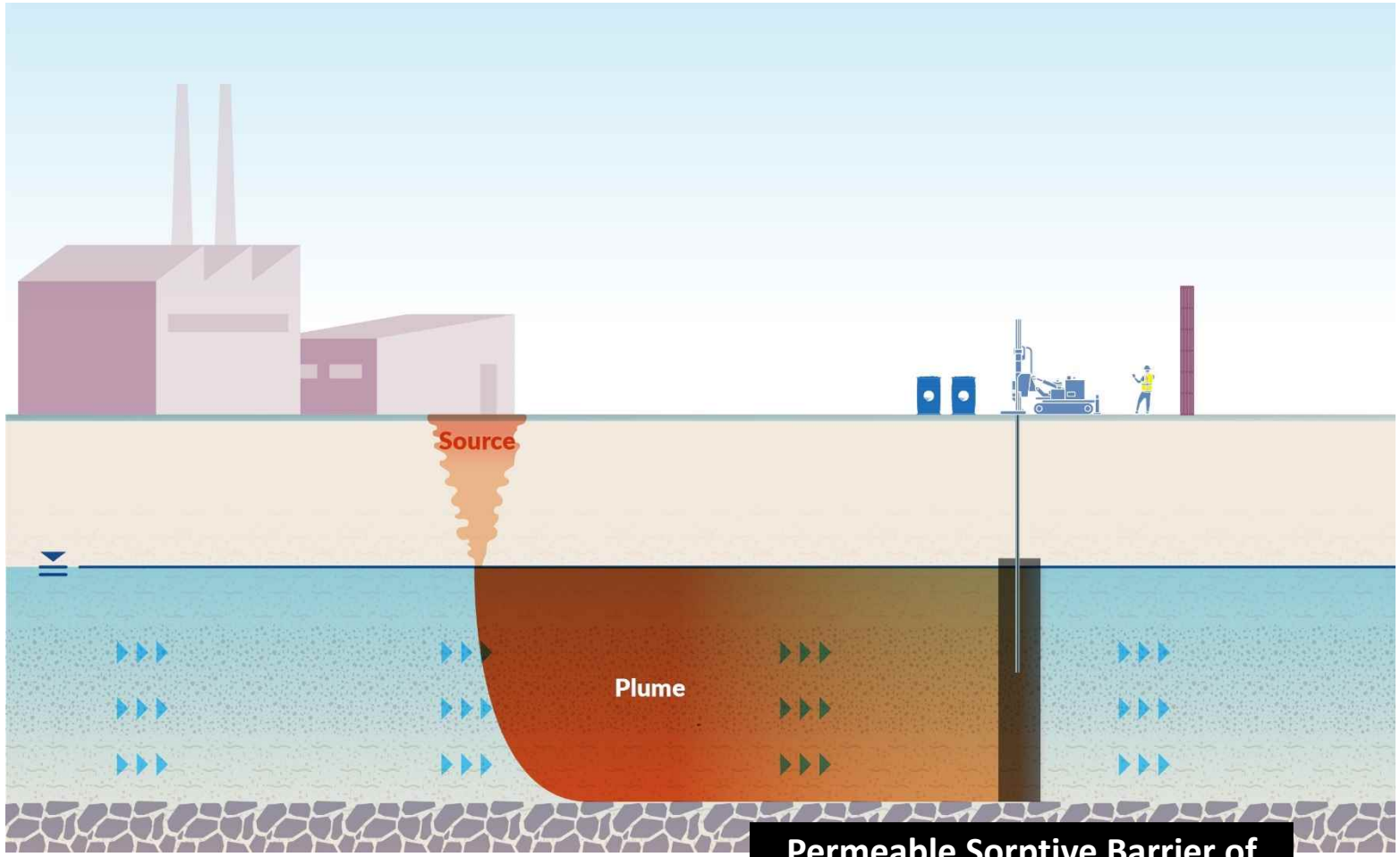
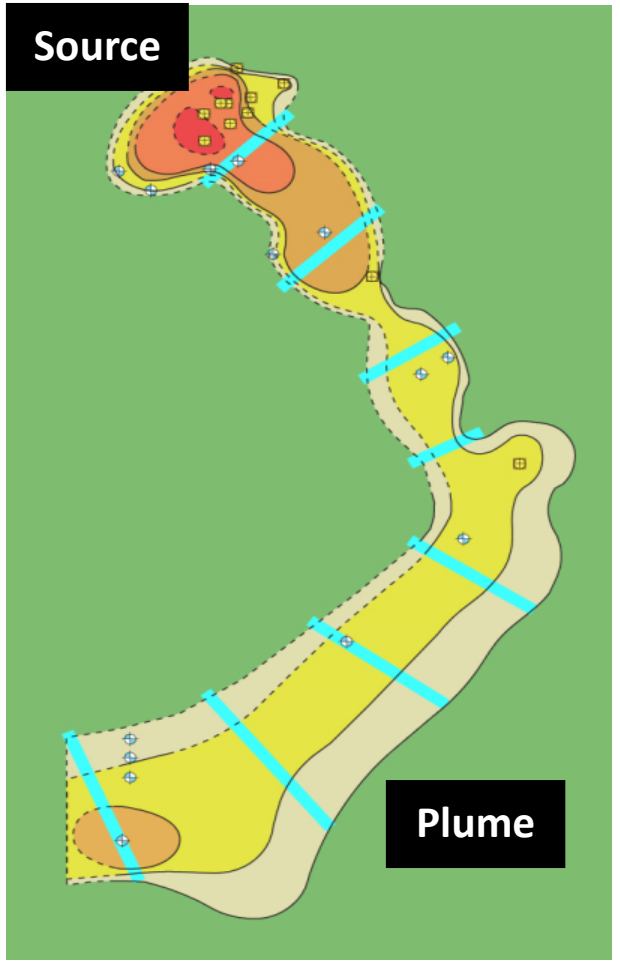
Management Options – In Situ

Passive Management With Injectable Reagent



Permeable Sorptive Barrier of Colloidal Activated Carbon



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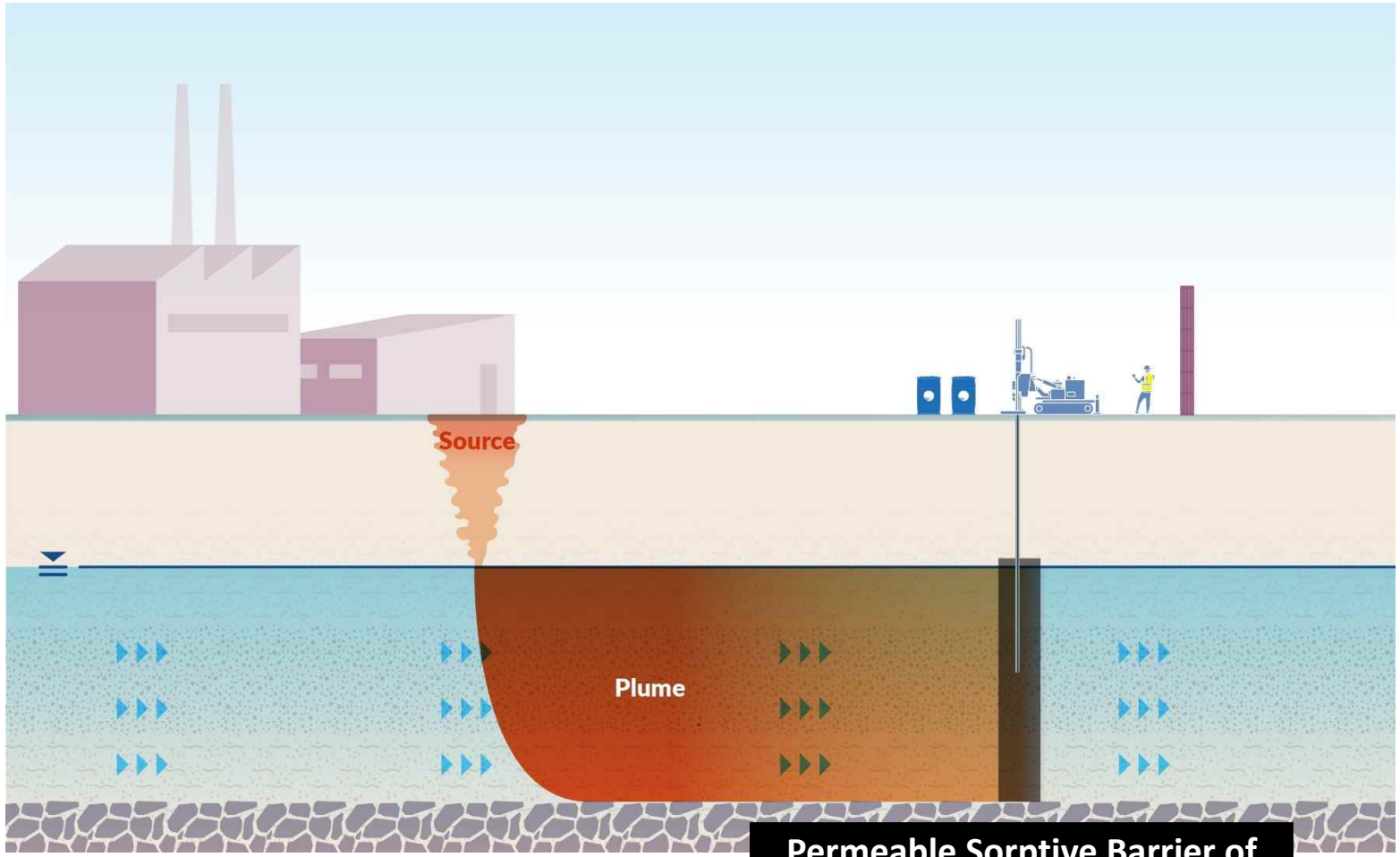
Management Options – In Situ

Passive Management With Colloidal Activated Carbon



Permeable Sorptive Barrier of Colloidal Activated Carbon

PLUME STOP®
Liquid Activated Carbon

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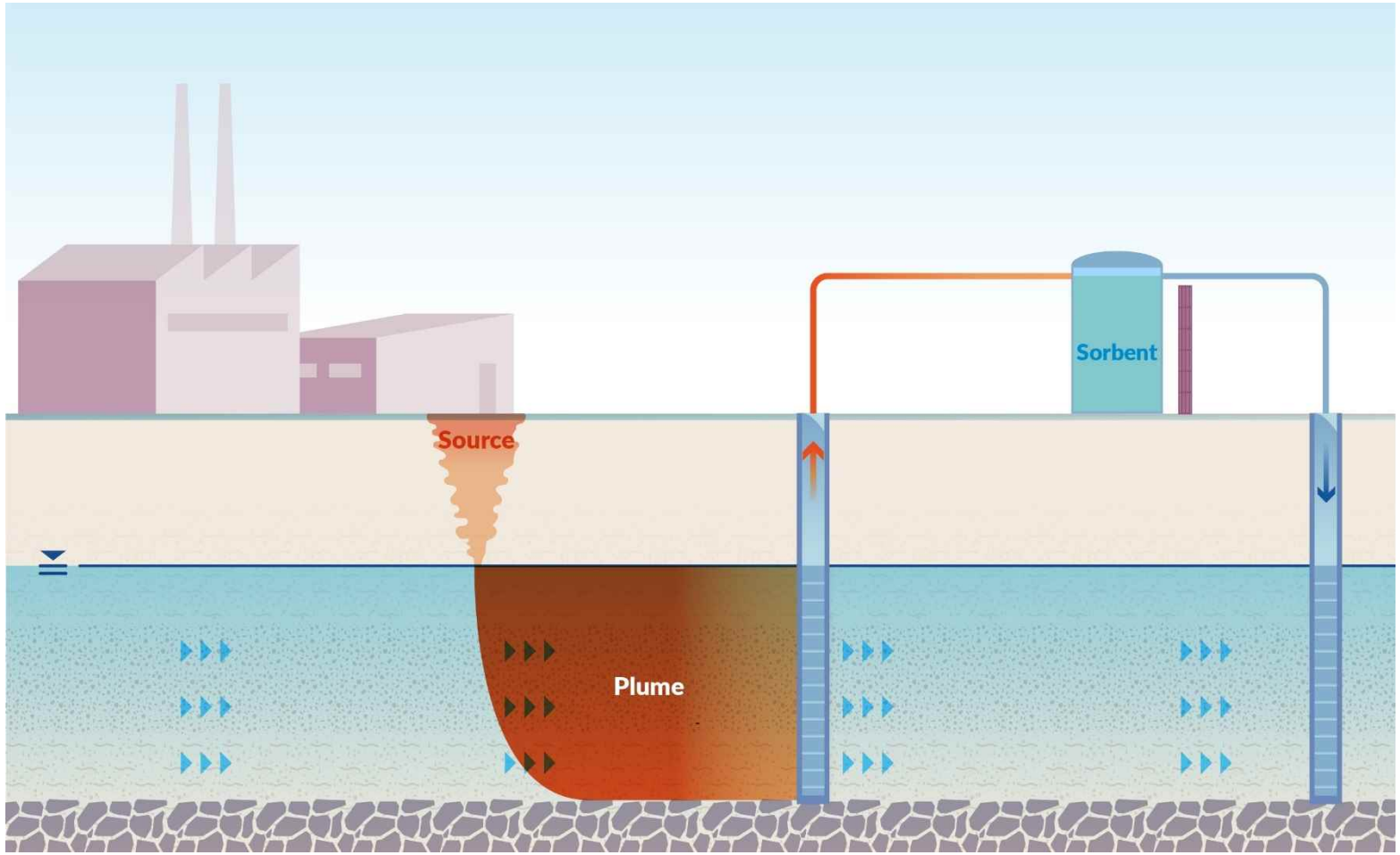
Management Options – Ex Situ “Pump and Treat”

Groundwater Extraction with Granular Activated Carbon Filtration



Hydraulic Containment via:

- Physically pumping groundwater to surface
- Contaminated water treated above ground
  - GAC filtration
- Clean water is discharged

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Overview of Study

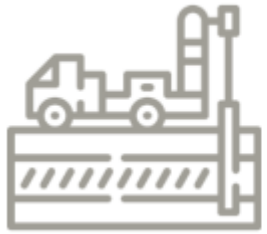
PFAS Contaminated Airport, UK

LCA for two remedial approaches:

- **In Situ Sorption and Retention Barrier**
  - Passive barrier of colloidal activated carbon (PlumeStop)
  - Recently implemented at the site

- **Ex Situ Pump and Treat**
  - Utilized granular activated carbon (GAC)
  - Theoretical, best-practice design

Life Cycle Inventory Analysis



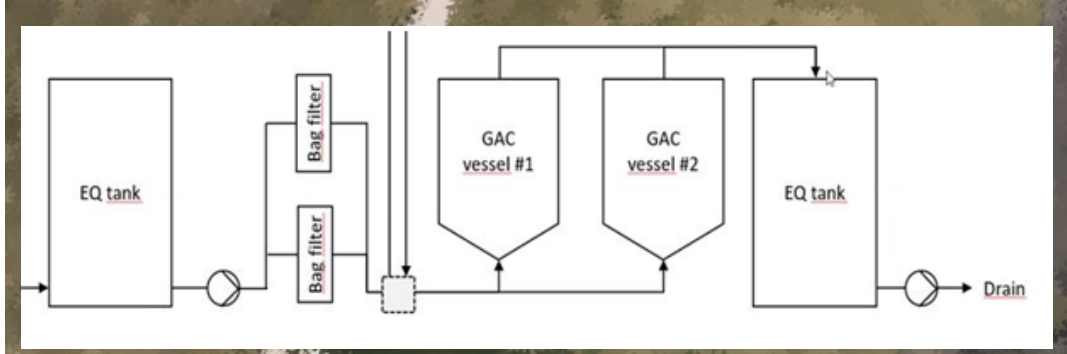
Immobilization with PlumeStop ®

- Single injection round
- Designed for 15 years of efficiency
- 102 injection points
- 120 yards long
- 74,000 lbs PlumeStop
- 420 gallons fuel used for injection
- 3 monitoring wells, 33 feet deep
- 2 times/yr, environmental monitoring

Life Cycle Inventory Analysis

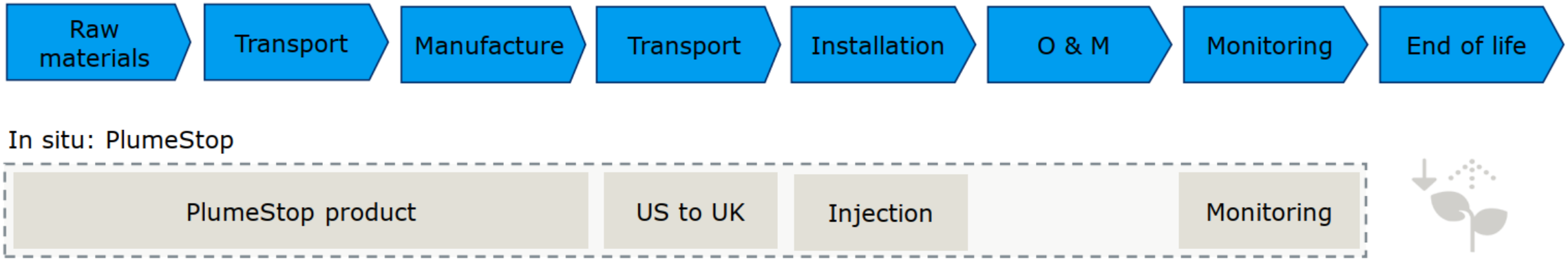
Pump & Treat with
GAC filtration

- Fixed equipment installation
- Continuous operation 15 years, 95% uptime
- 8 extraction wells, 25 feet deep
- 26 gal/min pumping rate
- 53,000 lbs GAC/yr usage rate
  - 100 mg/kg adsorption capacity
- 960 MWh/yr electricity consumption
- 4 times/yr O&M inspection from Bristol
- 420 gallons fuel used for installation
- 3 monitoring wells, 33 feet deep
- 2 times/yr, environmental monitoring



Scope of Assessment: Cradle to Grave

System boundary



Methods/Software

- ISO 14040:2006, ISO 14044:2006, ISO 14067:2018, PCR for Basic Chemicals
- GaBi 10 Professional, Sphera, Ecoinvent 3.8

Scope of Assessment: Cradle to Grave

System boundary

Raw materials → Transport → Manufacture → Transport → Installation → O & M → Monitoring → End of life

In situ: PlumeStop

- PlumeStop product
- US to UK
- Injection
- Monitoring

On-site: Pump & Treat

- Pump & Treat Equipment
- Extraction wells and transfer lines

- Civil works
- Materials
- Energy
- Maintenance

- Monitoring
- Waste management

Methods/Software

- ISO 14040:2006, ISO 14044:2006, ISO 14067:2018, PCR for Basic Chemicals
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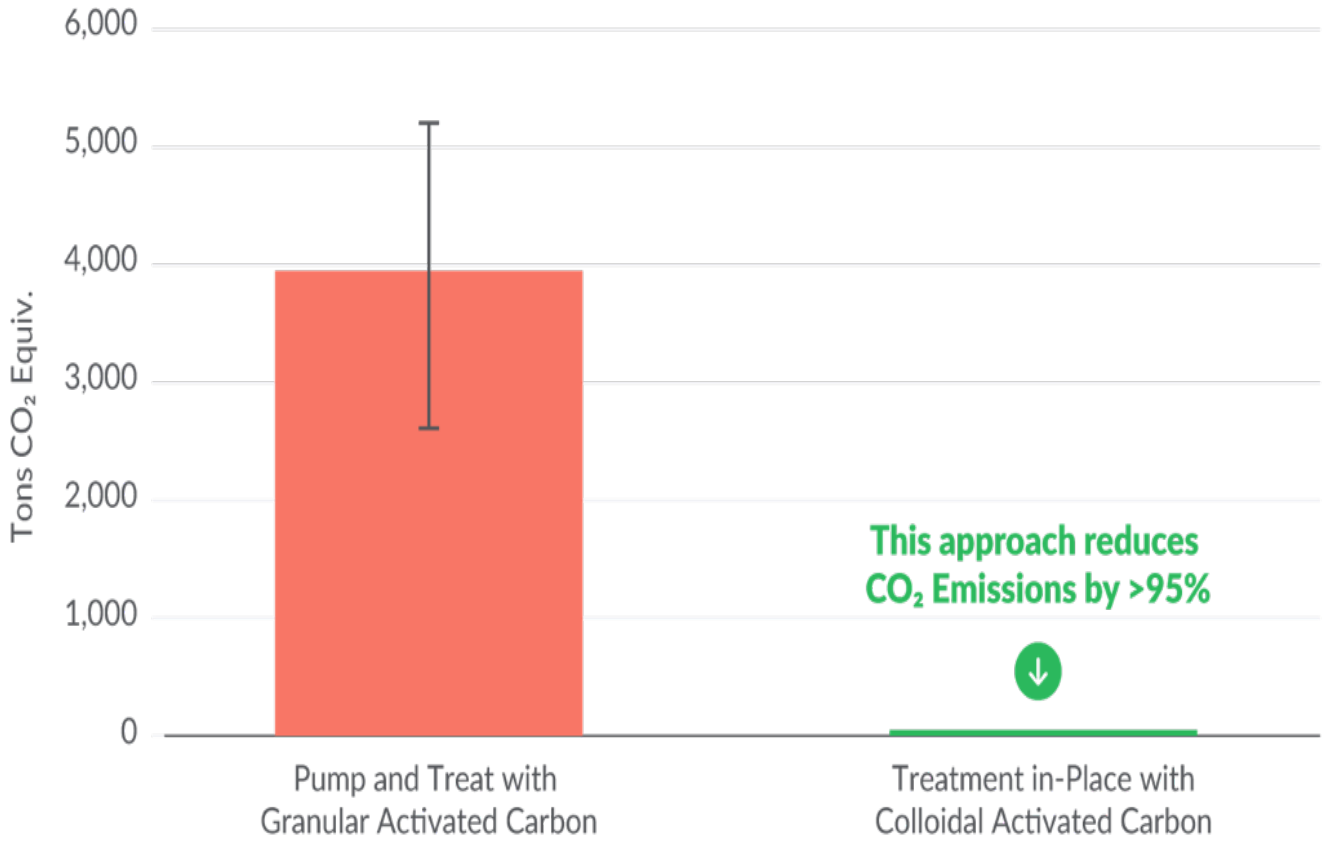
Results

Calculated Project Carbon Footprints



	PlumeStop	P&T w/ GAC
Remediation equipment		15,2
Civil works		
Fixed installations	0,05	0,9
Machinery	1,0	1,3
Remediation and operations		
PlumeStop / GAC	50,5	2 860
Electricity		281
Maintenance		3,6
Monitoring	4,0	4,0
Waste management		
Hazardous waste		112
Wastewater treatment		644
Total carbon footprint	**55,5**	**3 922**

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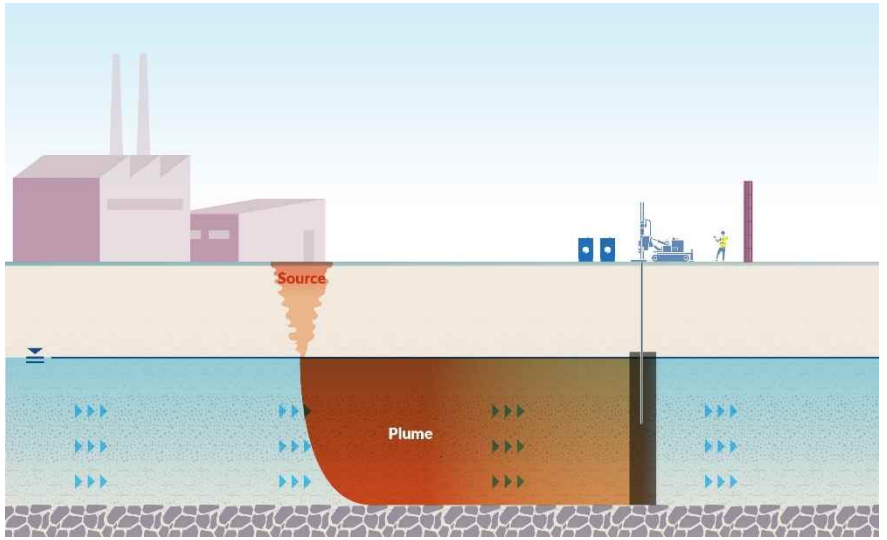
Key Conclusions

- Immobilization with CAC had 40-70 times smaller carbon footprint for PFAS remediation (in CO_2-eq emissions) compared to P&T
- Though results are site specific, a generalized assessment of the potential impacts can be clearly concluded.
- Additional sustainability indicators are currently being evaluated



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Thank You!

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Proven on PFAS Sites Worldwide

PLUME STOP® Liquid Activated Carbon

SourceStop™

>40 Completed Applications

- 22 Industrial
- 5 DoD
- 9 Airport
- 1 Landfill
- 4 Other

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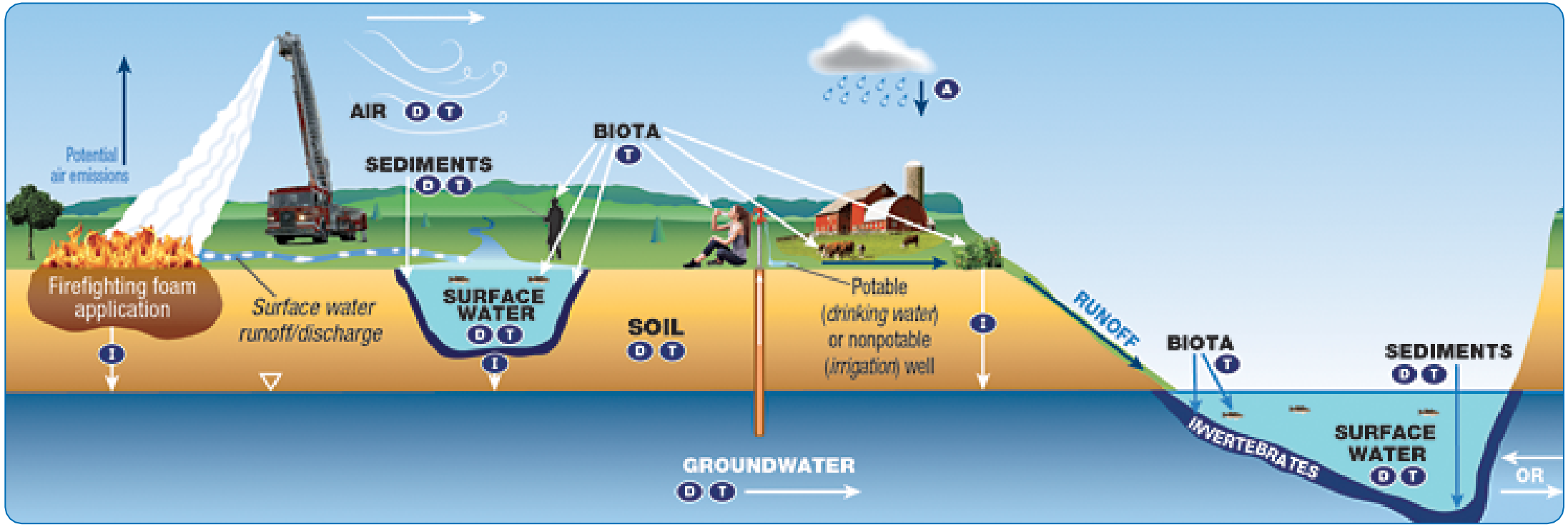
SourceStop™
PLUME STOP
Liquid Activated Carbon

PFAS in The Environment

Direct Releases from:

Airports Chemical Manufacturing Facilities Refineries, Bulk Storage Depots



CSM for Fire Training Area *Source: Adapted from figure by L. Trozzolo, TRC. Used with permission.*

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