

PILOT-SCALE TREATMENT TRIAL

PFAS Removal from a Highly Contaminated Groundwater Site

Pilot-Scale Performance of a Novel Adsorption Media (G400) Compared with Activated Carbon

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Industrial origins of PFAS contamination

Northern Italy has long been one of Europe's most industrialised regions, with a textile sector that made extensive use of per- and polyfluoroalkyl substances (PFAS).

For decades these synthetic chemicals were prized for their exceptional water, stain and oil repellency — a staple of fabric finishing, technical garments and industrial coatings.

Their persistence, mobility in water and resistance to degradation have caused significant, long-lasting contamination of groundwater and drinking-water supplies affecting hundreds of thousands of residents, triggering major public-health investigations and regulatory action.



Textile finishing

Water/stain/oil-repellent treatments



Chemical manufacturing

Legacy industrial discharge



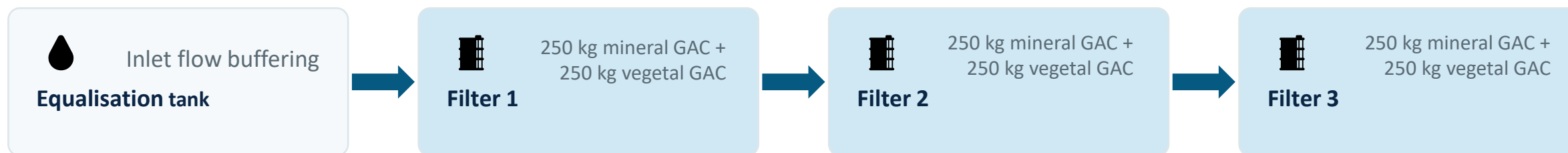
Tanning industry

Additional contaminant burden

A pattern repeated across Northern Italy's industrial corridors, leaving soils and aquifers burdened with persistent contaminants — driving the need for targeted remediation and stricter controls.

The existing groundwater treatment plant

Continuous operation for several years • nominal capacity 5 m³/h (current inlet ~2 m³/h)



Three filters in series, 1 m diameter each

Chlorinated contaminants treated

PCE (tetrachloroethylene)	up to 36 µg/L
TCE (trichloroethylene)	up to 230 µg/L
VCM (vinyl chloride)	up to 0.2 µg/L
Trichloroethane	up to 0.1 µg/L
1,2-Dichloroethylene	present

All consistently compliant with discharge / reinjection limits.

PFAS: generally well treated — except PFBA

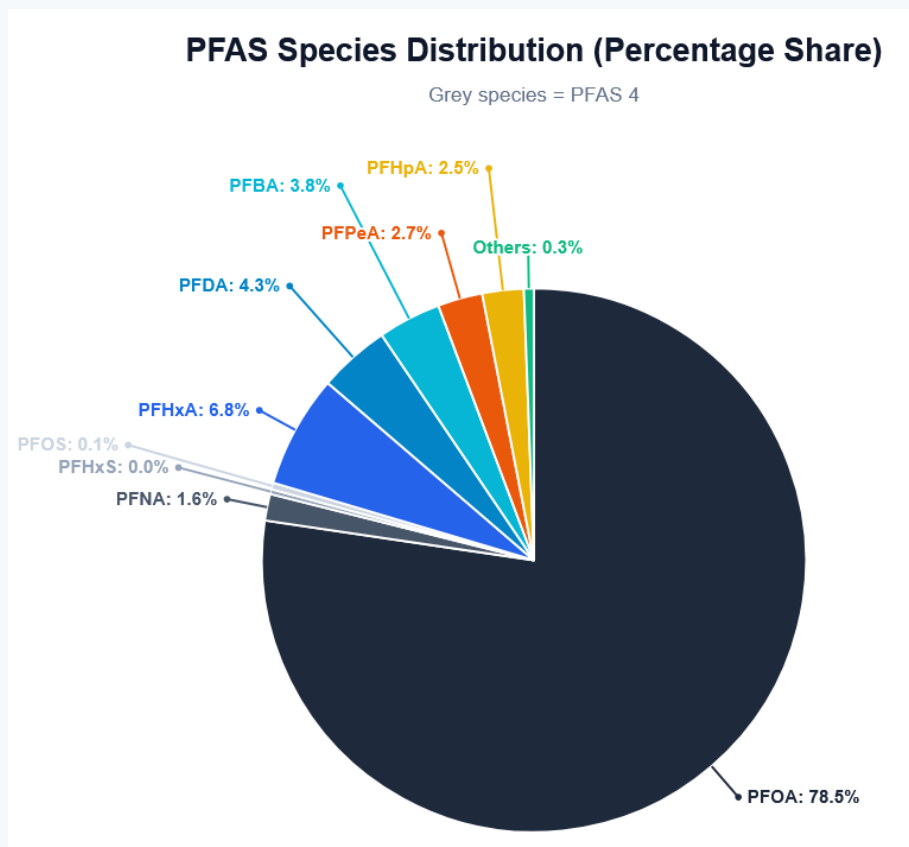
On-site PFBA limit: 10 ng/L (restrictive)

Inlet ranges (historical data):

- Sum of PFAS: 17,000–37,000 ng/L
- PFOA: 12,000–26,000 ng/L
- PFBA: 100–1,200 ng/L

Outlet: Sum of PFAS & PFOA stay below 500 ng/L; PFBA stays below 10 ng/L but not consistently over the long term.

Characterisation of the water to be treated



Reading the profile

PFOA dominates the influent load at **78.5%** of total PFAS by weight.

The four priority PFAS (PFAS4, shown in grey/blue) are predominant overall.

Short-chain PFHxA (6.8%) and PFBA (3.8%) form a meaningful secondary fraction — the compounds hardest for adsorption media to retain.

An evolving, fragmented European framework

EU Directive (EU) 2020/2184 sets harmonised sum-based drinking-water parameters, binding since January 2026: **Sum of PFAS $\leq 0.10 \mu\text{g/L}$** • **PFAS Total $\leq 0.50 \mu\text{g/L}$** . National transpositions, however, differ significantly.

IT**Italy — D.Lgs. 102/2025**

Multi-layered approach: extended “Sum of PFAS” list of 30 compounds; additional 20 ng/L limit for the four priority PFAS (PFOA, PFOS, PFNA, PFHxS); dedicated limit for ultrashort-chain TFA (10 ng/L, in force 2027); individual groundwater thresholds under the site-remediation framework.

ES**Spain — Real Decreto 3/2023**

Technical-sanitary water-quality criteria monitor the sum of the 20 PFAS defined by the Directive, consistent with the approach taken by several other European countries.

EU**Why it matters**

Performance requirements for treatment technologies — which compounds must be targeted, and to what levels — vary substantially across Europe, reinforcing the need for flexible, sustainable and effective alternatives to activated carbon.

Short-chain PFBA: the plant's persistent challenge

10 ng/L

Restrictive on-site discharge limit for PFBA

Activated carbon treats the plant's wider PFAS and chlorinated-solvent load reliably, but performance for the short-chain compound PFBA is not consistently satisfactory against this tight threshold — the main driver for trialling a new, purpose-built adsorption media.

Why short-chain PFAS is hard to treat

- Weaker hydrophobic interaction with adsorption media than long-chain compounds
- Earliest breakthrough during adsorption-based treatment — a limitation common across the technology class
- Increasingly targeted by regulation (e.g. Italy's dedicated TFA limit, entering force 2027)
- Requires either longer contact time or a dedicated polishing stage

The G400 filtering media trial

G400

A granular functionalised activated alumina supplied by Purafinity, purpose-designed for the removal of per- and polyfluoroalkyl substances (PFAS) from water.



0.5 m³/h

Trial flow (~1/10 of plant's 5 m³/h capacity)

1.5 min

Empty-Bed-Contact-Time (EBCT) at 0.5 m³/h

11.5 kg

G400 media per filter (12.5 L)

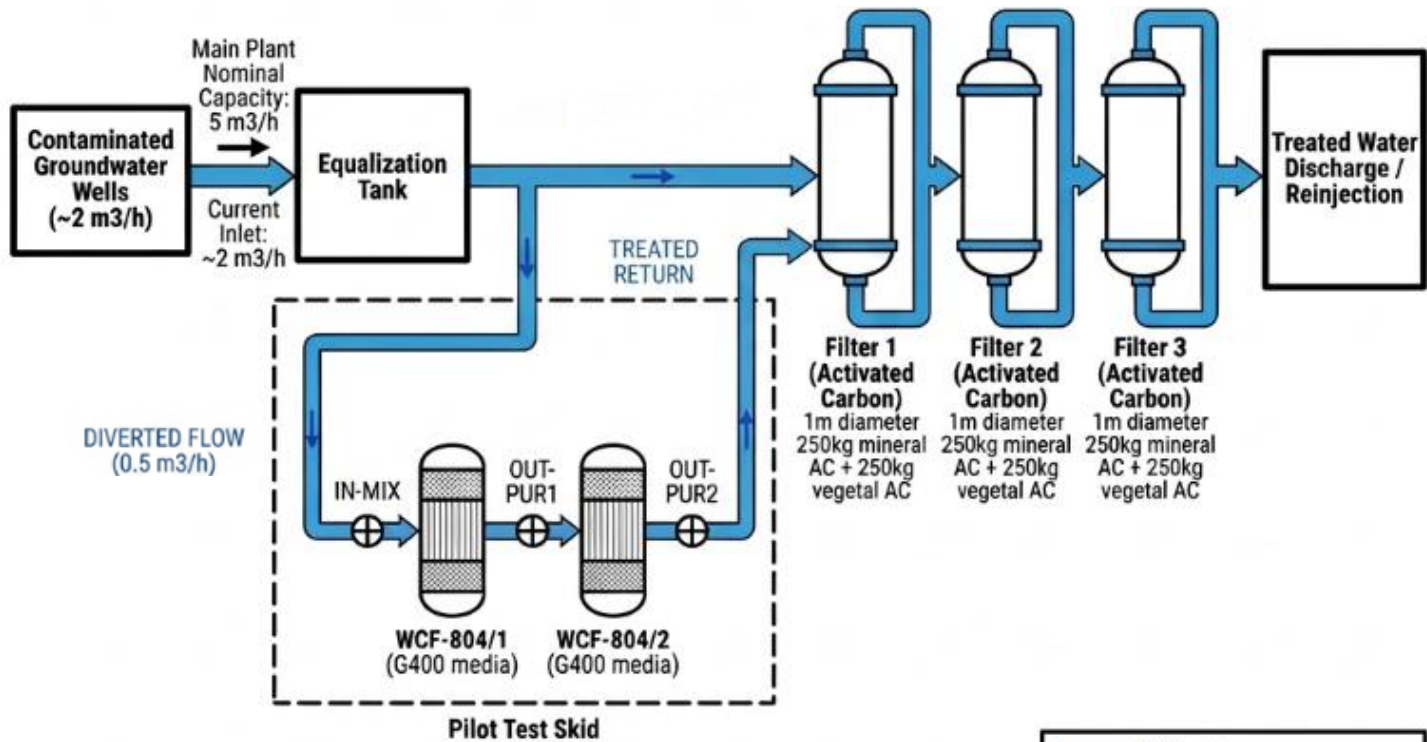
850 kg/m³

G400 bulk density (vs ~500 kg/m³ for GAC)

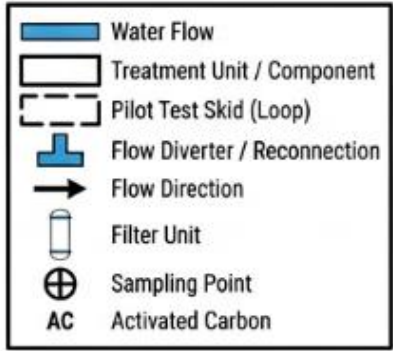
The trial operates as a closed loop: treated water re-joins the main plant line and passes through the existing three-stage carbon train before final discharge — normal compliance is never bypassed.

Flow path and sampling points

The trial diverts a side-stream from the main plant, treats it through two G400 filters, then returns it to rejoin the existing three-stage carbon train — a closed loop that never bypasses the plant's normal compliance path.



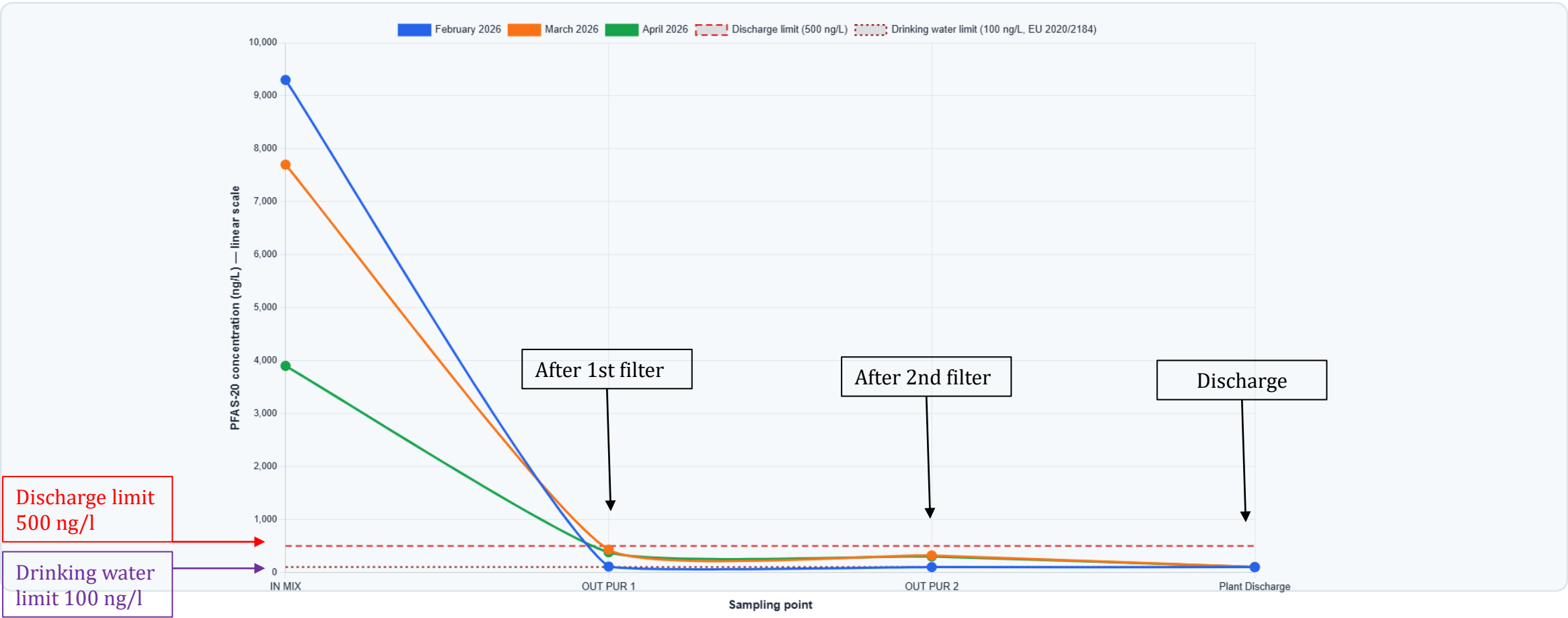
Three sampling points track performance at each stage — letting Phase 1 isolate how much each individual G400 filter contributes to overall PFAS removal.



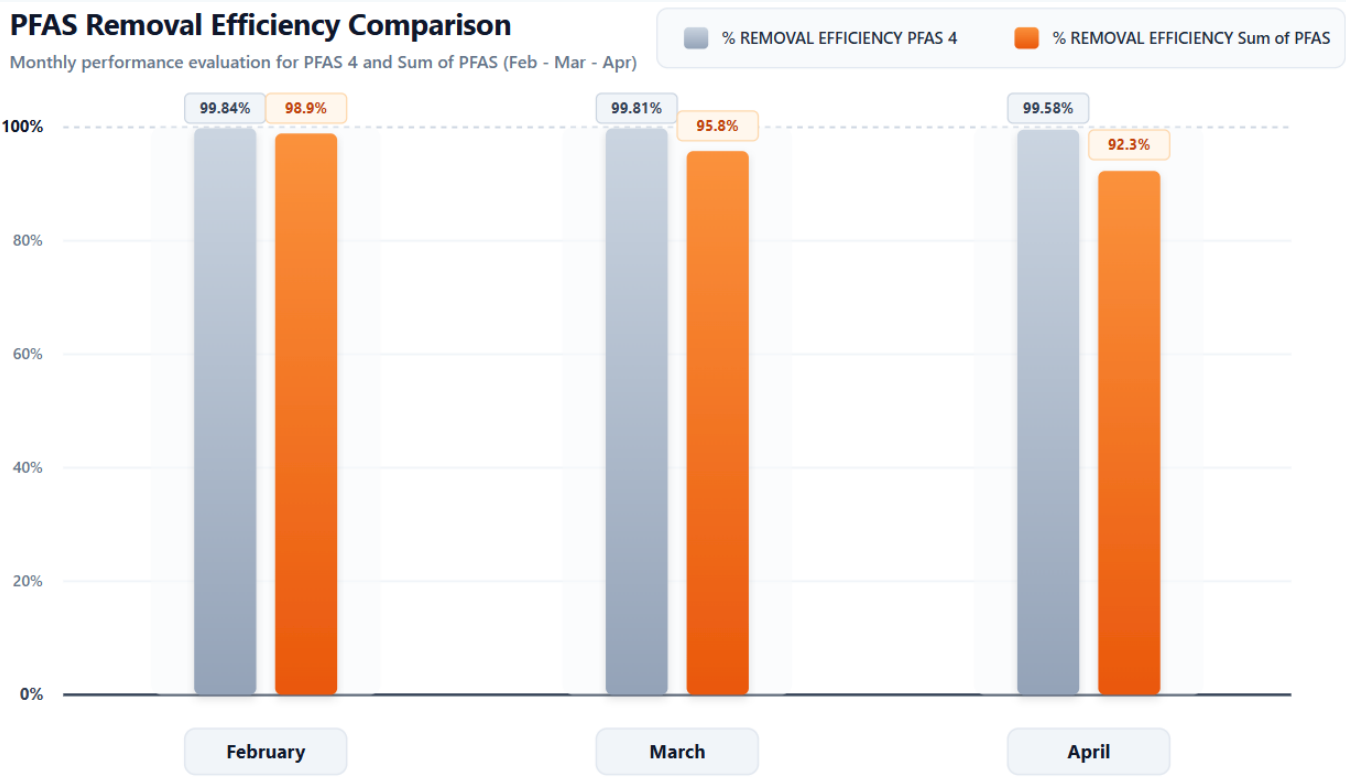
PFAS-20 concentration across sampling points

PFAS-20 (Sum of PFAS) Evolution — Feb/Mar/Apr 2026 (linear scale)

Source: Tables 1, 2 & 3 — Pilot-scale G400 vs Activated Carbon trial



Removal efficiency, month on month



PFAS4 removal

99.6–99.8%

Stable across all three months of monitoring — essentially unaffected by the PFBA breakthrough discussed next.

Sum of PFAS removal

92.3–98.9%

Gradual decline over time reflects rising short-chain contribution as the media approaches saturation for PFBA.

Key monitoring data, February–April 2026

Parameter	Feb 2026	Mar 2026	Apr 2026
Sum of PFAS — IN-MIX (ng/L)	9,300	7,700	3,900
Sum of PFAS — OUT-PUR2 (ng/L)	< 100	320	300
PFAS4 — IN-MIX (ng/L)	7,455.5	6,255.2	2,877
PFAS4 — OUT-PUR2 (ng/L)	< 12	< 12	< 12
PFBA — IN-MIX (ng/L)	350	280	240
PFBA — OUT-PUR2 (ng/L)	11	310	270
% removal, Sum of PFAS	98.9%	95.8%	92.3%
% removal, PFAS4	99.8%	99.8%	99.6%

PFBA saturation is the standout finding: outlet concentrations rise from 11 to 310–270 ng/L, exceeding the site's strict 10 ng/L limit — confirming that Phase 1 reached saturation for this short-chain compound.

G400 versus activated carbon for this site

Activated Carbon (current solution)

- Established, extensively field-tested three-stage solution for this site
- ~2,000 kg/year (~ 4.000 l/year) consumption to hold Sum of PFAS < 500 ng/L
- Bulk density ~500 kg/m³ — larger footprint and disposal volumes
- Reliable across the wider PFAS and chlorinated-solvent load

G400 (Puraffinity)

- + Estimated full-scale annual consumption of just 250 L (~8× less mass, ~16× less volume than GAC)
- + Bulk density ~850 kg/m³ — significant disposal, logistics and OPEX advantages
- + Maintains total PFAS < 500 ng/L for 5+ months of operation
- + Less footprint, increased sustainability

Phase 1 conclusions and next steps

Conclusions

- Excellent, consistent removal of PFAS4 and Sum of PFAS throughout Phase 1
- Short-chain PFBA requires further optimisation — the main limitation identified
- G400 offers major footprint and media-volume advantages over activated carbon
- A validated, low-footprint option for sites with achievable Sum-of-PFAS / PFAS4 targets

Next steps — Phase 2

- Trial continues to monitor PFAS removal performance over the longer term
- Determine overall PFAS loading capacity of the media (g PFAS / kg media)
- Trial a dedicated short-chain polishing media, proposed by Purafinity, as a downstream stage from G400 at the same site
- Delivered through Geostream's coordination as manufacturer and supplier of the water treatment plant

Thank You

Questions & Discussion

Keywords: *Geostream; Puraffinity; per- and polyfluoroalkyl substances; groundwater remediation; granular activated carbon; short-chain PFAS; EU Drinking Water Directive; pilot-scale trial*

