

Regeneration of Granular Activated Carbon (GAC) Used for Per- and Polyfluorinated Substance (PFAS) Remediation

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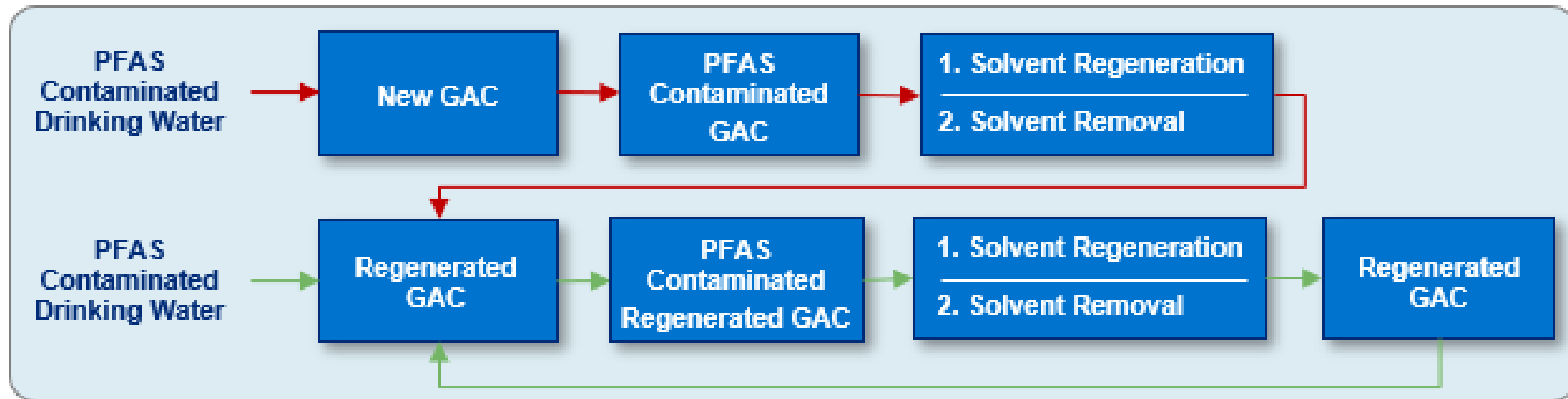
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Background

- Granular Activated Carbon (GAC) widely accepted and commonly used treatment technology
- Treats PFAS-contaminated groundwater, surface water, drinking water
- Cannot be regenerated without removal from the system
- Thermally reactivated at 1,700 °F in oxygen-free environment
- Incinerated to destroy PFAS

Objective

Develop a cost effective on-site method that can be used to regenerate GAC, lengthening the life of GAC and reducing lifetime cost of use



PFASGAC-01

Methodology

Contaminate
virgin GAC with
PFAS/uptake
study

Desorb PFAS
from GAC using
regenerant

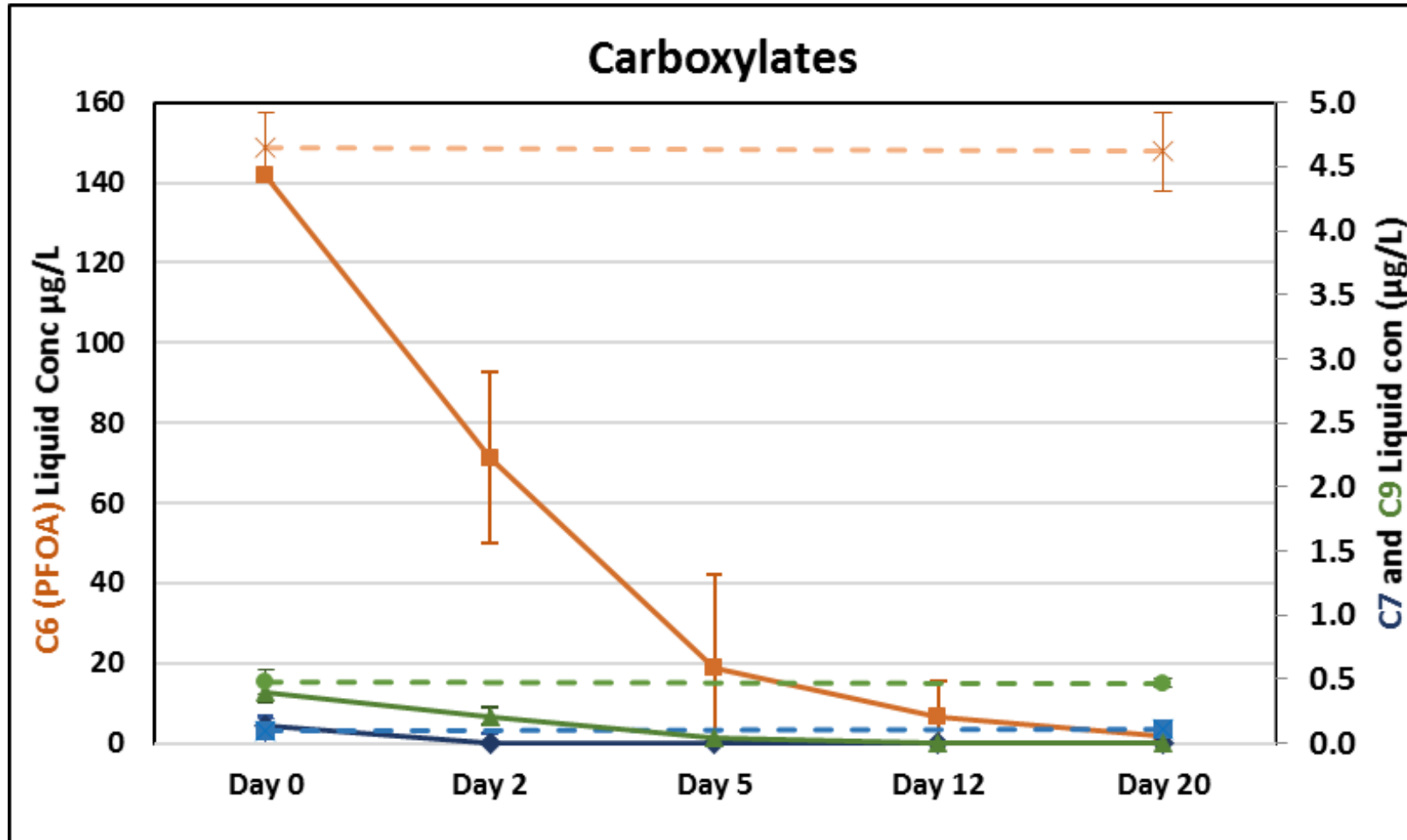
Conduct uptake
study with
regenerated
GAC

PFAS Uptake Study

- 5 mg GAC, 50 mL of 150 ppb PFOS (146 µg/L) and PFOA (142 µg/L) with background electrolyte
- Technical grade standard – additional PFAS present
- Aqueous PFAS concentrations measured using LC-MS/MS
- Sorbent concentrations calculated using the aqueous mass loss method

Carboxylate PFAS	Concentration (µg/L)	Sulfonate PFAS	Concentration (µg/L)
PFHpA (C7)	0.11	PFHxs (C6)	0.47
PFNA (C9)	0.47	PFHpS (C7)	3.78
		PFNS (C9)	0.16

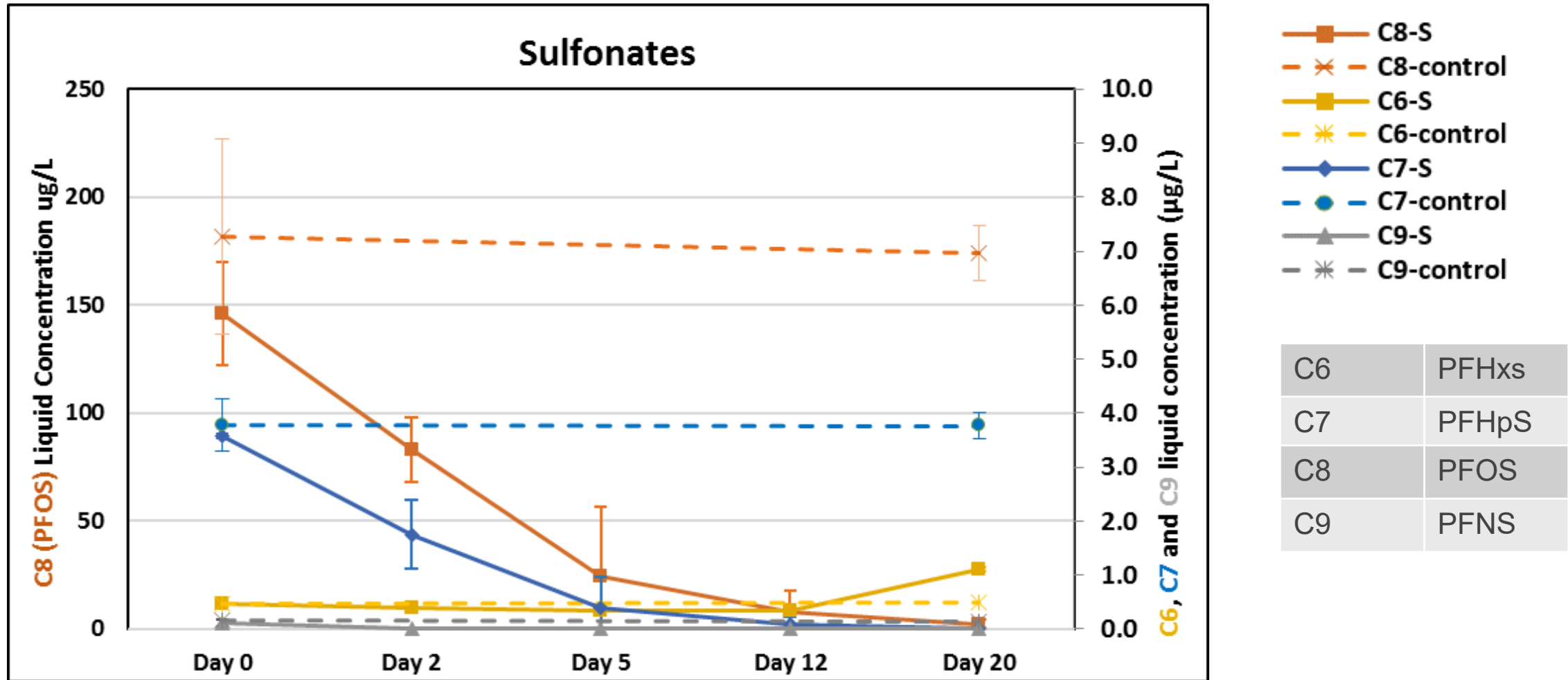
Results – Carboxylates liquid conc. in presence of virgin GAC (F-400)



- C8-A
- * - C8 control
- ◆— C7-A
- ■ - C7 control
- ▲— C9-A
- ● - C9 control

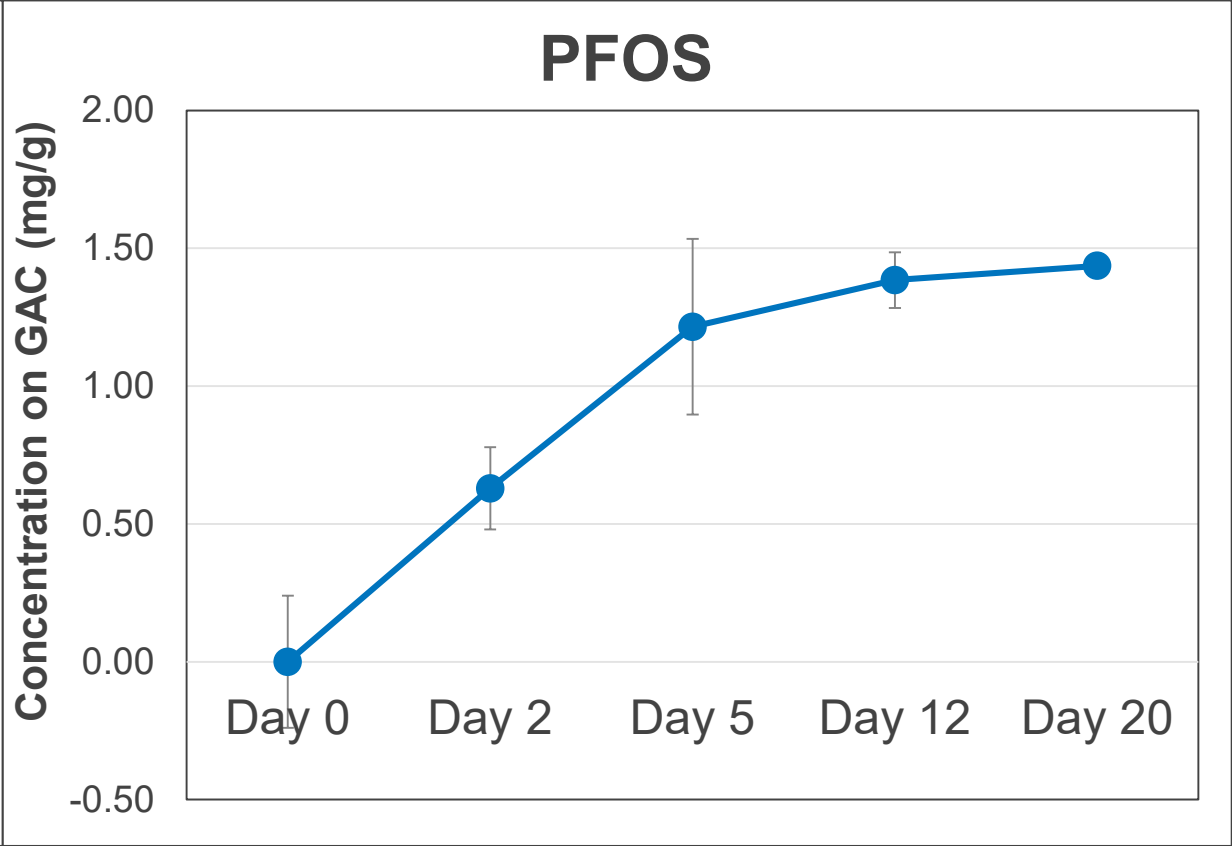
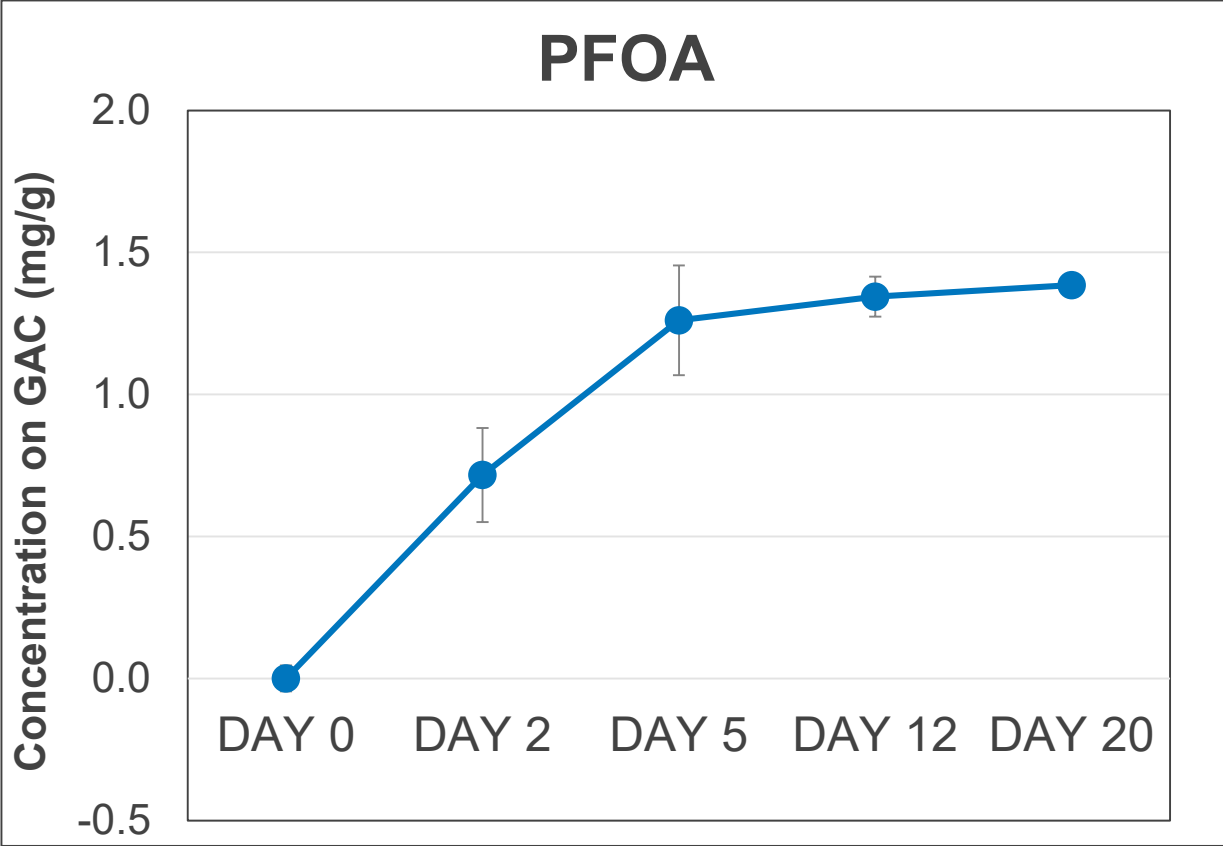
C7	PFHpA
C8	PFOA
C9	PFNA

Results – Sulfonates liquid conc. in presence of virgin GAC (F-400)



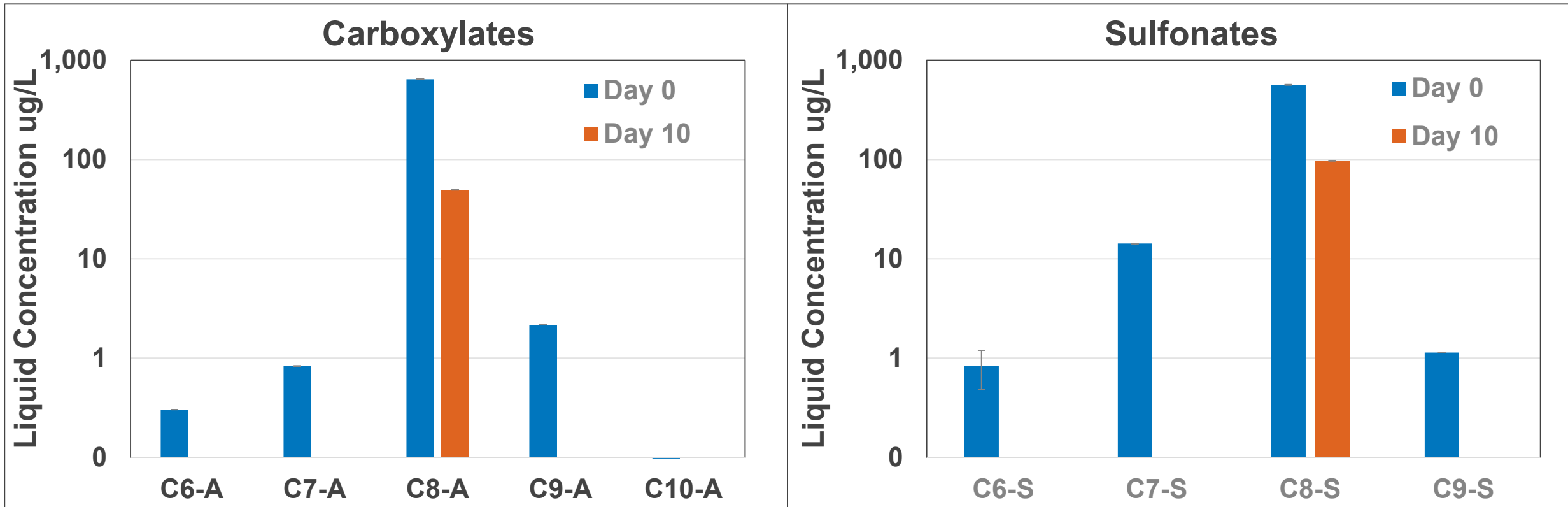
C6	PFHxs
C7	PFHpS
C8	PFOS
C9	PFNS

Results – PFAS Uptake using virgin GAC (F-400)



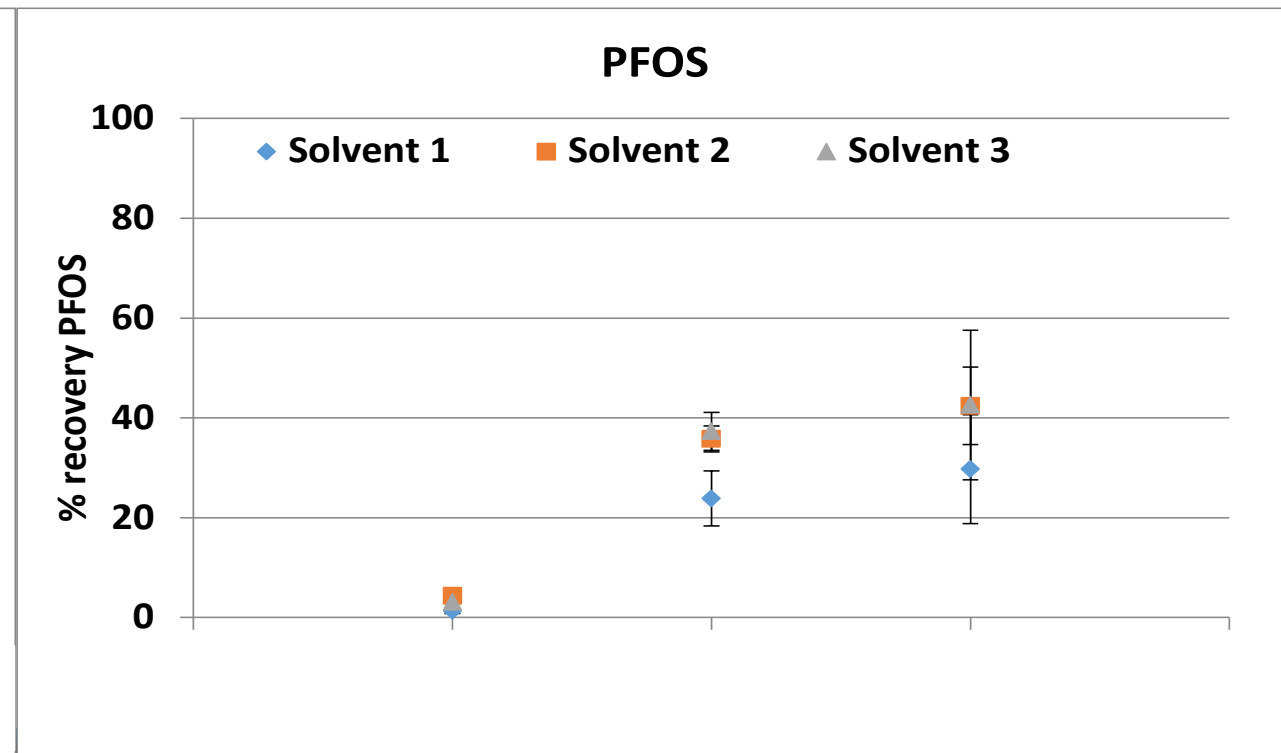
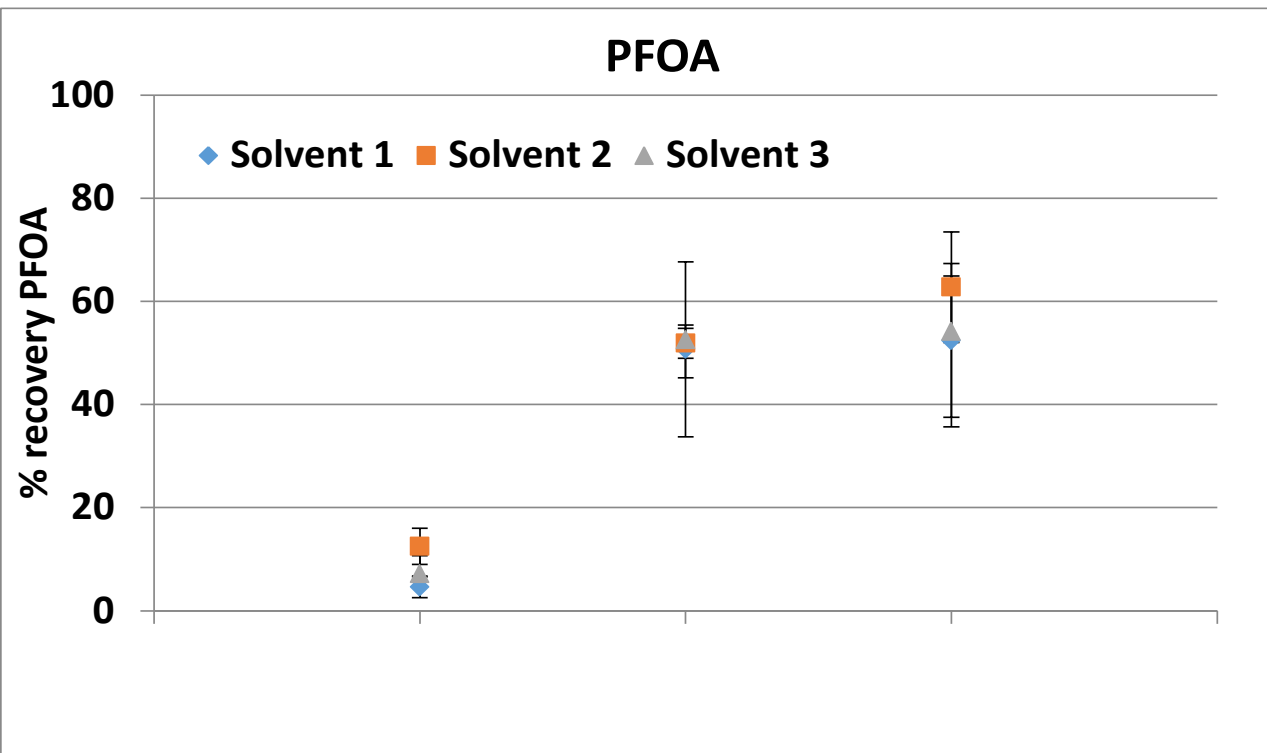
Contamination of GAC for desorption tests

- 100g GAC and 500 $\mu\text{g/L}$ PFAS



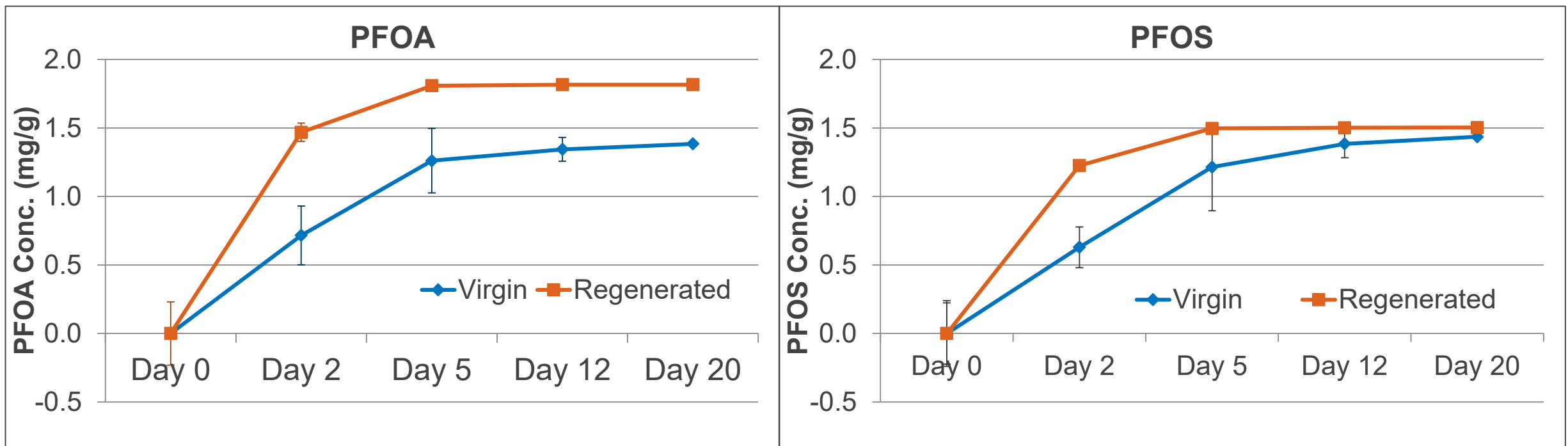
Results - Desorption

- Three solvents with three different regenerant variations
- Column extraction with 2 minute exposure time
- Cumulative desorption of three separate extractions
- Max 73% removal of PFOA, max 57% removal of PFOS

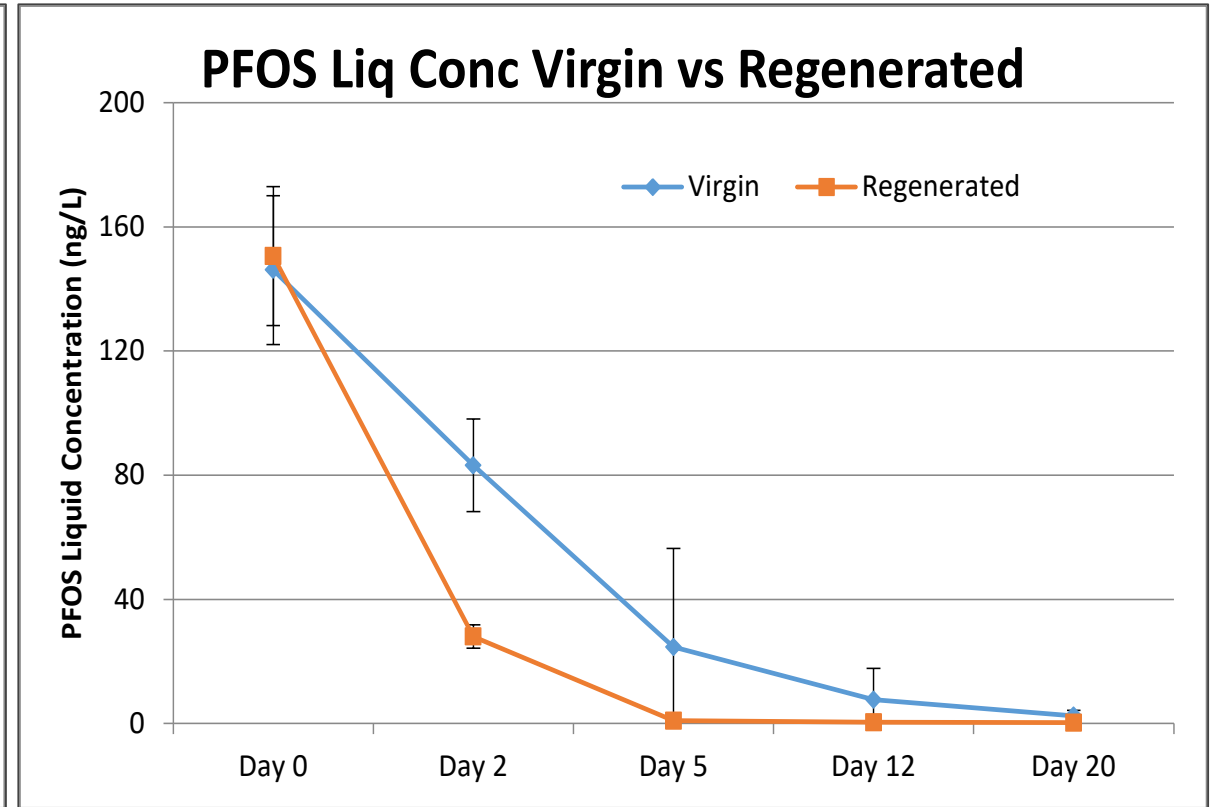
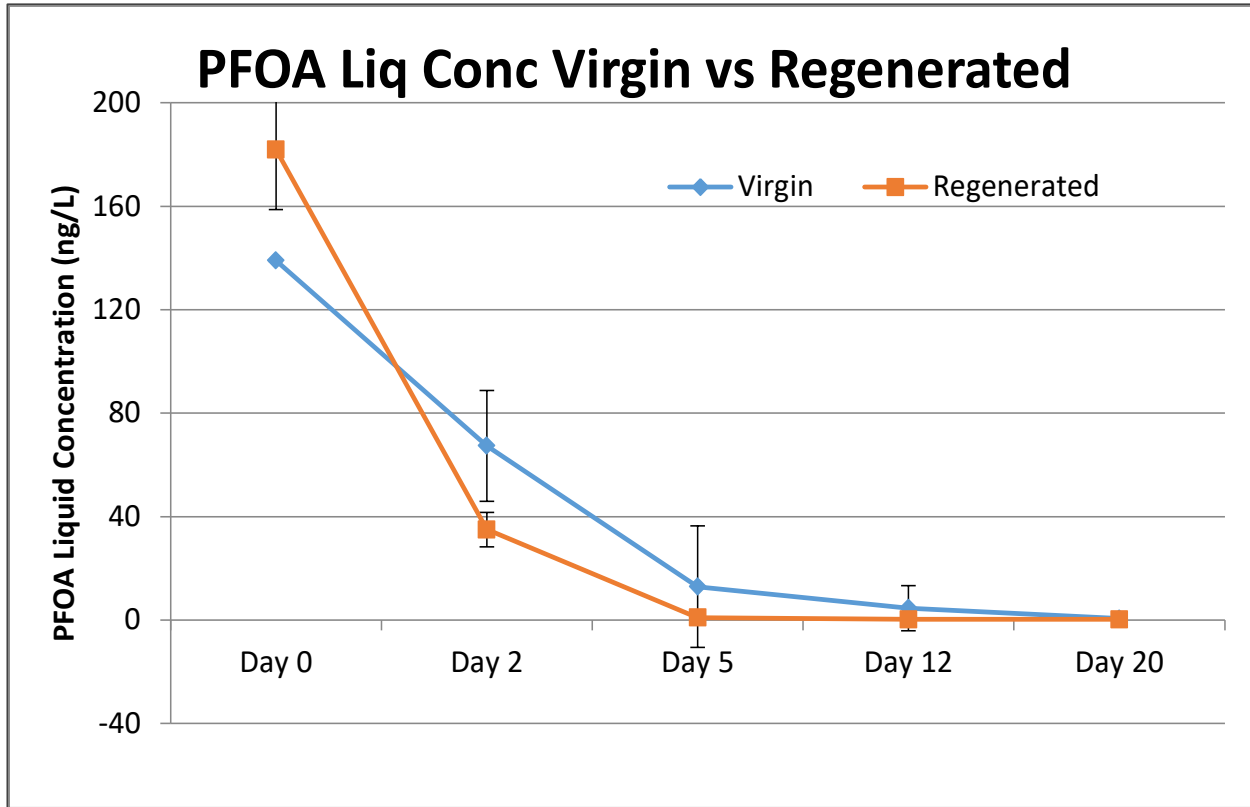


Resorption onto Regenerated GAC

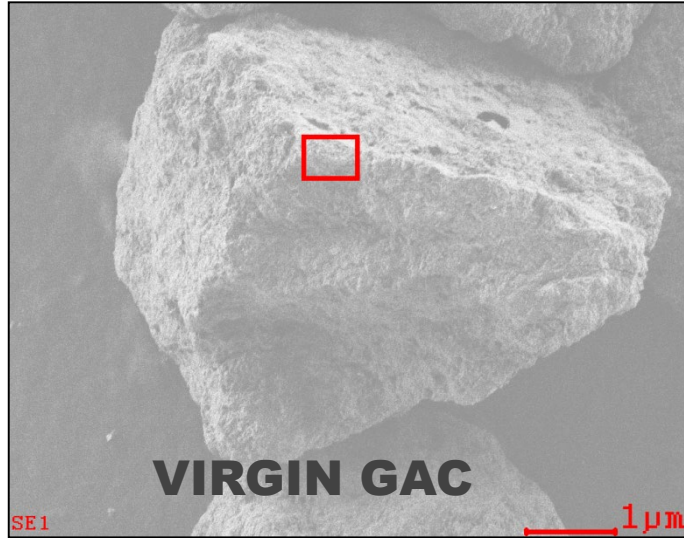
- Virgin GAC compared to regenerated GAC sorption isotherm
- PFAS uptake test set up same as original virgin GAC tests
- Regenerated GAC performed just as well as virgin GAC



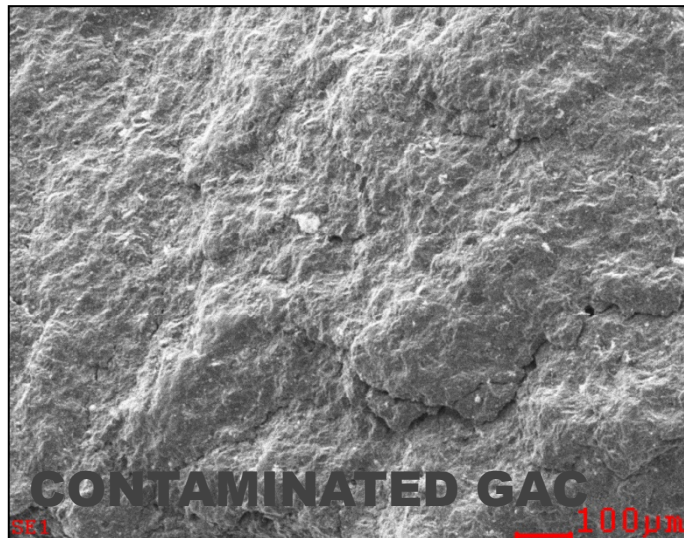
Resorption Liquid Concentrations



SEM EDS of virgin, contaminated and regenerated GAC.

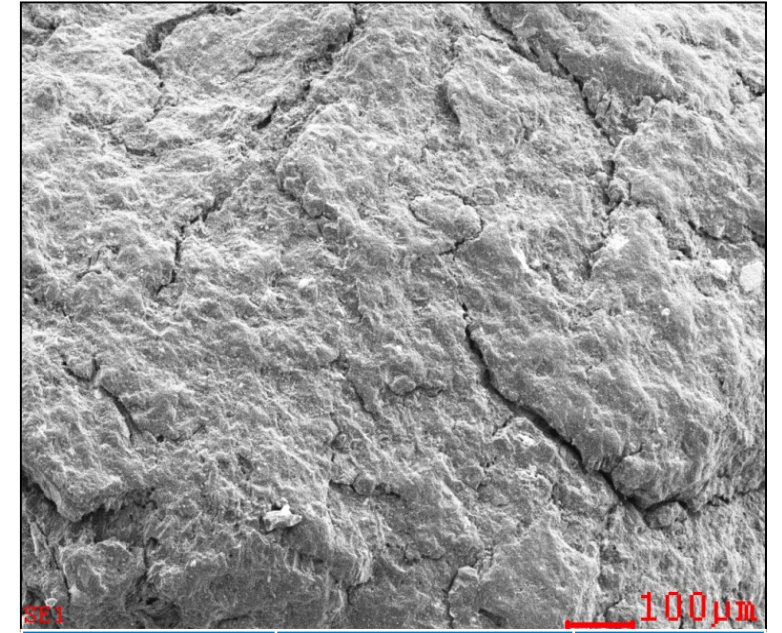


Element	Wt%	At%
C	79.47	89.07
O	02.58	02.17
F	00.28	00.20
Al	04.73	02.36
Si	12.95	06.21



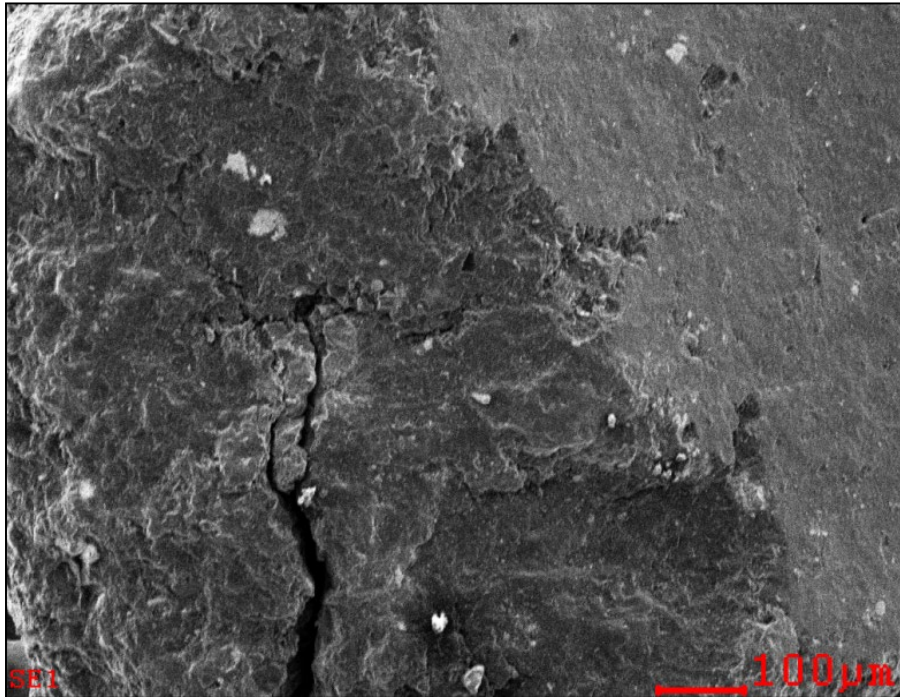
Element	Wt%	At%
C	85.61	90.98
O	06.44	05.14
F	01.37	00.92
Na	00.26	00.14
Al	01.67	00.79
Si	03.07	01.39
S	01.58	00.63

SOLVENT BASE TREATED GAC



Element	Wt%	At%
C	86.93	91.76
O	06.61	05.24
F	00.27	00.18
Na	00.73	00.40
Al	01.78	00.84
Si	02.22	01.00
S	01.45	00.57

Micropores of solvent treated GAC



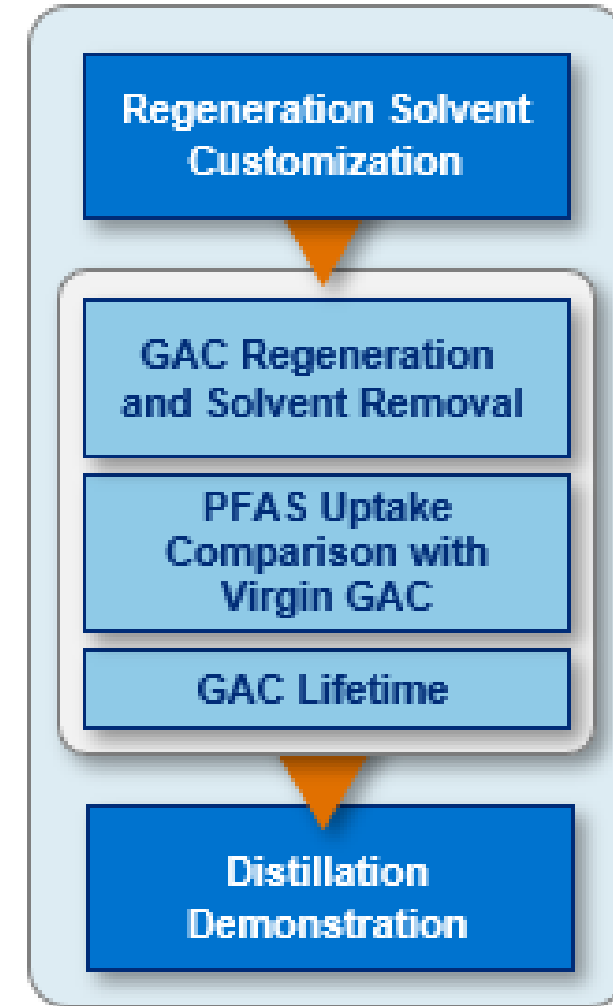
Element	Wt%	At%
C	86.95	91.78
O	06.04	04.78
F	01.01	00.67
Na	00.84	00.46
Al	01.70	00.80
Si	02.29	01.04
S	01.16	00.46



Element	Wt%	At%
C	79.47	89.07
O	02.58	02.17
F	00.28	00.20
Al	04.73	02.36
Si	12.95	06.21

Pilot Study Opportunity

- Regenerant customization to system GAC
- GAC regeneration and solvent removal
- PFAS uptake comparison with virgin GAC to demonstrate benefit and effectiveness of regeneration
- GAC lifetime demonstration to fully explore cost/benefit
- Distillation demonstration to address potential for solvent reuse and waste minimization



PFASGAC-02

Questions?

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