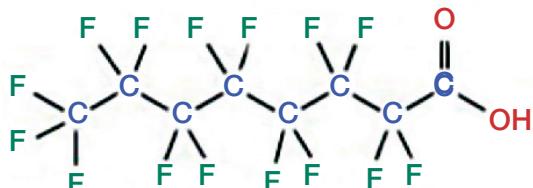


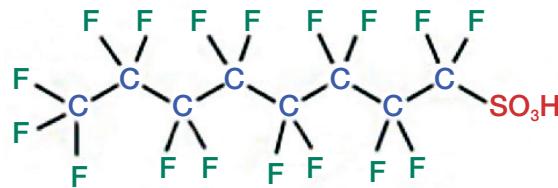
# FLUORO-SORB® - OPTIONS FOR TREATMENT OF PFAS COMPOUNDS

## BACKGROUND

CETCO®, a 35 year pioneer in the remediation product development has created FLUORO-SORB® to support the global per- and polyfluoroalkyl substances (PFAS) remediation initiatives. FLUORO-SORB® is a proprietary product specifically designed for the adsorption of PFAS compounds.



PFOA - perfluorooctanoic acid



PFOS - perfluorooctanesulfonic acid

## Treatment Options

Several technologies are being marketed for the treatment of PFAS. However, varying degrees of success have been demonstrated in the field. Many variables affect the performance of the treatment technology. Listed below are several leading modes of PFAS remediation.

- Filtration: GAC, PAC, Biochar, Other Minerals (Zeolite, Gibbsite, Kaolin), anion-exchange media, Fe containing compounds, coagulants and flocculants.
- Mechanical Separation: Reverse osmosis, Nano-filtration.
- Destructive Technologies: Ozone, Oxidation, Biodegradation.

## FLUORO-SORB® Treatment Applications

**Surface Water Treatment** - FLUORO-SORB® can be deployed through a variety of different treatment processes for surface water treatment including: pump and treat vessels, booms, and sediment capping systems.

**Groundwater Treatment** – Hydrogeology combined with challenging drinking water purity targets provide for a complex set of problems for PFAS remediation. FLUORO-SORB® can be used in multiple levels of treatment to restore drinking water specified levels for safe consumption. The best methods for this are still being determined, however either passive treatment methods such as Permeable Reactive Barriers (PRB) or distribution point filtration are envisioned.

**Soil Treatment** - *In-situ* stabilization (ISS) using FLUORO-SORB® was first demonstrated by Storch (2017) prior to the commercial release of the product. Storch's bench top laboratory study compared control samples with and without cement and investigated the adsorption performance between an AlOH/Carbon blend and FLUORO-SORB®. Storch's results are summarized in Table 1 where mix designs include cement to assist with stabilization. Future ISS work includes a pilot scale project at a DOD facility using 40 tons of FLUORO-SORB® 200 which is scheduled to be constructed in the summer of 2018.

**Table 1.** Results of a bench top ISS study using AlOH/Carbon Blend and FLUORO-SORB® using a deionized water with pH of 7.9 as the leaching fluid

PFAS Sum (mg/L)					
Control 1 Soil/GW	Control 2 Soil/GW & Cement	AlOH/Carbon Blend	AlOH/Carbon Blend & Cement	FLUORO-SORB®	FLUORO-SORB® & Cement
228	1.17	0.75	245	0.3	0.04

In-Situ Stabilization of PFAS in Groundwater, Peter Storch, Proceedings of Cleanup 2017  
Melbourne, Victoria

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## Isotherm Testing for FLUORO-SORB®

The CETCO® in-house research and development laboratory conducted a study using high, medium and low concentration PFAS leachates. The FLUORO-SORB® dosing levels were varied and the samples were exposed to FLUORO-SORB® for 18 hours prior to determining the concentration and percent removal (Table 2). The benchtop laboratory study was further supported using site specific groundwater taken from an active AFFF contaminated site that is looking for a treatment technology.

FLUORO-SORB® adsorption coefficients from the testing program for high, medium and low concentration PFAS leachates and constituents found in the monitoring well at the site have been plotted with the associated PFAS substances molecular weight. Figure 2 can be used to estimate the adsorption coefficient for non-measured PFAS substances. Additionally, the data indicates that FLUORO-SORB® is not negatively impacted by other constituents that may exist at a contaminated site.

**Table 2.** Summary of the dosing studies for laboratory prepared samples and a site specific case

Leachate Description	Mass Sorbent (mg)	Volume Leachate (mL)	Total PFAS Concentration of Leachate (ng/L)	% Removal
Baseline Conditions Prior to the Addition of FLUORO-SORB®				
PFAS Leachate [High]	0	250	2991	N/A
PFAS Leachate [Medium]	0	250	1218	
PFAS Leachate [Low]	0	250	305	
Adsorption of PFAS by FLUORO-SORB® for High, Medium & Low Concentrations				
FLUORO-SORB® in [High] Lab Leachate (3000 ng/L)	5	250	2433	19
FLUORO-SORB® in [Medium] Lab Leachate (1200 ng/L)	5	250	893	27
FLUORO-SORB® in [Low] Lab Leachate (300 ng/L)	5	250	216	29
FLUORO-SORB® in [High] Lab Leachate (3000 ng/L)	100	250	263	91
FLUORO-SORB® in [Medium] Lab Leachate (1200 ng/L)	100	250	169	86
FLUORO-SORB® in [Low] Lab Leachate (300 ng/L)	100	250	42	86
Site specific case study using different FLUORO-SORB® treat levels				
FLUORO-SORB® in field monitoring Well (28,600 ng/L)	2000	250	154	99
FLUORO-SORB® in field monitoring Well (28,600 ng/L)	200	250	486	98
FLUORO-SORB® in field monitoring Well (28,600 ng/L)	20	250	22400	22

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Figure 1 – In-situ stabilization using FLUORO-SORB® with an hydraulic mixing head, and adsorption column study in CETCO's Research and Development Laboratory

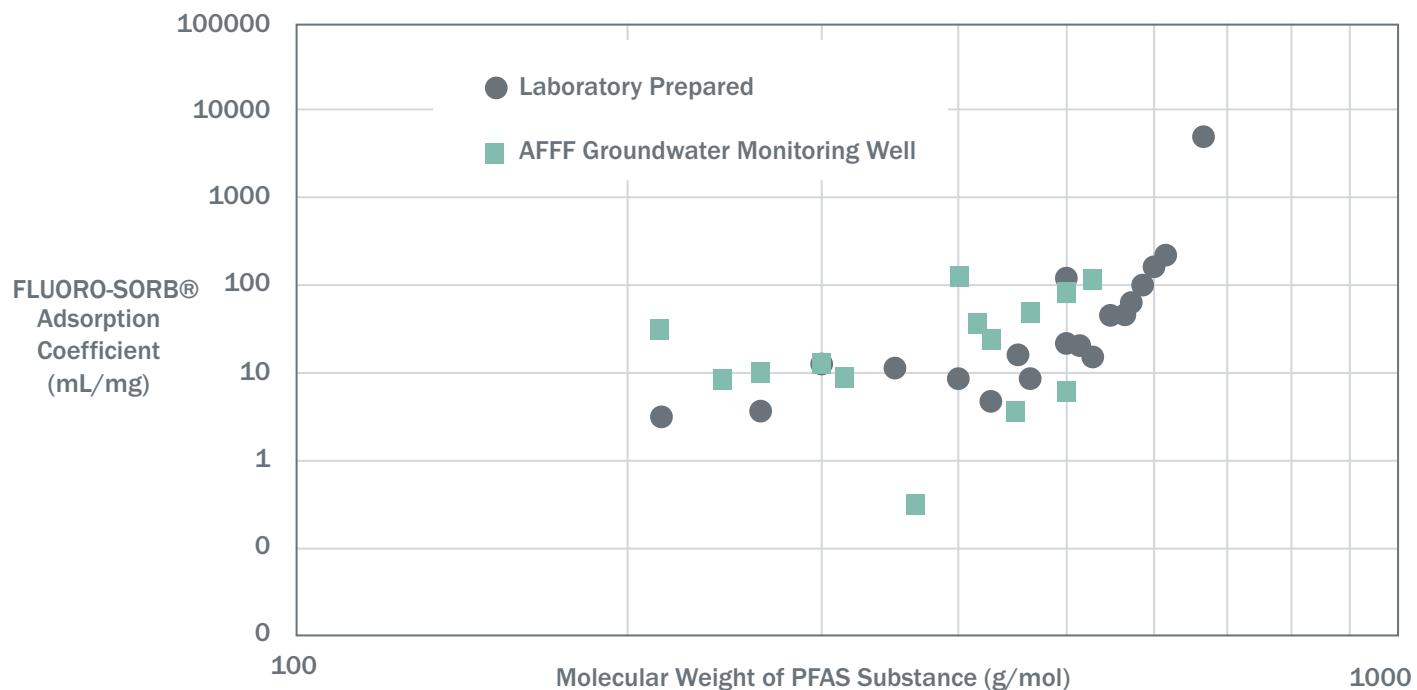


Figure 2 – Adsorption Coefficients for a Field Sample & Laboratory Prepared Specimens Plotted with PFAS Molecular Weight

FLUORO-SORB® was also investigated as a soil amendment with different soil types. A laboratory spiked sample was developed and two soils from the aforementioned AFFF site were also treated. A five and ten percent treatment loading by dry weight was selected and blended into the soils. Desorption was estimated using EPA Method 1311 (TCLP) and the extracted leachate was analyzed for its PFAS concentration. The reduction in PFAS concentrations for this work are presented in Figure 3.

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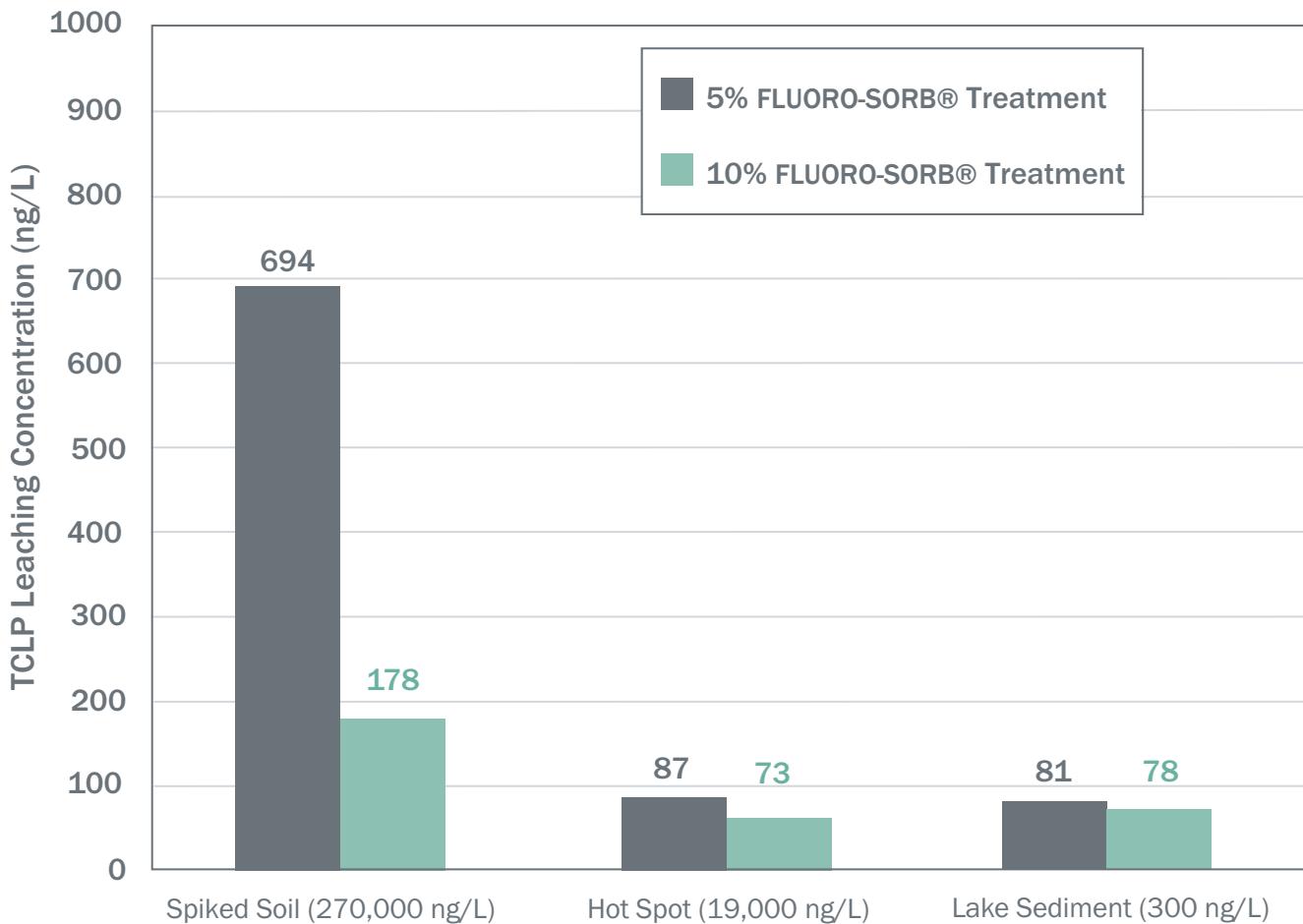


Figure 3 – TCLP Leaching results for three soil types treated with FLUORO-SORB®

## Ongoing and Future Work

CETCO® has ongoing bench-scale and field pilot-scale work for numerous PFAS contaminated sites. We are continuing to develop data on the removal efficiency FLUORO-SORB® and look forward to sharing more information about FLUORO-SORB® as the data becomes available.

## Summary

- FLUORO-SORB® is commercially available
- FLUORO-SORB® provides an economical alternative to other available technologies
- FLUORO-SORB® is not impacted significantly by other contaminants that may be present

## Contact CETCO®

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