# CASE STUDY

## FLUORO-SORB® ADSORBENT HELPS CLEAN UP NORTH AMERICA'S FIRST FULL SCALE PFAS REMEDIATION

Per- and polyfluoroalkyl substances (PFAS) are a class of persistent organic pollutants which are emerging as contaminants of concern world-wide as awareness around their health and environmental risks continues to grow. A major source of PFAS contamination in soil and groundwater is the historical use of Aqueous Film Forming Foam (AFFF), a commonly used fire suppression agent. As a result of these historical practices, the Fire Fighter Training Area (FFTA) at the Air Force Base (AFB) had soil and groundwater contamination by PFAS. During training exercises, AFFF and water were released at the surface enabling overland flow (and through a retention pond system) and eventual infiltration through vadose zone soils to groundwater. AFFF use ceased in 2009, and PFAS contaminants were first detected in 2015. Several PFAS are present, but perfluorooctane sulfonate (PFOS) is the main driver of remediation.

# PROJECT DETAILS

### LOCATION

North American Air Force Base

### CETCO PRODUCTS

FLUORO-SORB® 200 Adsorbent

Reactive Core Mat®

### SOIL AMOUNT:

19,000 Metric Tonnes

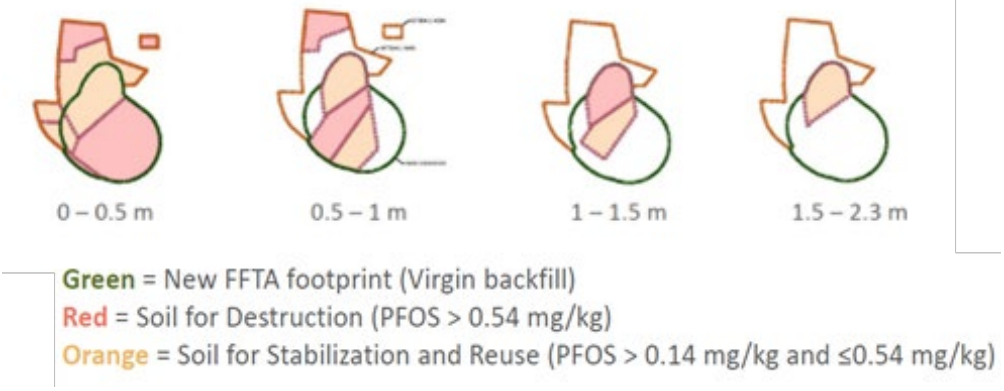


Figure 2: Simplified vertical slices of the treatment area. Zones are highlighted based on applied remediation approach. Red zones represent soil that will be excavated and incinerated. Orange zones represent soil that will be excavated, stabilized with a fixant, and reused as backfill. The green outline represents area slated for virgin backfill as required to meet new FFTA construction requirements.

## LABORATORY TESTING TO IDENTIFY THE FIXANT

A significant challenge was the identification of a commercially available fixant that could significantly reduce PFAS leachability when applied to contaminated soils. In addition to superior PFAS adsorptive affinity, the ideal fixant needed to be easily applied by mixing mechanically with the excavated soil. Rapid delivery and uniform application at the appropriate dosages was desired. Only commercially available fixants that were available in sufficient quantities to complete the project in calendar year 2021 were considered. To identify the fixant, a treatability study was completed in the laboratory of a leading engineering consulting firm by staff experienced in PFAS soil stabilization.

Two commercially available products were tested: (1) FLUORO-SORB® 200 Adsorbent, manufactured by CETCO Minerals Technologies, Inc., New York, NY, and (2) a proprietary blend of aluminum hydroxide and granular activated carbon (AlOH/GAC). The stability of PFAS in the treated soil was determined using 120 hour water leaching tests, as well as with semi-dynamic leaching via the United States Environmental Protection Agency (US EPA) Leaching Environmental Assessment Framework (LEAF) Method 1314.

Representative PFAS-contaminated soil samples from the site were collected in 2019. The soil was a sandy loam with 94% ash content and 6% organic matter content. The soil samples were composited, and 100 g was mixed with amounts of each fixant from 0.5% to 5% by weight and 200 mL of deionized water. The vessels were mixed on a roller table for 120 hours and then centrifuged to separate the soil/fixant mass from the liquid. The liquid was analyzed for PFAS and compared to a no fixant control to determine the percent reduction in PFAS leaching.

As presented in Table 1, FLUORO-SORB® Adsorbent was highly effective at reducing the leachability of a variety of PFAS from the soil. For PFOS, leaching was reduced by 99.8% for the required weight dose. In comparison, the 0.5% AlOH/GAC fixant reduced PFOS leaching by 54.8%. It took 4-5% of the AlOH/GAC fixant to achieve the same reduction in leaching as 0.5% FLUORO-SORB® Adsorbent for PFOS and the average of all PFAS tested (Table 1).

| | Reduction in Leaching | | | |
|---|---|---|---|---|
| | PFOS | | Average for All PFAS Tested | |
| Fixant Weight % | FLUORO-SORB® Adsorbent | AlOH/GAC Fixant | FLUORO-SORB® Adsorbent | AlOH/GAC Fixant |
| 0.5% | 99.8% | 54.8% | 88.9% | 46.3% |
| 1% | 99.9% | 84.0% | 92.7% | 67.8% |
| 2% | 100.0% | 94.2% | 92.6% | 80.2% |
| 3% | 100.0% | 96.1% | 94.1% | 84.0% |
| 4% | 100.0% | 98.3% | 93.9% | 89.0% |
| 5% | 100.0% | 98.2% | 95.3% | 89.8% |

Figure 3 shows the difference in PFAS leachability between the two fixants at 1% dosing. FLUORO-SORB® Adsorbent reduced the PFAS leached over the control by an average of 92.7%, as compared to an average of 67.8% for the AlOH/GAC fixant.

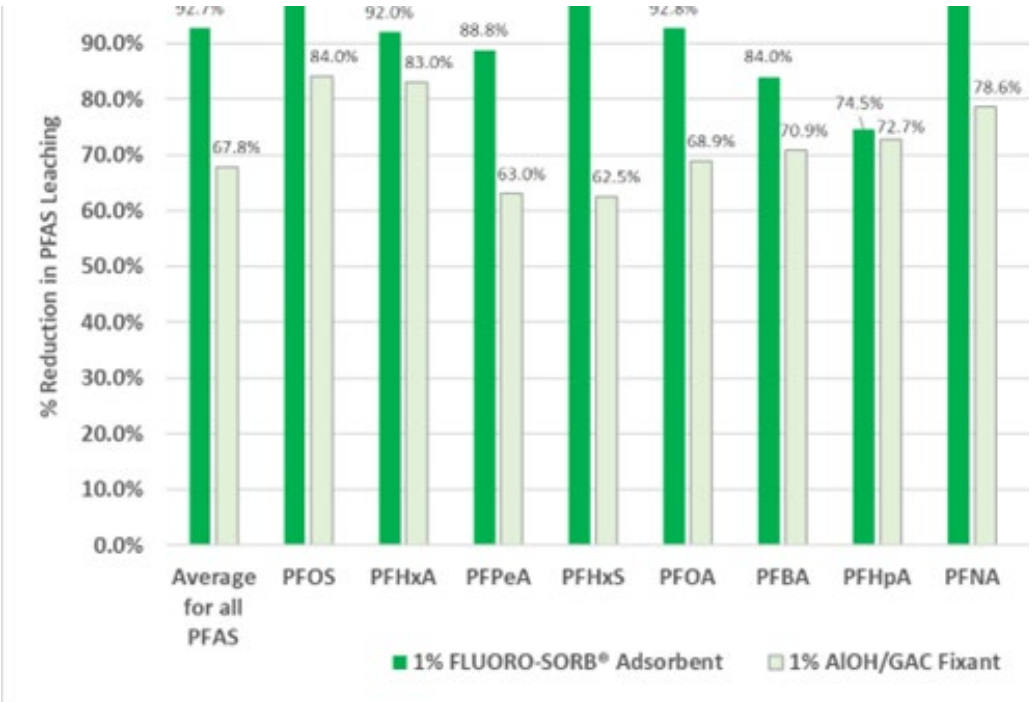


Figure 3: PFAS stabilization in soil – comparison of fixants at 1% by weight dose



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Figure 4 presents the percent of the total PFAS in the soil that leached when assessed by the US EPA LEAF 1314 method for the untreated control, as compared to the trials with 1% or 2% FLUORO-SORB® Adsorbent. Mixing 1% or 2% FLUORO-SORB® Adsorbent with the PFAS-contaminated soil resulted in greater than 91% reduction in PFAS leaching.

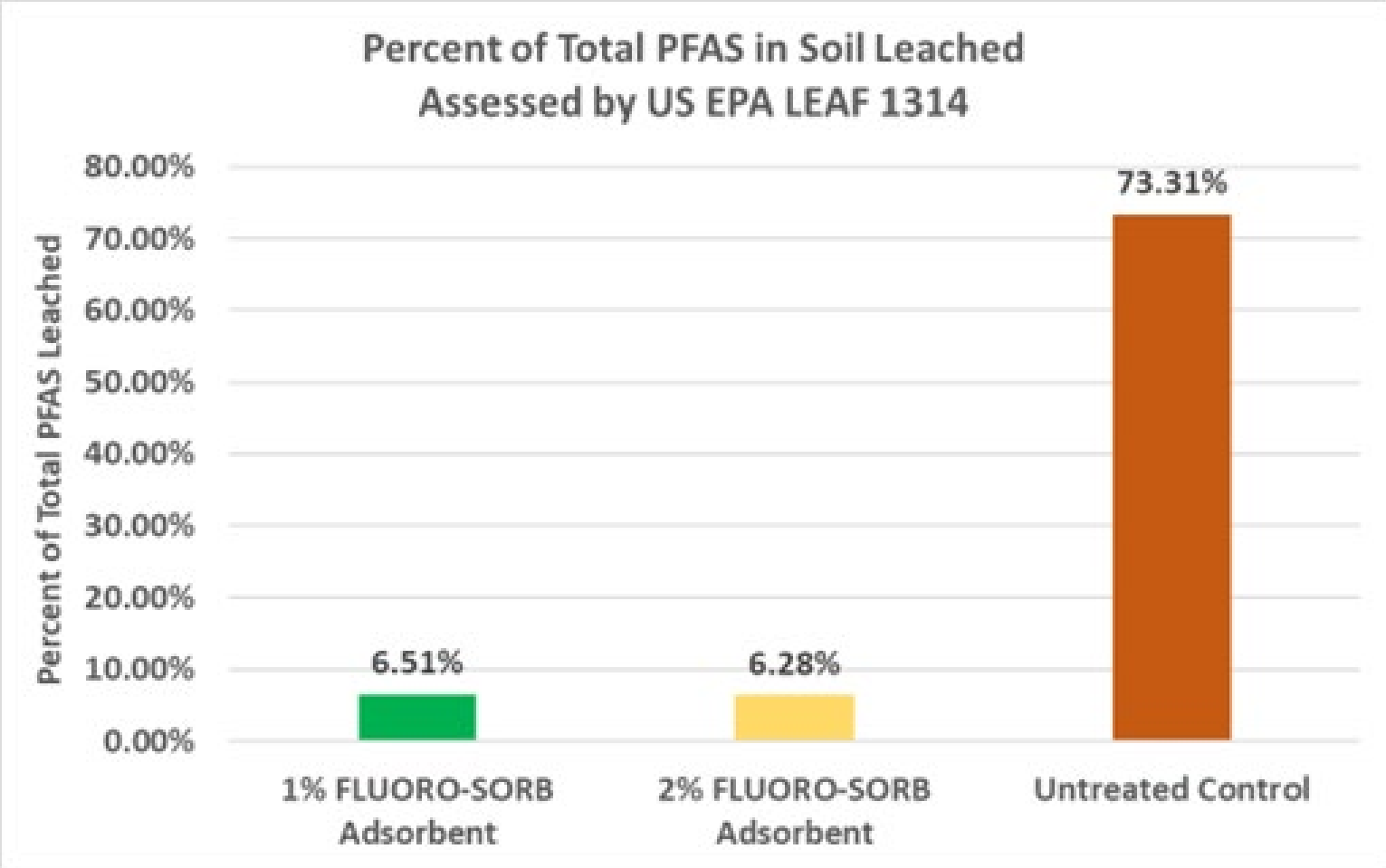


Figure 4: Percent of the total PFAS in soil that was leached when assessed by the US EPA 1314 method.

The conclusion of the treatability test was that 1% by weight dose of FLUORO-SORB® Adsorbent was sufficient to reduce PFAS leaching. The results of the treatability study are specific for the site soils tested and results should not be extrapolated to other sites. Additionally, the results of the treatability study should not be used to make forward-looking projections about full-scale site performance, which must be verified over time with groundwater monitoring.

## FULL-SCALE SOIL STABILIZATION APPLICATION WITH FLUORO-SORB® ADSORBENT

In 2021, CETCO shipped 22 truckloads of FLUORO-SORB® Adsorbent to the on-site staging area, the contractor successfully deployed the product with their specialized mixing methodology and equipment. CETCO worked closely with the contractor to develop on-site mixing procedures that would ensure a homogeneous distribution of the fixant. In addition, the contractor installed CETCO's Reactive Core Mat® (RCM) with FLUORO-SORB® Adsorbent to line a swale pond (engineered wetland) that will be constructed on the site. RCM is composed of FLUORO-SORB® Adsorbent sandwiched between two permeable geotextiles and needle punched together. As contaminated water passes through the RCM, PFAS is removed from the water by FLUORO-SORB® Adsorbent, and the hydraulic flow is not altered. The liner will prevent future migration of PFAS from stormwater run-off and infiltration of PFAS from seasonally fluctuating groundwater levels and upgradient untreated areas of the site.

## CONCLUSION:

In 2021, RCM (10,500 square feet) and FLUORO-SORB® Adsorbent (831,000 lbs.) were manufactured and delivered to the site. The fixant was mixed with 19,000 metric tons (20,944 short tons) of excavated, PFAS contaminated soil (2% by weight) and reinstalled in the excavation. RCM was used to line a swale pond for further PFAS treatment. Soil and groundwater monitoring will be performed over time to determine the effectiveness of the soil stabilization remedy.

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