REGENESIS®

Sustainable and Low-Cost PFAS Source Treatment

Pilot Studies incorporating SourceStop horizontal barrier treatments demonstrate reduction of leaching

Overview

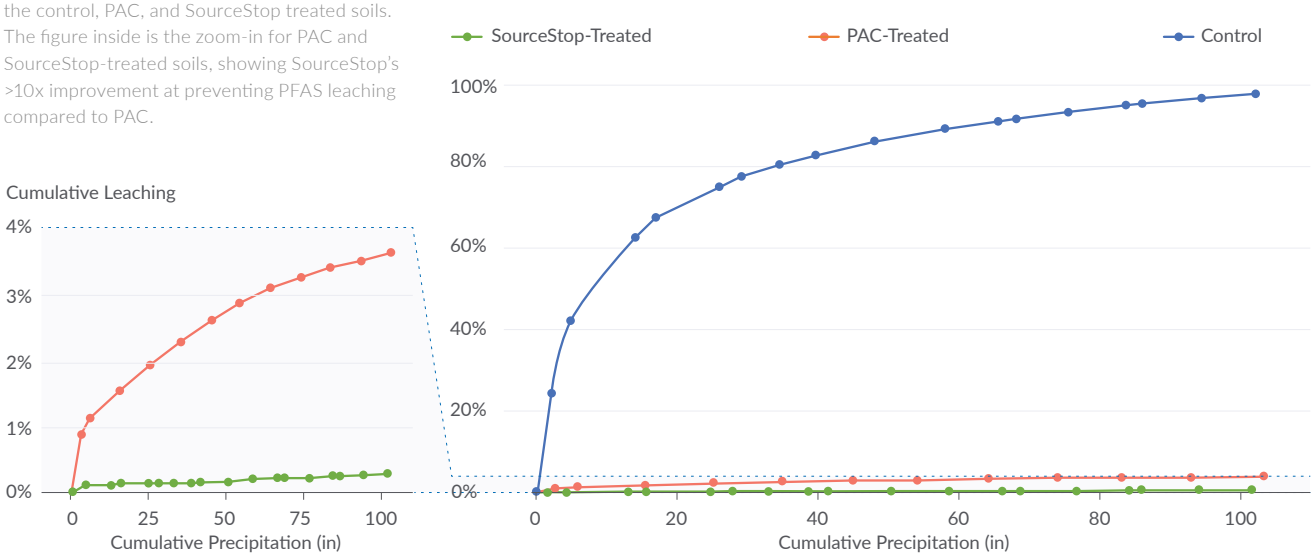
Field-scale pilot studies for the *in situ* treatment of soils at PFAS source zones were completed at firefighting training areas on two aviation sites where PFAS-containing AFFF (i.e., aqueous film-forming foam) was historically discharged.

SourceStop®

The PFAS source treatments applied site-specific amendment blends of SourceStop®, a new concentrated form of colloidal activated carbon (CAC), in conjunction with powdered activated carbon (PAC). SourceStop is a micron scale aqueous carbon suspension emplaced as a horizontal PFAS barrier at the base of the target treatment zones to improve remediation effectiveness dramatically. In controlled laboratory studies, SourceStop has been proven to prevent PFAS leaching with >10x more effectiveness than PAC.[1] Figure 1

Figure 1 Cumulative Leaching Percentages of Total PFAS

Cumulative leaching percentages of total PFAS as a function of cumulative precipitation from the control, PAC, and SourceStop treated soils. The figure inside is the zoom-in for PAC and SourceStop-treated soils, showing SourceStop's >10x improvement at preventing PFAS leaching compared to PAC.

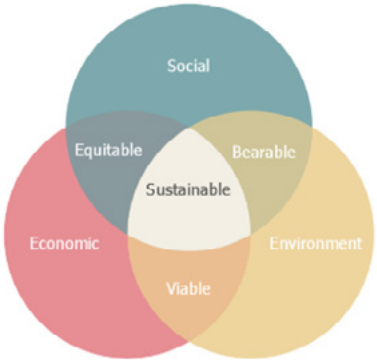


1. Source: Technical Bulletin SourceStop - A High Concentration Colloidal Activated Carbon product for Immobilizing PFAS at the Source. https://REGENESIS.com/wp-content/uploads/2019/12/TB_REG_PFAS_SourceStop_1_v8.pdf

Both pilot tests demonstrated PFAS soil leachate concentrations reduced by >99% following the source zone treatments.

Additionally, 6-month-post-application sampling at the first of the sites where treatment was applied shows PFAS leachate concentrations further reduced to non-detect levels. Post-application sampling (6-month) for the second site is planned and expected to achieve similar results.

The *in situ* PFAS source treatments, incorporating SourceStop, apply accelerated sorption kinetics to immediately halt PFAS contaminant plume development and prevent impacts to downgradient receptors. Compared to other mechanical and physical PFAS treatment methods, the sustainable remediation alternative smartly applies enhanced attenuation to effectively remove unacceptable PFAS exposure risk at a low cost with minimal impacts to businesses and the environment.



Sustainable Remediation, defined by ISO 18504:2017, is the *"elimination and/or control of unacceptable risks in a safe and timely manner whilst optimizing the environmental, social and economic value of the work."*

Enhanced Attenuation, according to the Interstate Technology and Regulatory Committee (ITRC), *"is any type of intervention that might be implemented in a source-plume system to increase the magnitude of attenuation by natural processes beyond that which occurs without intervention. Enhanced attenuation is the result of applying an enhancement that sustainably manipulates a natural attenuation process, leading to an increased reduction in mass flux of contaminants."*[2]

2. ITRC (Interstate Technology & Regulatory Council) Attenuation Processes for Metals and Radionuclides Team. A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater. Published online 2010.

Pilot Test Site Locations

PFAS source areas at two U.S. aviation facilities were selected for implementation of the field pilot testing program:

- Site 1–Grayling, Michigan (MI)
- Site 2–Washington (WA).

Repeated AFFF discharges left high concentrations of PFAS in the shallow soils leaching to the underlying groundwater.

An approximate 225-square-foot (ft) area and a 10-ft vertical mixing zone were demarcated at each site, and utilities were cleared for the SourceStop pilot test Figure 2 and Figure 3. The pilot test areas were placed within more extensive PFAS source zones and only partially encompassed them.

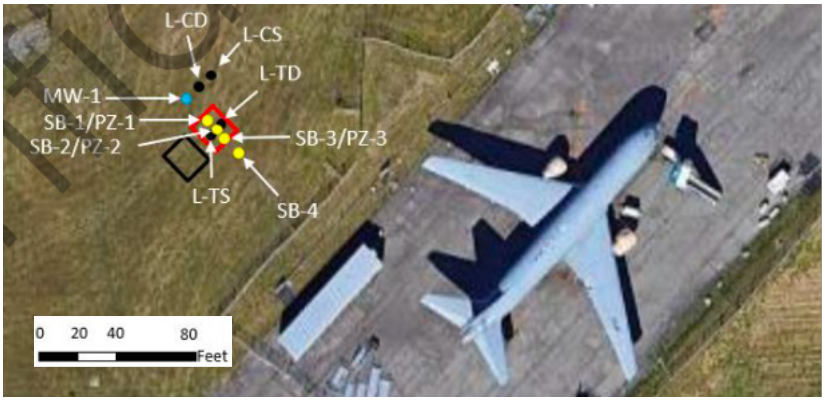
The near-surface soil was predominantly sand, overlain by a topsoil layer. Groundwater was encountered at approximately 14 feet and 15.5 ft depth at Site 1 and Site 2, respectively. Therefore, these treatments were fully contained within the vadose zone.

Figure 2

Aerial view showing Site 1 treatment area and sampling locations.

Figure 3

Aerial view showing Site 2 treatment area and sampling locations.



Baseline Soil and Groundwater Sampling

Pre-treatment soil sampling was performed by homogenizing soils collected at 0 to 5 ft below ground surface (bgs) and 5 to 10 ft bgs in three soil core boreholes advanced within each target treatment area, totaling six samples per site. At Site 2, following the same procedures, a fourth boring was advanced outside the treatment area as a control.

Leachate extracts were prepared from these samples using U.S. EPA's SW-846 Test Method 1312: Synthetic Precipitation Leaching Procedure (SPLP), subsequently analyzed for PFAS by Method 537.1, to provide baseline PFAS leachate concentrations.

The baseline sampling results revealed average/maximum PFAS concentrations in soil leachate of 1,376/3,835 nanograms per liter (ng/L) at Site 1 and 7,079/16,115 ng/L at Site 2. PFOS (perfluorooctanoic acid) comprised approximately 90% of the total PFAS detected at both sites.

Application

Application Details: Site 1

Location	Michigan
Treatment Area	225 square feet
Treatment Depth	0 to 10 ft bgs
Soil Volume Treated	84 cubic yards
Max. Total PFAS in Leachate	3,835 ng/L
Surficial Geology	Sand, topsoil cover
Implementation Date	September 2022
SourceStop-PAC Blend Applied	12,800 lbs

Application Details: Site 2

Location	Washington
Treatment Area	225 square feet
Treatment Depth	0 to 10 ft bgs
Soil Volume Treated	84 cubic yards
Max. Total PFAS in Leachate	16,115 ng/L
Surficial Geology	Silty, clayey sand, topsoil cover
Implementation Date	January 2023
SourceStop-PAC Blend Applied	9,200 lbs

Using the following methods, REGENESIS Remediation Services completed the PFAS source treatments in September 2022 at Site 1 and in January 2023 at Site 2.

Source soils were excavated from the target treatment area and temporarily stockpiled on the adjacent ground surface at each pilot test location. The topsoil layer was segregated for later use during site restoration.

After reaching the excavation completion depth (10 ft bgs), a base layer of SourceStop solution was spray-applied to evenly coat the excavation bottom and sidewall bottom edges, allowing the material to infiltrate the underlying undisturbed soils before replacing the excavated soils. This process formed the SourceStop horizontal barrier base layer to mitigate against any further vertical migration of PFAS.

Once the SourceStop horizontal barrier was emplaced, stockpiled soil was placed back into the open excavation in horizontal lifts, ranging from 2.5 to 4 feet thick, along with a prescribed blend of powdered activated carbon (PAC) and SourceStop. These materials were thoroughly mixed into the soils using the excavator bucket or a rotary mixing head until achieving a homogeneous consistency. Soils within the treatment area were turned multiple times before moving to the next lift to ensure complete treatment. Each completed lift was graded flat and compacted with a small trench compactor.

During this process, representative samples were collected from treated test cells and analyzed for PFAS leachate in soil per the above-described laboratory methods to provide a snapshot of “immediate” efficacy.

Approximately 84 cubic yards of soil were amended for each pilot test. After completing the soil treatment, the surface was graded and feathered into the surrounding undisturbed areas, resulting in a slight mounding in the immediate area of approximately six inches above baseline conditions. Topsoil vegetation removed and segregated previously was restored as the final surface cover, re-seeded, and protected with straw erosion control matting.

Results

For both pilot tests, samples were collected in designated test cells within hours after treatment and analyzed for PFAS in soil leachate before backfilling. At Site 1, six-month (March 2023) post-treatment samples were collected from the baseline sampling locations using the sampling and analysis procedures described above. The results observed at each site are described as follows.

Site 1–MI

PFAS concentrations in soil leachate were reduced by 99.4%. After six months, no PFAS were detected. The laboratory detection limits for all compounds were less than 1 ng/L for these samples. Figure 4

Site 2–WA

PFAS concentrations in soil leachate were immediately reduced by 99.5%. Figure 5 A six-month post-sampling event is scheduled for completion in the Summer/Fall of 2023.

Figure 4

Site 1 Average PFOS/PFAS in Soil Leachate

Site 1 PFOS and remaining PFAS concentrations in soil leachate at baseline and post-treatment.

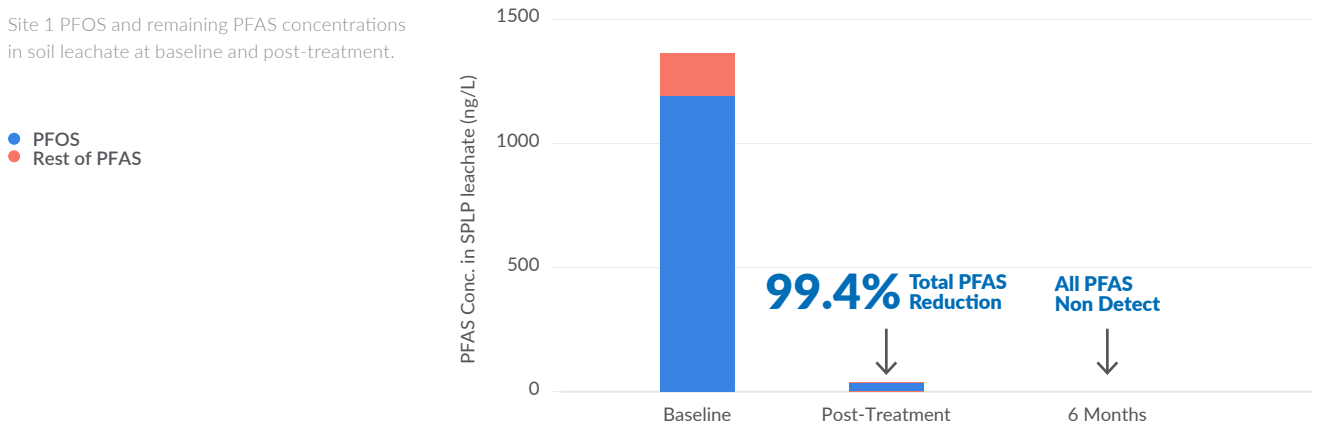
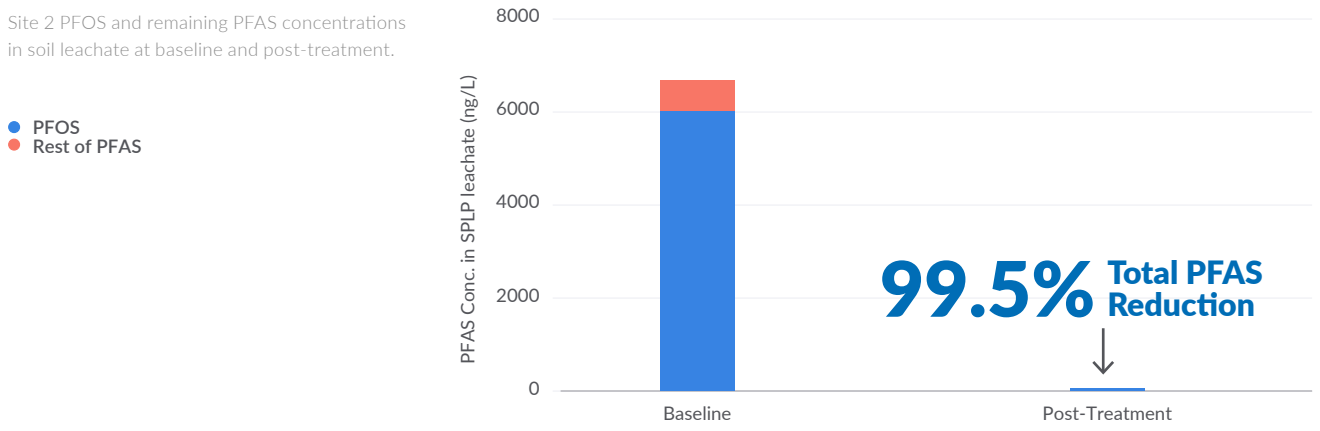


Figure 5

Site 2 Average PFOS/PFAS in Soil Leachate

Site 2 PFOS and remaining PFAS concentrations in soil leachate at baseline and post-treatment.



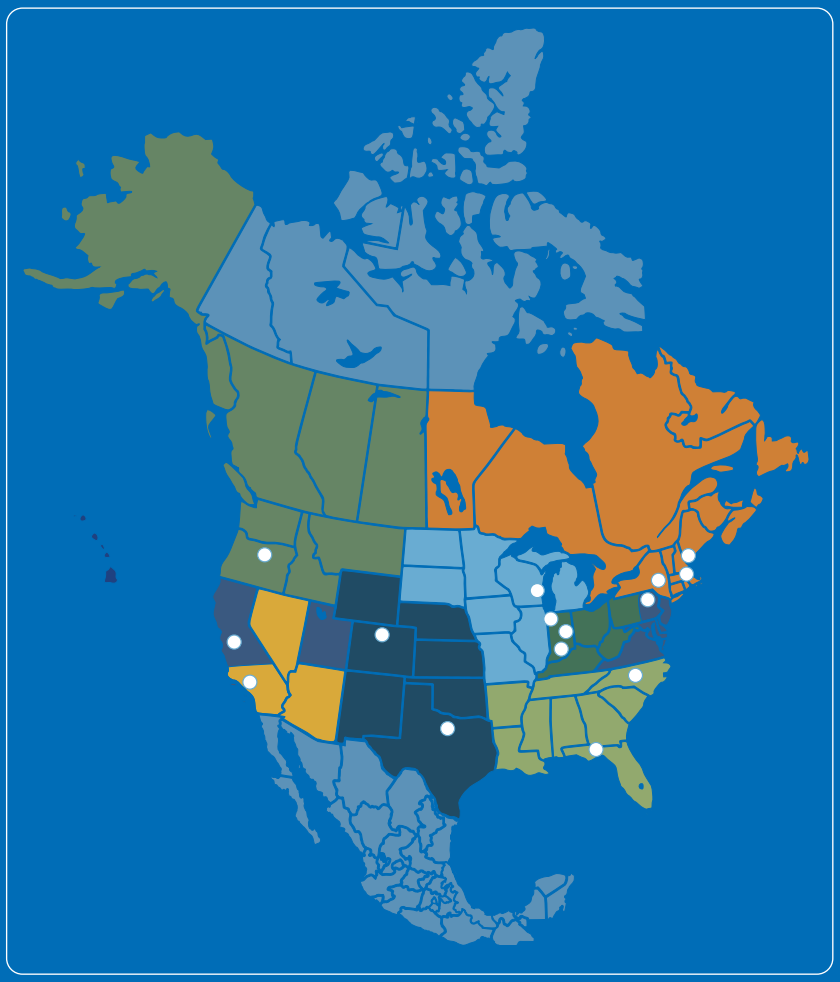
Conclusions

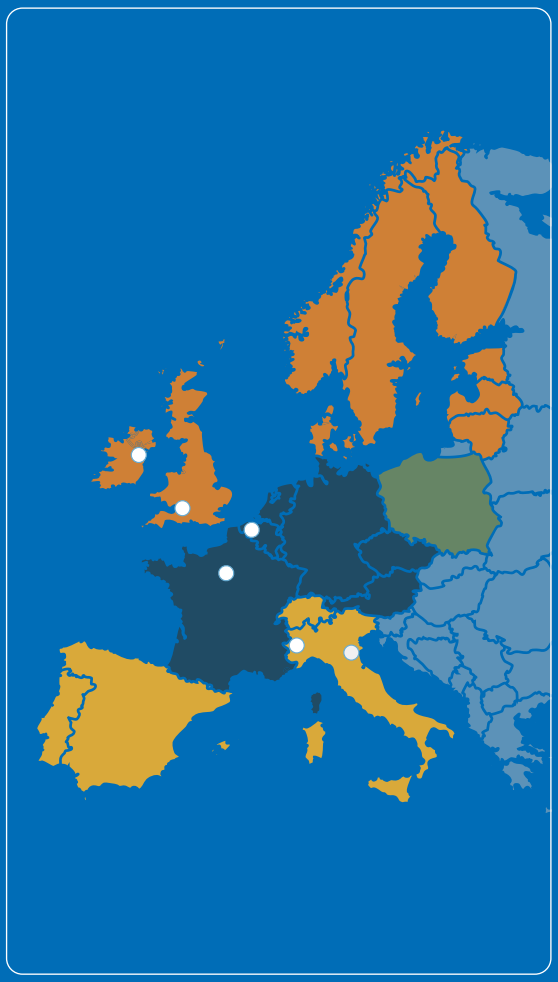
Vadose zone soils at or below the location of a PFAS release act as significant PFAS reservoirs at thousands of sites globally, presenting a long-term source of contamination long after the polluting events have ceased. The pilot tests completed at two prototype AFFF-release sites resulted in the immediate, complete, and sustained elimination of PFAS in soil leachate, demonstrating how these PFAS sources can be rapidly and effectively mitigated. The *in situ* PFAS source treatments emplaced SourceStop horizontal barriers at the base of the treatment zones to significantly improve PFAS retention (i.e., prevent PFAS leaching) over commodity carbon materials like PAC.

The highly sustainable remedy can be flexibly applied to vadose zone soils, the capillary fringe, and groundwater at PFAS source areas, tailored to meet site-specific conditions. SourceStop can be used as a standalone treatment or combined with PlumeStop in remediating the plume body to enhance the attenuation of PFAS contaminant plumes and mitigate exposure risks.

These enhanced attenuation remedies replace non-sustainable remedial methods like dig & haul or pump & treat, which create more PFAS waste materials and generate greenhouse gases that further pollute the environment. REGENESIS Remediation Services now offers these *in situ* PFAS treatments as a turn-key service for deployment at AFFF-release and other PFAS source areas.

We're ready to help you find the right solution for your site





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