REGENESIS®

In Situ PFAS Remediation Protects Offsite Environment at Airport in Norway

SourceStop Barrier Prevents PFAS Contaminant Migration During Impacted Soil Excavation

Summary

SourceStop® Liquid, a colloidal activated carbon (CAC), was applied as a permeable sorptive barrier to reduce PFAS migration hydraulically, downgradient of a source area at an airport in Norway where highly contaminated soils were removed. Through nine months of monitoring, the two primary PFAS of concern, PFOA and PFOS, have been reduced by 96% and 98%, respectively, while Total PFAS has been reduced by 94%.

Background

Large PFAS source area remediation implemented at airport in Norway

Avinor is a state-owned company operating most of the civil airports in Norway.

At Haugesund Airport in Norway, Avinor and their environmental consultant COWI implemented a remediation plan to reduce the migration of PFAS (per- and polyfluoroalkyl substances) in groundwater from a fire training ground where aqueous film-forming foam (AFFF) was used.

The remediation included excavating approximately 7,400 tons of contaminated soil from the source area, containing an estimated 13 kg of PFAS, and transporting it to a PFAS landfill.

It was anticipated that excavation of the PFAS-impacted soils could lead to further desorption into the groundwater through disturbance. This mass, plus that already existing in the groundwater beyond the excavation limits required remediation to protect the downgradient environment. Consequently, an *in situ* remediation solution was used to minimise the further migration of PFAS in groundwater during and after the source removal measures were completed.

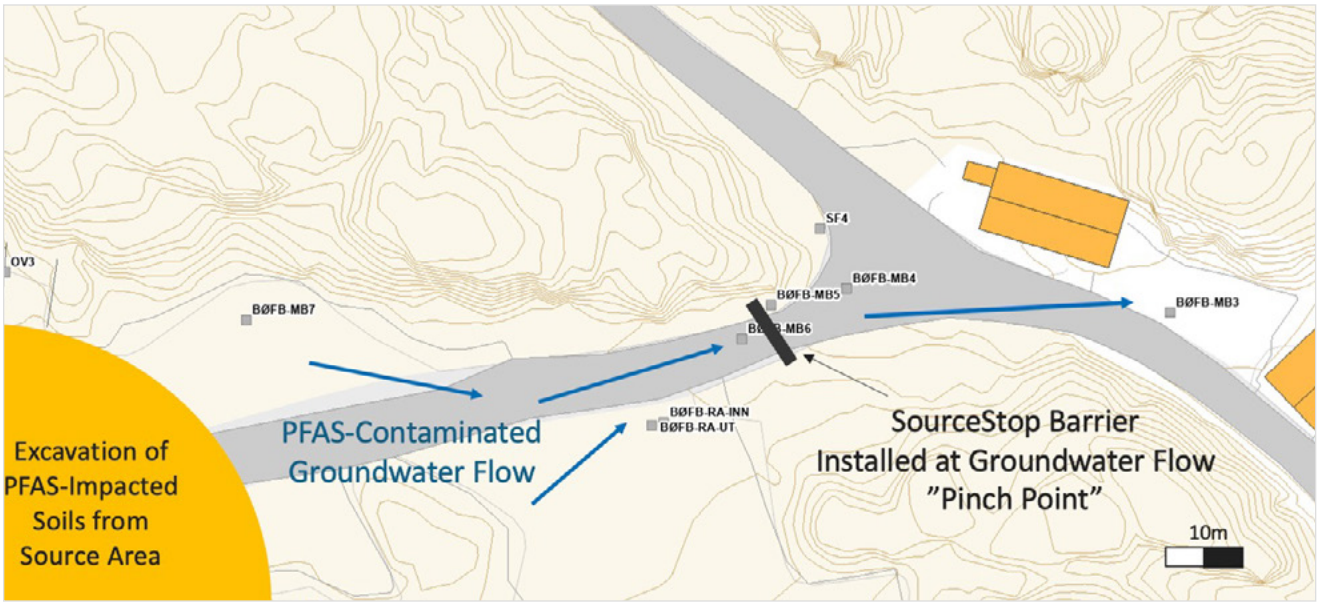
In Situ Remediation

SourceStop permeable sorptive barrier implemented to reduce PFAS migration in groundwater during and after source area removal

A SourceStop CAC permeable sorptive barrier was designed and implemented downstream of the excavation area to mitigate the ongoing dissolved-phase transport of PFAS during and post-excavation.

The selected location for the barrier was within a narrow gap (i.e., 'pinch point') in the crystalline bedrock through which the groundwater flowed beneath an airport roadway.

Figure 1 SourceStop Barrier Location



Map depicting location of SourceStop barrier. Credit: Avinor

Excavation where the SourceStop barrier was implemented, shows crystalline bedrock geology.

The barrier was constructed by excavating the surface materials and broken crystalline bedrock to a depth of 3 m, spanning the hydrological 'pinch point'. SourceStop Liquid was thoroughly mixed with imported sand using an excavator and placed into the excavation. Care was taken to ensure that the SourceStop was evenly distributed throughout the barrier treatment zone. Following the barrier's installation, sub-base granular material was placed on top, and the roadway was restored.

The final treatment barrier dimensions were 10 m long by 3 m deep by 1 m wide (along flow), see Figure 1. Installation was rapid, requiring only two days in the field for completion.

The intention of the barrier was to adsorb the influx of PFAS contaminants while permitting groundwater to flow through it unimpeded. As such, the SourceStop CAC barrier effectively operates as an *in situ* purifying filter for PFAS.

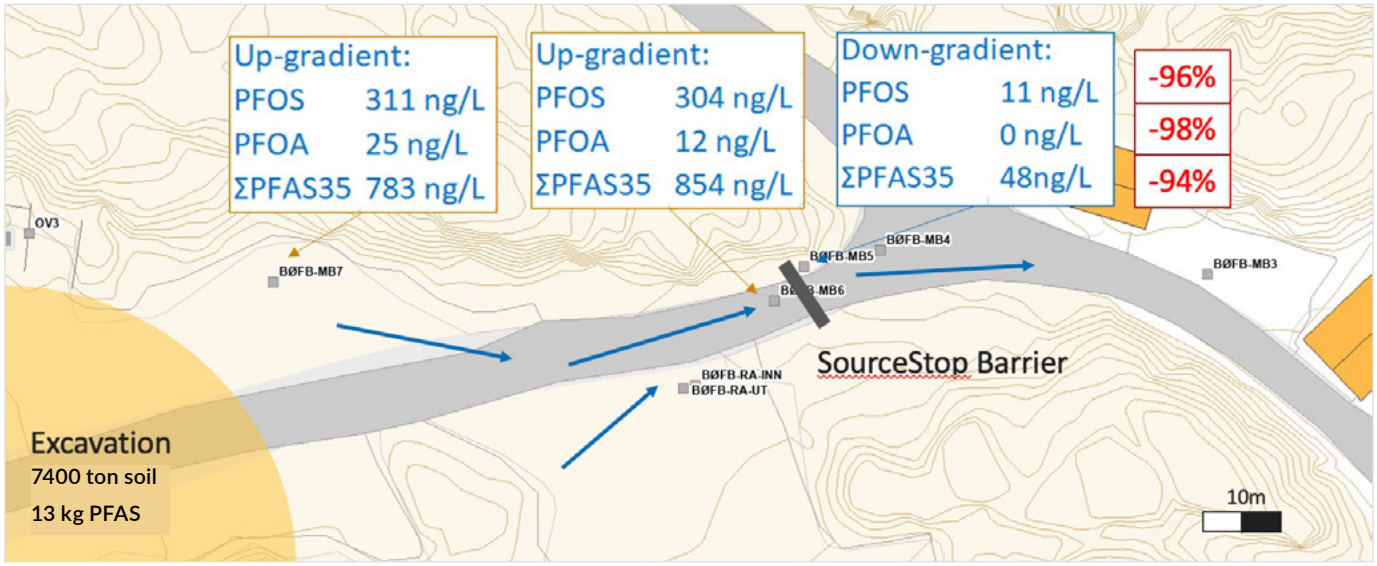
Results

SourceStop barrier reduces PFAS mass flux in groundwater by 94% to 98% through 9 months of performance monitoring

Nine months post installation, the average PFOS concentration was reduced by 96% and PFOA by 98% compared to the ingress concentrations. The total PFAS (sum of 35 analysed PFAS) concentration was reduced by 94%. These results demonstrate the achievement of the remedial goal.

Higher PFAS concentrations further downgradient of the barrier are expected to decline over time as the removal of source mass and reduction of residual PFAS mass flux by the SourceStop barrier upgradient begin to be reflected by these more distant wells.

Figure 2 Performance Data



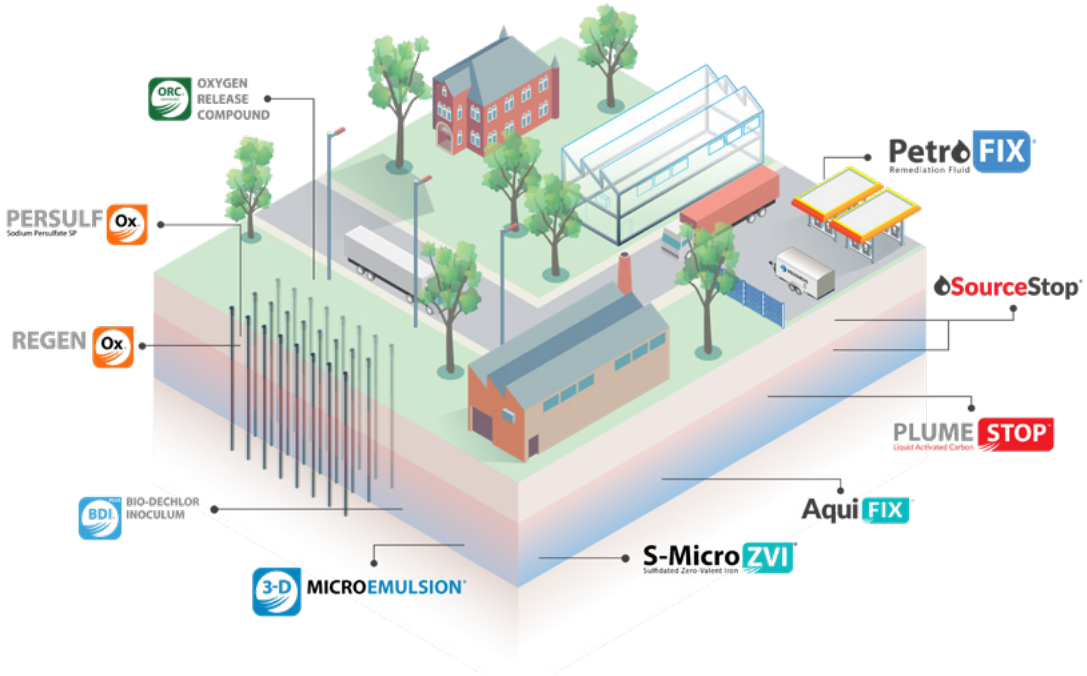
Mean PFAS concentrations are shown upgradient and downgradient (treated) of the SourceStop barrier through nine months following the SourceStop barrier installation. Credit: Avinor

Conclusion

SourceStop will continue to treat PFAS-impacted groundwater with no pumping or waste produced

The SourceStop CAC barrier was rapidly implemented and has since consistently prevented PFAS migration, successfully achieving the project objectives. The performance monitoring wells will continue to be used by Avinor for long-term monitoring.

The permeable sorptive barrier filters PFAS out an estimated 2,500 litres per day, providing ongoing protection of the downgradient environment without pumping, an external power source, or waste generation.



REGENESIS Technologies

PlumeStop® Liquid Activated Carbon™ is composed of very fine (1-2 micron-size) activated particles suspended in water through a unique, organic polymeric dispersion chemistry that resists clumping and allows permeation through aquifer materials. PlumeStop sorbs to the aquifer matrix soon after injection, rapidly removing contaminants from the groundwater to eliminate risk. It can be co-applied with electron donors, electron acceptors, or used as a stand-alone amendment to treat most organic groundwater contaminants.

SourceStop® prevents leaching of PFAS from soils and halts further migration in groundwater to eliminate the risk to downgradient receptors. Available in Liquid and Solid formulations, SourceStop's colloidal activated carbon (CAC) technology provides unsurpassed distribution, penetrating and permanently coating impacted soils. Engineered for easy application, rapid results and long-term treatment, SourceStop is an adaptable and affordable solution for PFAS sites.

PetroFix® is a colloidal activated carbon technology used to remediate total petroleum hydrocarbons (TPHs) from contaminated environments. Petrofix uses a proprietary formula of activated carbon to adsorb total petroleum hydrocarbons. It then adds electron acceptors to stimulate hydrocarbon biodegradation.

RegenOx® is an *in situ* chemical oxidation (ISCO) reagent used to directly oxidize contaminants. Its unique catalytic component generates a range of highly oxidizing free radicals that rapidly and effectively destroy a range of target contaminants including both petroleum hydrocarbons and chlorinated compounds. RegenOx is an injectable, two-part ISCO reagent combining a solid sodium percarbonate based alkaline oxidant (Part A), with a liquid mixture of sodium silicates, silica gel and ferrous sulfate (Part B), resulting in a powerful contaminant destroying technology.

PersulfOx® is an advanced *in situ* chemical oxidation (ISCO) reagent that destroys organic contaminants found in groundwater and soil through abiotic chemical oxidation reactions. It is an all-in-one product with a built-in catalyst which activates the sodium persulfate component and generates contaminant-destroying free radicals without the costly and potentially hazardous addition of a separate activator.

ORC Advanced® is an engineered, oxygen-release compound developed for enhanced, *in situ* aerobic bioremediation of petroleum hydrocarbon contaminants in groundwater and saturated soils. Containing 17% by weight molecular oxygen, ORC Advanced provides a controlled release of molecular oxygen-an electron acceptor that optimizes microbial utilization in a treatment zone for up to 12 months post-application.

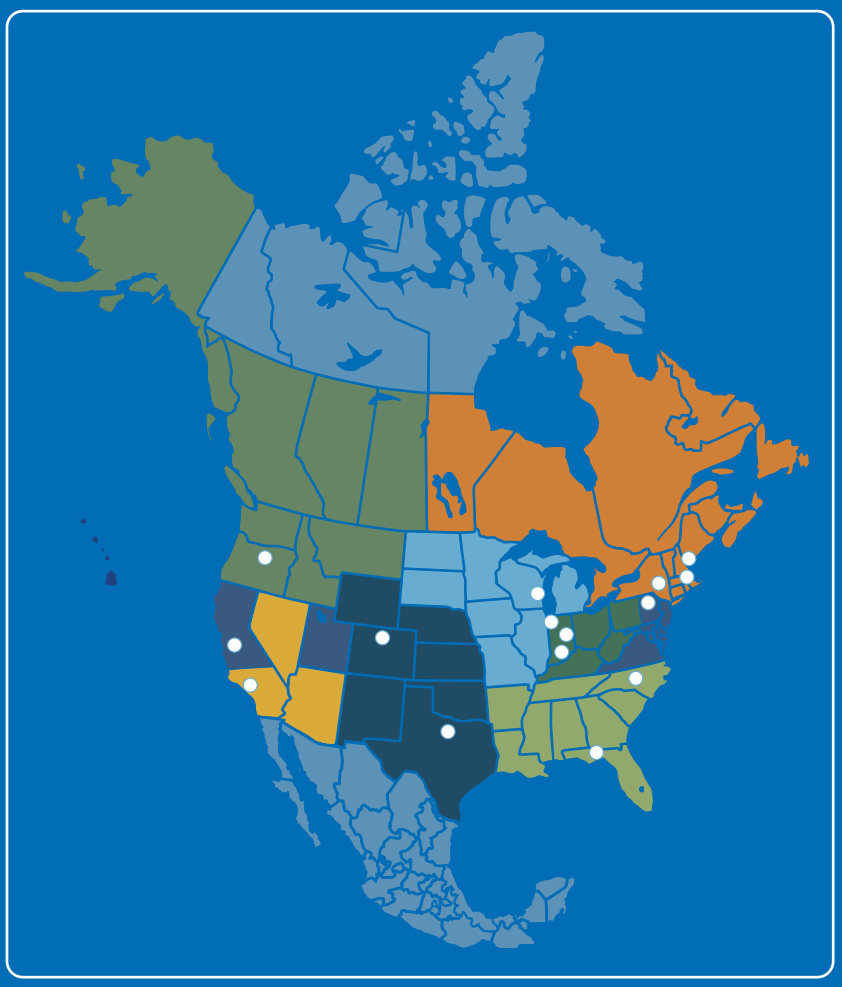
3-D Microemulsion® is an easy-to-apply remedial amendment for the *in situ* treatment of chlorinated solvent-contaminated aquifers. The patented technology, applied as a micellar suspension, provides a controlled, self-distributing hydrogen source to facilitate biologically mediated enhanced reductive dechlorination. 3-D Microemulsion's unique chemistry enables its distribution by naturally flowing groundwater while persisting for years after injection, resulting in much greater treatment coverage and faster degradation rates than other electron donor amendments.

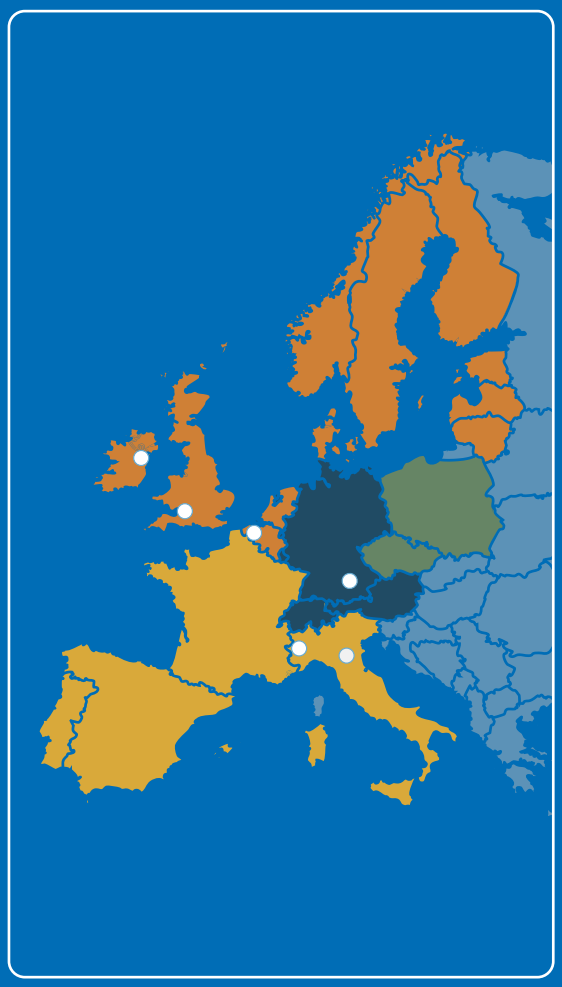
AquiFix™ is a solid, colloidal remediation amendment for the *in situ* treatment of chlorinated solvent-contaminated aquifers, designed for direct mixing and co-application with PlumeStop. The novel formulation, patent-pending, includes a nutrient-enriched, solid-phase, fatty acid source that quickly establishes and sustains enhanced reductive dechlorination over long timeframes (e.g., ten years post-injection). AquiFix's optimized hydrogen release profile significantly improves remediation efficacy and reduces life-cycle costs to treat these contaminants.

BDI PLUS® (Bio-Dechlor INOCULUM Plus) is an enriched natural consortium containing *Dehalococcoides sp.* and other dechlorinating microbes for biologically augmenting enhanced reductive dechlorination remedies. Co-applied with electron donor amendments such as 3-D Microemulsion and AquiFix, BDI PLUS has proven to improve chlorinated solvent remediation efficiency.

S-MicroZVI® is a colloidal suspension of sulfidated zero-valent iron that promotes the destruction of a wide range of organic pollutants including chlorinated solvents, pesticides, haloalkanes and energetics. S-MicroZVI is engineered to promote rapid contamination degradation through multiple pathways which leads to faster cleanup while minimizing daughter product formation. Compared to larger particle size ZVI products, S-MicroZVI's 2-3 micron-sized particles, suspended in a proprietary polymer, make it easy to handle and simple to inject, leading to significantly better reagent distribution.

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





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