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PFAS immobilization using in-situ application of colloidal activated carbon at a geologically complex site

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Due to the exceptional persistence and resistance to degradation of per- and polyfluoroalkyl substances (PFASs), novel technologies for in-situ treatment and remediation of these pollutants are urgently needed. While there is still a need for more evidence from well-documented field applications, a promising technique is the use of activated carbon (AC) sorbents that can immobilize PFASs in groundwater and thereby prevent further spreading of the contaminants.

In Arboga Sweden a small fire-fighting training area connected to aviation industry is contaminated by PFAS from aqueous film forming foams (AFFFs). This site has been characterized for PFAS contamination and hydrogeological parameters affecting the spreading of contaminants with the groundwater in a few smaller site investigations since 2016 and continuous monitoring since 2018. In November 2019 colloidal activated carbon (CAC) was injected in a pilot-scale test to study the capability of CAC to immobilize PFASs in a part of the contamination plume.

The complex geology of the site made the injection of CAC challenging and special measures had to be taken to avoid excessive preferential flow of the CAC particles even at low-pressure injection. The injection pattern was modified and $CaCl_2$ was injected downstream of the CAC injection to reduce CAC mobility and create a defined zone of CAC intercepting the PFAS plume in the groundwater, thus acting like a PFAS-immobilizing permeable barrier.

PFAS concentrations were initially reduced by 74% (for a sum of 11 PFASs) directly downstream of the CAC-barrier. However, a few months later PFAS concentrations rebounded to levels equally high or higher than before CAC injection, after which the levels have been going down again. The reasons to the rebound are likely connected to seasonal changes and fluctuations in the groundwater flow directions, causing bypass of the permeable CAC barrier. Lessons learned from applying CAC injections at this field site include the key importance of understanding the groundwater flow patterns and its temporal variability. CAC was able to produce significant reduction in PFAS concentrations (74%), but only when the PFAS plume was properly intercepted. The results illustrate the challenges with application of permeable barrier techniques particularly at geologically complex field sites. At such sites, sorbents for immobilization of PFAS plumes in groundwater should be applied in the most straightforward location where a year-round interception of the plume can be obtained.