Sustainable PFAS Remediation: Comparing the Environmental Impact of Enhanced Attenuation Using Colloidal Activated Carbon to Pump and Treat

Kristen Thoreson, Ph.D. (kthoreson@regenesis.com) (Regenesis, San Clemente, CA)
Gareth Leonard (Regenesis Ltd, Bath, UK)

Background/Objectives. Per- and polyfluoroalkyl substances (PFAS) present several challenges to the groundwater remediation practitioner seeking to provide long-term risk mitigation. PFAS are known to be recalcitrant to full biological degradation, toxic at low concentrations, highly mobile, and often have sources providing an ongoing discharge to groundwater. The result is dilute and long-lived plumes that may impact a range of downgradient receptors.

Methods of PFAS remediation in groundwater include an enhanced attenuation (EA) strategy. One method of EA employs the in situ emplacement of colloidal activated carbon (CAC) into PFAS-impacted groundwater to enhance PFAS retention and reduce mass flux. The PFAS influx is adsorbed by the CAC to provide a significant and long-term reduction in downgradient concentrations. Following installation, treatment through enhanced retention is designed to last decades and can be maintained through occasional re-application, or may be sufficient if source treatment/removal is also completed. This approach has been used on over 30 sites in the US, Canada, Europe, Scandinavia and the Middle East.

With the increasing interest in the sustainability of remedial approaches from problem holders, regulators and engineering firms, it was determined that a study should be completed into the environmental impact of this long-term EA method. Comparison was then made to the default groundwater remediation approach of water extraction and filtration to remove PFAS.

Approach/Activities. A Life Cycle Analysis (LCA) study was completed on the CAC material to gain an overall view of the environmental impacts into manufacturing, shipping and application of the product. The LCA boundary encompassed ‘cradle to grave’, i.e. it considered upstream sourcing of the material, core processes including activation and milling and also the downstream processes of transport and injection. The LCA was undertaken according to ISO14044/ISO14025 by using GaBi Professional software in order to meet EN15804 standards to create an Environmental Product Declaration (EPD).

Following this, a site was chosen on which CAC had been applied to remediate PFAS contamination. This comprised a commercial airport at which AFFF use had created a PFAS plume that was egressing the site and impacting an adjacent Site of Specific Scientific Interest (SSSI) and a river. The 110 m CAC injectable permeable reactive barrier (IPRB) was applied at the site boundary, immediately downgradient of the fire training area. The IPRB design was then analysed to determine the environmental impact. A ‘pump and treat’ system was then designed that could provide an alternative groundwater treatment along the same length, to achieve similar parameters over the same treatment period. A comparison was then made between the two approaches using GaBi Professional software. The comparisons included greenhouse gas emissions, acidification, photochemical ozone formation, hazardous waste, slag/ashes, energy use, cost, and site disturbance.

Results/Lessons Learned. A description of the LCA approach and results will be shown. The target site conditions, IPRB installation and alternative pump and treat design will be explained. The comparison methodology and output will be shown and conclusions drawn on the relative sustainability and environmental impact of each remedial treatment approach process.