Colloidal Activated Carbon Used to Enhance Natural Attenuation of PFAS at Airports Worldwide: A Multiple Site Review

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Background/Objectives. Per- and polyfluoroalkyl substances (PFAS) are emerging contaminants in soil and groundwater at airports worldwide, primarily from the use of aqueous film-forming foams (AFFF) for firefighting and training activities. PFAS compounds are part of a family of thousands of chemicals that are known for their risk to both human health and the environment, and PFAS is known to be resistant to biological and chemical degradation. These factors, along with extremely low clean-up criteria, create a unique problem when remediation is needed to mitigate risk to receptors associated with PFAS contamination.

An environmentally sustainable strategy to address PFAS risk is the use of colloidal activated carbon (CAC) to enhance the natural attenuation of PFAS in situ. CAC comprises exceptionally fine particles of activated carbon suspended in a polymer that can be injected into aquifers under low pressure or mixed into source area soils. The CAC binds to the soil matrix and serves as an in situ filter to remove PFAS from groundwater as it encounters the activated carbon particles or used to reduce the mass discharge of PFAS into groundwater from impacted vadose soils. The use of one or both applications, will virtually eliminate further discharge of PFAS mass into aquifers thus making enhanced attenuation of PFAS a preferred remediation approach.

Approach/Activities. The presentation will be a case study review of seven airport sites that use an enhanced natural attenuation strategy to address PFAS impacts in soil and groundwater through treatments with CAC. The size and scope of the CAC projects vary along with the injection methods and treatment configurations between grids and permeable reactive barriers. Groundwater was primarily targeted for treatment, but on a few occasions source vadose soils were also treated. Prior to the implementation of the CAC, design verification testing (DVT) and advanced mass flux and predictive competitive sorption modeling were completed to refine the site conceptual models. Also, during the application process, field placement validation steps, such as post-injection soil cores and piezometers, were used to observe and refine the CAC distribution.

Results/Lessons Learned. Results of the study show that in most of the sites treated, CAC was distributed effectively within the aquifer and achieved stringent remedial standards for a sustained period (up to 4.5 years) often below the laboratory detection limits. Contaminant reductions typically exceeded 99%. Furthermore, the advanced modeling demonstrated a theoretical PFAS retardation spanning decades from one-time treatments of CAC. This study indicates that an in situ application of CAC to enhance attenuation is a viable and environmentally sustainable remediation method to address the risk associated with PFAS contamination at airports.