

Fate and Transport Modeling of PFOS in a Fractured Chalk Aquifer towards a Large-Scale Drinking Water Abstraction

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Background/Objectives. In December 2005 the largest explosion in Western Europe since World War Two occurred at the Buncefield Oil Storage Terminal in the UK. In controlling the resulting fires approximately 250,000 liters of firefighting foam containing PFOS were deployed, a proportion of which directly impacted the underlying chalk Principal Aquifer which lies within a protected drinking water abstraction zone. Investigations identified PFOS to be present in groundwater beneath the site resting at approximately 35 m below ground level, source concentrations of PFOS ranged from between 20 to 50 µg/L well above the 0.3 µg/L guidance values in the UK.

Many questions remain regarding the fate, transport, attenuation, and remediation of PFOS, which is classed as a persistent organic pollutant (POP). Recent advancements in the science of environmental toxicology of PFAS have drawn attention to these chemicals and the need for a better understanding of their behavior in the environment.

Approach/Activities. We evaluated the transport of PFOS in fractured bedrock groundwater towards the drinking water abstraction. In this case, PFOS was discharged concurrently with the fuels and provided an opportunity to characterize the transport of both PFOS and hydrocarbons including benzene, toluene, ethylbenzene, xylenes (collectively, BTEX), and the fuel oxygenate methyl tertiary butyl ether (MTBE). The transport properties of BTEX and MTBE are well known. Therefore, comparing the transport of these hydrocarbons with transport of PFOS at this well-characterized site after a known discharge event has afforded a unique opportunity to gain insight into the transport of PFOS in the environment.

Site investigation activities included the completion of soil boring and bedrock boreholes, downhole geophysical investigations and the installation and sampling of groundwater monitoring wells for concentrations of PFOS, BTEX, and MTBE. Routine sampling of monitoring wells has ensued on a near-monthly basis for a period of up to five to seven years, thereby providing a detailed record of environmental monitoring. Contaminant modelling has also been undertaken during the quantitative risk assessment process along with remediation activities including groundwater pumping and capping of 12,000m³ of shallow soils impacted with PFOS both designed to remedy the potential impacts of the original incident

Results/Lessons Learned. The project has resulted in significant insights being gained regarding transport of PFOS in fractured rock at the site, including characterization of background PFOS concentrations and attenuation mechanisms such as retardation and dual-porosity mass transfer characteristics. Given the significant increase in recognition of the number of potential PFAS source zones globally and the significant number of drinking water supplies at risk these insights will be of interest to a wide audience.