# An Adaptive Remediation Strategy to Mitigate Biofouling in a Hydraulic Containment and Ex Situ Treatment System

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**Background/Objectives.** A Hydraulic Containment System (HCS) was installed at a fractured bedrock site in the UK, following identification of organic solvents (mainly trichloroethene [TCE]) at concentrations of up to 450 mg/L. The site is an operational manufacturing facility, where TCE was used for approximately 40 years and has been detected at concentrations of up to 1 mg/L in downgradient surface water receptors. A Remedial Options Appraisal identified the HCS to be the most appropriate contaminant management strategy and a pumping system was designed and installed to contain the plume and recover TCE. Following system commissioning extensive and unexpected fouling was noted within the remediation process equipment, reducing system uptime, efficiency and operational performance.

**Approach/Activities.** Baseline groundwater sampling prior to system commissioning confirmed the groundwater contained the previously detected high TCE concentrations and low concentrations of other contaminants of concern. Pumping commenced as planned, however within 30 days significant fouling impacts, in the form of bioslimes, were noted both in the abstraction wells and the treatment equipment (most notably within an air stripping unit and in the liquid phase carbon treatment vessels).

The magnitude of the fouling impacts was such that significant amendment of the remedial treatment system was anticipated in order to maintain continuous and safe operation of the HCS. To determine the cause of the fouling and identify appropriate system adaptations, a 'lines of evidence' investigative approach was undertaken, including an initial detailed program of sampling focusing on the organic and inorganic groundwater chemistry, together with microbiological analyses. The results of the initial testing were used to define any additional data requirements and assess the system adaption and treatment strategy required to maintain operation. Identified system adaptations would be subject to feasibility testing to confirm suitability, ahead of full-scale deployment.

**Results/Lessons Learned.** The initial lines of evidence from chemical sampling revealed significant concentrations of previously unidentified organic matter that could act as a potential substrate under aerobic conditions. Microbiological analysis identified the presence of total coliforms, fecal coliforms and E. Coli, which are indicator species for the presence of raw sewage and sanitary waste within the aquifer. A review of the site infrastructure identified a fractured foul sewer, carrying sanitary and kitchen waste as a source.

The results collated to date illustrate an unusual situation where a complex combination of organic, inorganic and microbial contaminants were considered the source of the fouling and presented both Health and Safety risks and operational challenges. The next steps are likely to include adaptation of the HCS to include additional treatment technologies, such as Ultraviolet sterilization, dosing with biocides and system disinfection. The sewer system will also be repaired to remove the on-going carbon source, although the issue is considered likely to persist for several months after this occurs.

This paper will present detailed results of the chemical and microbiological analyses, how the HCS was modified, along with discussion of how this adaptive strategy was implemented to achieve the project objectives.