Conceptual Site Model Development and Environmental Molecular Diagnostics Use for PlumeStop® Liquid Activated Carbon™ Application at a Trichlorofluoromethane Groundwater Plume

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Background/Objectives. Understanding the geochemical and the microbial profile within a groundwater plume are valuable components of the conceptual site model (CSM). Proper site characterization is a critical component of CSM development, and without it, the CSM will often be incomplete and can lead to improper remedial design and remedy selection. Environmental Molecular Diagnostics (EMDs) and accompanying sample collection methods have made microbial data collection easy and efficient. Increased use of EMDs and robust databases have also improved the value of collecting microbial data and maximizing the use of that data during CSM development.

Approach/Activities. This presentation will describe the geochemical and microbial data collected in conjunction with other parameters and methodologies used to develop a remedial design at a foam manufacturing site in North Carolina. Remedial investigation activities identified volatile organic compounds (VOCs) and chlorinated volatile organic compounds (CVOCs) typically associated with the foam manufacturing process, including trichlorofluoromethane (Freon 11), methylene chloride, tetrachloroethene (PCE), trichloroethene (TCE), and 1,4-dioxane. In addition to VOCs, groundwater samples were analyzed for various geochemical parameters and by a QuantArray Chlor® (DNA) method to develop the microbial profile.

Following completion of the Remedial Investigation (RI) and development of the Remedial Action Plan (RAP), a limited remedial investigation and injection pilot study were completed. The remedial investigation and pilot study had two main objectives. The first objective was to collect design verification data for use with full scale design. This included the collection of sufficient data to plan and execute a full-scale groundwater treatment and validate performance of contaminant sorption and bioremediation by stimulating rapid, biologically mediated, destruction of VOCs and CVOCs in groundwater. This was accomplished through in-situ injection of PlumeStop® Liquid Activated Carbon™ (PlumeStop®) and Hydrogen Release Compound (HRC®) through an array of direct push injection (DPI) points in the shallow aquifer. The second objective was to gain Regulatory approval for State-wide use of PlumeStop®, a new remedial technology at the time. This site was one of two pilot studies performed in North Carolina to obtain Regulatory approval.

Results/Lessons Learned. By completing design verification and remedial investigation work while the pilot study was in progress, the CSM was completed, and State-wide use of PlumeStop® was approved. A complete CSM provided a clearer understanding of the groundwater transport mechanisms and location of contaminant mass reaching the treatment areas which allowed for the proper PlumeStop® dosing and placement, currently the largest application in the world at a site contaminated with Freon 11. By evaluating the microbial profile, it was possible to determine types of active microbes and gene functions associated with biodegradation of the target constituents. When combined with field parameters and geochemical analysis, a compelling base of evidence was established for *aerobic* co-metabolic bioremediation of groundwater constituents. The overall case study for the foam manufacturing

site, remedial investigation, remedial design and selection, and the closure strategy with an emphasis on the role of EMD's and *aerobic* co-metabolic bioremediation will be presented.