A Comprehensive Evaluation of MNA Mechanisms for TCE and DCE in a Large, Dilute Plume

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Background/Objectives. The North Industrial Corridor (NIC) Site comprises more than 4,000 acres of industrial, commercial, and residential property in Wichita, Kansas. The site is underlain by a large, dilute TCE and DCE plume originating from multiple sources in the area. The Corrective Action Decision for the site recommended monitored natural attenuation (MNA) for the northern part of the site, but previous investigations showed little evidence for MNA based on the conventional reductive dechlorination pathway. Therefore, the Kansas Department of Health and Environment required a rigorous assessment of MNA to determine whether MNA is an appropriate remedy, the results of which are to be incorporated into the remedial design for this part of the site.

Approach/Activities. The comprehensive MNA assessment for TCE and DCE consisted of a two-pronged approach. The first component was an assessment of the "traditional" reductive pathway that was the primary focus of EPA's 1998 protocol. The second included evaluating aerobic cometabolism and biogeochemical reduction pathways that have been the subject of much research in the last 20 years. This was in large part based on a preliminary evaluation of available site data using the tracer-corrected method. The data suggested that TCE was degrading with a half-life averaging about 4 years in the shallow aquifer, and about 9 years in the deeper aquifer, despite predominantly aerobic conditions throughout much of the site. The MNA assessment at the NIC site included two rounds of groundwater sampling and one set of soil samples. Groundwater samples were analyzed for contaminants and other chemical parameters relevant to MNA pathways such as degradation products and redox-sensitive parameters. In addition, a suite of other analyses were performed, including more novel techniques for evaluating alternative MNA pathways to reductive dechlorination. Specifically, enzyme activity probes and magnetic susceptibility were used to assess aerobic cometabolism and biogeochemical reduction, respectively. Metagenomics and quantitative polymerase chain reaction were also employed to analyze for specific TCE and DCE degrading enzymes, as well as to characterize various aspects of the microbial community. Microcosm studies were performed using site soil and groundwater to determine whether degradation could be observed in the laboratory. Finally, compound specific isotope analysis was used to determine whether TCE and DCE degradation was apparent in site groundwater samples based on spatial and temporal trends of ^{13}C enrichment in the plume.

Results/Lessons Learned. Using this broad suite of tools, it was evident that natural attenuation is occurring in most of the area of interest by reductive dechlorination in some cases, and aerobic cometabolism and/or biogeochemical reduction in others. Previous degradation rate calculations were updated based on the new data and suggest that TCE will decrease below the alternative cleanup goal for the site of 21 μg/L by about 2021.