Analysis and Interpretation of Geochemical, Isotopic, Hydrogeologic and Direct-Sensing Data to Support CSM Development for a Complex Site

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Background/Objectives. Historical releases of tetrachloroethene (PCE) and trichloroethene (TCE) occurred at a confidential active aircraft parts manufacturing facility located in a mixed commercial/industrial and residential setting. Work is being conducted under a Consent Order with the United States Environmental Protection Agency (USEPA). Previous investigations indicated elevated concentrations of chlorinated volatile organic compounds (VOCs) in soil, soil gas, and in groundwater within both the shallow overburden and sedimentary bedrock aquifers. A targeted in situ chemical oxidation (ISCO) remedy implemented in the early 2000s to address the most impacted areas at the facility was successful in reducing contaminant mass onsite; however, a dissolved-phase plume extending beyond the facility property boundary into a hydraulically downgradient residential neighborhood persists, necessitating operation of vapor mitigation systems at residential properties to mitigate vapor intrusion risk. Designing a remedy to adequately address the risks associated with remaining source and dissolved-phase constituents of concern (COCs) requires a robust conceptual site model (CSM) to identify sources, define plume extent, determine primary fate and transport mechanisms, and assess risks to multiple receptors via multiple exposure routes.

Approach/Activities. The identification of COC source areas and plume definition was conducted in an iterative fashion. Initial activities consisted of high-resolution site-characterization tools including membrane interface probe (MIP), electric conductivity (EC) and hydraulic profiling tool® (HPT) to efficiently identify potential sources and delineate the horizontal extent of impacts within the overburden. The extensive chemical and physical data set provided by this high-resolution, direct-sensing technology was used to develop three-dimensional visualization (3DV) models of COC impacts and identify primary mass storage zones within the overburden at the site. Depth-discrete soil and groundwater samples were collected to confirm MIP/EC/HPT responses in the overburden and 17 continuous multi-channel tubing (CMT®) wells were installed to depths of up to 100 feet to supplement the existing monitoring well network and evaluate the bedrock saturated zone through the collection of groundwater samples at up to seven discrete vertical intervals. Comprehensive groundwater sampling events were conducted to provide COC, geochemical, isotopic, and molecular data sets. Select groundwater samples were submitted for compound specific isotopic analysis (CSIA) to assess contaminant degradation and fingerprint multiple source zones. Select samples were also submitted for Quant-Array® microbial analysis to quantify bacterial populations and assess the functionality of microbial species that may be capable of degrading COCs.

Results/Lessons Learned. The MIP/EC/HPT tooling and confirmation sampling results provided a cost-efficient means of identifying remaining sources and defining the extent of the dissolved-phase plume within the overburden. Increased sampling density afforded by direct-sensing equipment identified previously unknown source areas that may not have been discovered using conventional investigation techniques. Discrete sampling using CMT® wells provided high-resolution, three-dimensional delineation of the dissolved-phase plume within a sedimentary bedrock sequence. Combining conventional and innovative presentation techniques provided additional insight into contaminant fate and transport in a complex hydrogeologic system. COC trend charts, Piper Plots, VOC molar ratios, CSIA data charts, and

3DV modeling collectively provided the basis for an accurate, defensible CSM that will support evaluation and design of an appropriate remedy.