Incorporating Natural Source Zone Depletion Concepts in Remediation of a Jet Fuel Plume

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Background/Objectives. After over 20 years of in situ treatment of jet-fuel contaminated soil and groundwater, with limited detailed information on groundwater geochemistry, the facility demolition allowed for the opportunity to re-design the site remediation. The facility had been in operation over 80 years and during that time various grades of jet fuel were released into the underlying soil and groundwater, resulting in a 20-acre light non-aqueous phase liquids (LNAPL) plume. Prior to restarting active deep remediation, the natural, existing geochemical and biodegradation conditions were assessed to (1) document the site's capacity for natural degradation of naptha- and kerosene-based jet fuel LNAPL, and (2) provide baseline conditions to guide the selection and implementation of a more effective remedy to include a natural attenuation component. After on-site biotreatment of the upper 10 feet of source-zone, petroleum-affected soil, deeper contamination by jet fuel LNAPL remains, with the highest LNAPL saturations comprising a 2-acre area with a 10-foot thick smear zone. The lateral occurrence of LNAPL and dissolved hydrocarbons have been shown to be very stable. Based on field testing (described below), the selected remedy will include expansion of the soil vapor extraction well network, a higher density of LNAPL recovery wells, and a greatly expanded density of air sparge wells. Nevertheless, it is expected that application of these technologies will not result in complete LNAPL removal, and thus achieving regulatory closure will require a defensible demonstration that natural source zone depletion (NSZD) processes can be relied upon to ultimately meet site cleanup goals.

Approach/Activities. Characterization activities for the NSZD assessment included intensive biogeochemical soil testing; groundwater testing and analysis for assessment of geochemical features, hydrocarbons, and metabolite distributions; CO_2 mass flux survey; and groundwater temperature survey for assessing biodegradation heat generation. This multi-faceted data collection and evaluation are providing a multi-perspective snapshot of the biogeochemical and fate processes surrounding the LNAPL and dissolved-phase hydrocarbons. The LNAPL conceptual site model is constantly being refined to reflect these data and associated insights.

Results/Lessons Learned. Integration of decades of characterization and remediation data with an expanded understanding of the occurrence and distributions of groundwater parameters (including, SO_4, CH_4, temperature, alkalinity, ORP, petroleum and metabolite fractions), as well as CO_2 mass flux, and solid-phase biogeochemical changes is serving to reveal important features concerning biodegradation of the aged jet fuel LNAPL plume. The characterization activities have been completed and will be summarized with presentation of key data and interpretations. The mineralogical and geochemical testing of soil (27 samples) conducted to demonstrate and quantify important aspects of NSZD for this plume will be presented separately.

Direct, inexpensive measurements of CO_2 flux and of groundwater temperature allow for snapshot insights on how the LNAPL plume is naturally biodegrading and form a baseline design for optimizing the integration of active remediation with subsequent demonstration of NSZD.