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Natural Source Zone Depletion Interacts with Active Remediation at an LNAPL Recovery Site

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Background/Objectives. Practitioners for petroleum release sites are increasingly incorporating natural source zone depletion (NSZD) monitoring for post-remedy management, but largely unexplored is the interaction between active remediation and NSZD early in a remedy. Total fluids (LNAPL+water) recovery is one active remediation technique that may interact with NSZD, in addition to removing petroleum hydrocarbons via pumping. One possible interaction (active remediation affecting NSZD) would be a depressed water table from pumping that increases hydrocarbon volatilization from the LNAPL smear zone. Another possible interaction (NSZD affecting active remediation) would be high natural hydrocarbon losses in permeable soils that decrease LNAPL transmissivities. This presentation will report both types of interactions to provide context for plume stability at a recent petroleum release site.

Approach/Activities. The subject site is an active facility where LNAPL body and dissolved-phase plume stability are remedy objectives. Baseline SZD monitoring was conducted across a transect of the LNAPL body, paired with total fluids extraction wells. Monitoring tools included: 1) CO_2 efflux measurements by dynamic closed chamber (DCC), 2) subsurface temperature measurements, 3) vadose zone gas profiling, 4) groundwater geochemical testing, and 5) Bio-Traps™. Together, these tools provide information on SZD depletion in both the dissolved and vapor phases. The full baseline SZD monitoring results were compared with LNAPL transmissivity testing results at the collocated total fluids extraction wells.

Results/Lessons Learned. NSZD rates measured by DCC varied from 0 g TPH m^{-2} day^{-1} upgradient of the LNAPL body to approximately 20 g TPH m^{-2} day^{-1} within the plume center. Downgradient of the LNAPL body, NSZD rates were 1.5 g TPH m^{-2} day^{-1}, suggesting that plume stability is achieved not just by active remediation but by continued volatilization/biodegradation from the dissolved phase plume. Vadose zone temperature and gas measurements corroborate this interpretation, demonstrating methane generation and oxidation zones both above the LNAPL body and downgradient. NSZD rate variation within the LNAPL body suggests multiple interactions with active remediation. At one location, NSZD measurements with and without pumping indicate that the system likely introduces oxygen (exhaust from pneumatic pump) for aerobic biodegradation. This observed interaction suggests that total fluids extraction enhances hydrocarbon removal even though pumped LNAPL recovery rates are low there. At two other locations, there is an inverse relationship between NSZD rate and LNAPL transmissivity, a possible additional indicator of NSZD contribution to hydrocarbon removal where LNAPL recovery is conducted. The results provide a picture of how active remediation can be used to enhance NSZD depletion and insight into future transitions for a system to achieve continued plume stability.