Natural Source Zone Depletion Rate Comparison over a 40-foot Thick Smear Zone

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Background/Objectives. At an active southern California refinery approximately 38 million gallons of LNAPL have been recovered through hydraulic recovery since 1985. Historical groundwater fluctuations of 40 feet created a large vertical smear zone with an estimated 30 million gallons of submerged LNAPL remaining. A natural source zone depletion (NSZD) study was conducted to evaluate the rate of natural depletion of the LNAPL across the full footprint and compare it to current diminishing hydraulic recovery rates.

Approach/Activities. Two methods were used to evaluate NSZD at the site: thermal profiling and carbon dioxide (CO_2) flux measurements. The first method evaluates the thermal anomaly resulting from the aerobic biodegradation of petroleum hydrocarbons using dedicated thermocouple strings placed in existing monitoring wells. Vertical temperature profiles were measured at nine (9) wells within the LNAPL footprint and four background wells monthly for six months (July through December). Temperature anomalies were derived from the differences in the temperature profile between LNAPL and background locations. Temperature anomalies are converted to heat fluxes and then NSZD biodegradation rates. The second method looked at CO_2 produced during the biodegradation of LNAPL, which partitions into the gas phase and migrates upward to the surface. CO_2 traps were installed at ten (10) locations to derive NSZD rates from the flux of CO_2 across the ground surface. Multiple locations used both thermal profiling and CO_2 flux to support a direct comparison of NSZD rates from each method.

Results/Lessons Learned. Both methods had a wide variation in NSZD rates. The variation in NSZD rates were examined as a function of the smearzone thickness in the formation. Thicker smear zones provide greater contact area where reactions may occur. Where both NSZD methods were used the average NSZD rates were similar.