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A study on unsaturated zone characterization and feasibility of soil vapor extraction at a DNAPL-contaminated site in Korea

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Groundwater contamination by Dense Non-Aqueous Phase Liquids (DNAPLs), such as trichloroethylene (TCE), have been found in many industrial complexes, which is one of the most pressing problems in contaminant hydrology. As DNAPL is denser than water, it migrates downward through the overlying sediments and water table, and there, it forms a long term source of contamination due to its low solubility in water. DNAPL research site, located in Wonju, Republic of Korea, is contaminated with TCE (trichloroethylene), which was used as solvent from 1988 to 1997, and contaminated top soil dug out up to 3 m deep in 2004 to 2005. However, a high concentration (15 mg/L) of TCE in groundwater exceeding drinking water standard (0.03 mg/L in Korea) is still detected in the source zone area. Recent studies showed that the rise in water table led to an increase in TCE concentration, indicating that TCE sources existed in unsaturated zone above/around the water table. Therefore, the purpose of this study aims to characterize unsaturated zone in terms of air permeability and flow connectivity between the boreholes penetrating unsaturated zone, which will consequently be used for the design of pilot scale soil vapor extraction (SVE) system. Five boreholes with three multi-level screens at the depth of 3.0 to 4.5 m, 5.5 to 7.0, and 8.0 to 12.0 m were installed at the source zone for field tests. Pneumatic tests were performed to determine the air permeability. The average air permeability was measured to be 2.18×10-6 cm2. Pressure-drawdown curve well matched leaky aquifer type, indicating that air leaks through the ground surface. Air flow tests were also carried out to investigate air flow connectivity between multi-level wells. When injecting air through the upper level of the well, vertical air flow toward the surface mainly took place with horizontal flow limited. On the other hand, when injecting air to the lower part, the horizontal air flow was well made through unsaturated zone to the neighboring wells. The results of air tests suggested that air blow into or extraction from the lower level be required to increase the efficiency of SVE. Based on air tests, the pilot scale SVE system is being constructed, and its feasibility will be evaluated for the DNAPL-contaminated research site.