Project Title: **Evaluation of Direct-Push Soil-Gas Sampling Methods to Support Assessment of Vapor Intrusion**

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Introduction to Problem: Vapor intrusion is defined as vapor phase migration of volatile organic and/or inorganic compounds into occupied buildings from underlying contaminated ground water and/or soil. Until recently, this transport pathway was not routinely considered in RCRA, CERCLA, or UST investigations. Therefore the number of buildings or homes where vapor intrusion has occurred or is occurring is undefined. However, considering the vast number of current and former industrial, commercial, and waste processing facilities in the United States capable of causing volatile organic or inorganic ground-water or soil contamination, contaminant exposure via vapor intrusion could pose a significant risk to the public. Also, consideration of this transport pathway may necessitate review of remedial decisions at RCRA and CERCLA sites as well as implementation of risk-reduction technologies at Brownsfield sites where future development and subsequent potential exposure may occur. EPA's Office of Solid Waste and Emergency Response (OSWER) recently (2002) developed guidance to facilitate assessment of vapor intrusion at sites regulated by RCRA and CERCLA where halogenated organic compounds constitute the bulk of risk to human health. EPA's Office of Underground Storage Tanks (OUST) is considering modifying this guidance to include underground storage tank sites where petroleum compounds primarily determine risk and biodegradation in subsurface media may be a dominant fate process.

The guidance provides attenuation factors for use with soil-gas concentrations to assess potential for vapor intrusion at a given site. Due to the expensive of drilling and installation of dedicated vapor probes, truck-mounted direct-push methods such as the Geoprobe Post-Run Tubing (PRT) system are commonly used to sample soil-gas at depths greater than 50 feet near homes in streets and driveways. Hand-held rotary-hammer methods such as the AMS rotary-hammer system have been used to sample soil-gas at depths less than 15 feet within 3 feet of a house especially when there is concern regarding extrapolation / interpolation of data from a more distant location. Information however is lacking in the referred literature on potential bias associated with direct-push sampling methods compared to dedicated vapor probes, the generally accepted reference method. Thus, an assessment of bias associated with direct-push sampling methods is necessary to support the OSWER guidance and vapor intrusion investigations.

Background: Soil-gas sampling will be conducted near homes east of the former Raymark Superfund Site in Stratford, Connecticut. Ground-water 15 to 20 feet beneath these homes is contaminated with 1,1,1-trichloroethane, trichloroethene, 1,2-cis-dichloroethene, 1,1-dichloroethene, and benzene.

Objectives: The overall objective of this work is to assess potential bias (compared to dedicated vapor probes) of two direct-push soil-gas sampling techniques (truck-mound Geoprobe PRT and hand-held AMS rotary-hammer systems). The results of this investigation will be used to provide specific recommendations on soil-gas sampling to support vapor intrusion investigations.

Approach: Dedicated vapor probes and probes from Geoprobe PRT, and AMS rotary-hammer systems will be sampled at identical depths (3, 7, and 11 feet) at distances less than 3 feet from each other. The sequence of testing will be varied to avoid potential bias in sample concentration due to sampling sequence. Six to nine soil-gas samples will be collected at the same depth using the Geoprobe PRT system within an area of 3 ft^2 to assess spatial variability. This testing is necessary to separate concentration differences due to sampling methodology from random variation. Selected dedicated vapor probes, Geoprobe PRT and AMS rotary-hammer probes will be sampled after a variety of purge volumes (up to 200) to assess the impact of purging prior to sampling. O_2, CO_2 and total VOCs will be monitored in the purge stream continuously using a Landtec landfill gas meter and portable photoionization detector.

Experimental Design: Vapor samples from all three systems will be collected into Tedlar bags using a peristaltic pump, Teflon tubing, and a Masterflex tubing. Use of a peristaltic pump will ensure that sampled air does not circulate through a pump causing potential cross contamination and leakage. All tubing will be discarded between sampling locations to eliminate the possibility of cross-contamination. Sample flow rate will be set from 0.5 to 1 LPM and measured using a flowmeter. Tedlar bags used for sample collection will be analyzed on-site by EPA's New England Regional Laboratory using a field-based GC. The sampling train for collection of vapor samples from dedicated vapor probes is illustrated in Figure 1 while probes used for the Geoprobe PRT system and AMS system are illustrated in Figures 2 and 3 respectively.

Accomplishments to Date: Sampling has been completed. EPA report preparation is in progress.

Figure 1. Sampling train (peristaltic pump, flowmeter, landfill gas meter) for collection of samples from dedicated vapor probes

Figure 2. Probe used for Geoprobe PRT system

Figure 3. Probe used for AMS vapor sampling system