Risk Factors and Sampling Approaches for VI Preferential Pathway Investigations

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Background/Objectives. The topic of preferential pathways for vapor intrusion (VI) has gained increasing attention in recent years. Nevertheless, there remains little specific technical or regulatory guidance on how to assess this pathway. Guidance that does exist tends to favor sampling soil gas in utility backfill material as a way to evaluate whether preferential pathways are a concern. This, however, is not consistent with the growing body of research and case study examples that indicate that sewers and utility tunnels themselves function as the vapor migration pathway. Because of uncertainties in both the conceptual model and investigation methods, VI preferential pathways are not currently being investigated in a consistent manner. Therefore, through the Department of Defense ESTCP program, we have conducted systematic testing to characterize volatile organic compounds (VOCs) in sewers, refine the conceptual model, and develop an investigation protocol to address this issue.

Approach/Activities. Our research project involved measuring VOC concentrations in sewer lines at more than 35 different sites with documented contamination in shallow groundwater. Multiple rounds of sampling were conducted at a subset of the sites to evaluate temporal variability in the VOC concentrations. We supplemented our dataset with data compiled from literature and other sources. In addition to studying relationships between VOCs in groundwater and sewers, we utilized perfluorinated tracer (PFT) compounds to measure vapor migration between sewers and individual buildings. The tracer testing was conducted at a total of seven residences and eight commercial buildings. Attenuation factors were developed for the groundwater to sewer vapor pathway, and the sewer vapor to building pathway.

Results/Lessons Learned. Data collected for this project were used to update the conceptual model for the sewer/utility tunnel preferential pathway for VI. Sites with higher risk for preferential pathway issues are characterized by direct interaction between the subsurface source and the preferential pathway (e.g., sewer line below the water table). These sites exhibited less attenuation from groundwater into the sewer line as well as potentially-elevated VOCs within sewer lines beyond the inclusion zones for typical VI investigations. In contrast, lower risk sites were characterized by indirect interaction between the subsurface source and the preferential pathway (e.g., sewer line located in the vadose zone above the groundwater plume). At these sites, VOC concentrations in sewers decreased rapidly away from contaminant source areas. Although temporal variability at both types of sites was low on a short (1-3 day) timescale, VOC concentrations within sewer lines typically varied by a factor of 10 or more over the course of a year. Based on these and other refinements of the conceptual model, we have developed an investigation protocol to evaluate sewer/utility tunnel preferential pathways for VI that includes recommendations on when, where, and how to sample.