Evaluation of Spatiotemporal Variability in Site-Specific Attenuation Factors

Matthew A. Lahvis (matthew.lahvis@shell.com) (Shell Oil Products US, Houston, TX, USA)
Robert A. Ettinger (rettinger@geosyntec.com) (Geosyntec Consultants, Inc., Santa Barbara, CA, USA)

Background/Objectives. The spatiotemporal variability in indoor air (IA) and subsurface (SS) vapor concentrations creates uncertainty in empirically derived vapor attenuation factors (AFs) used for vapor intrusion (VI) screening. The variability is attributable to numerous site-specific factors which relate to the VI conceptual site model (CSM), including source type (groundwater or shallow soil), building type (residential or non-residential), and heating, ventilation, and air-conditioning (HVAC) operation. Certain regulatory agencies recommend the collection of multiple IA and SS samples at multiple locations to help address the variability and target maximum exposure conditions. Questions remain over the critical factors affecting the spatiotemporal variability and whether the additional and targeted vapor sampling actually improves VI screening and risk assessment.

Approach/Activities. An empirical AF database was created, containing over 14,000 IA and SS vapor data pairs from more than 100, predominantly trichloroethylene (TCE) and tetrachloroethylene (PCE), sites in California. The vapor data were extracted from site investigation reports contained in California Environmental Protection Agency's Geotracker and Envirostor electronic databases. Data filtering was performed to eliminate data pairs associated with low SS and IA concentration sources potentially affected by background (non-VI) sources and vapor data of suspect data quality. The filtered TCE and PCE database contained 1,130 IA and SS data pairs (i.e., AF values) collected at 151 buildings and 60 sites. The AFs were statistically derived from the filtered IA and SS database using descriptive statistics (box-and-whisker plots) and compared to assess mean, median, 95th percentile values and their variance. The AFs were compared for various building (residential versus non-residential) types and building locations.

Results/Lessons Learned. Results of the analysis showed:

- higher median/mean AFs at buildings with lower SS vapor concentrations because IA concentrations were generally independent of SS vapor concentrations;
- greater variability in AFs for non-residential versus residential buildings, although median and mean AFs for these building types were largely similar;
- greater than four orders of magnitude variability in AFs for individual non-residential buildings depending on when and where vapor samples were collected;
- over five orders of magnitude variability in AFs depending on HVAC operation, which explains some of the variability observed for non-residential buildings;
- largely similar variability in AFs for different buildings located at individual sites, although median, mean, and 95th % AFs ranged by over an order of magnitude depending largely on SS vapor concentration; and,
- over an order of magnitude variability in median, mean, and 95th % AFs for buildings located at individual sites with the same vapor (groundwater) source.

Additional studies are recommended to improve the understanding of fundamental relations between IA and SS vapor concentrations and key factors affecting VI. In the meantime, these findings can help inform VI screening and limit unnecessary data collection.