Variability in Sub-Slab TCE Vapor Concentrations in a Multi-Family Housing Complex

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ABSTRACT

Sub-slab soil gas data is one line of evidence commonly used to determine the potential for subsurface vapor intrusion into an overlying building at a site. Soil gas samples from immediately beneath a building's concrete slab are analyzed for volatile organic compounds (VOCs) and when compared to empirical attenuation factors can help assess the potential for vapor intrusion to into a building exceeding a health risk-based screening level. At a former housing area at Moffett Field, California, trichloroethene (TCE) data from multiple sub-slab sample locations suggests that variability in sub-slab data may underestimate the potential vapor intrusion indoor air risk. Multiple sub-slab probes were installed in each of eight residential units (in the kitchen, bathroom, and living room). Each probe was sampled twice in September 2008. The highest TCE concentration was typically found in the bathroom sample, where sub-slab TCE concentrations were generally two to nine times higher than the living room sub-slab samples.

Study Site

The sub-slab vapor study was part of a larger vapor intrusion research project conducted at a multi-family housing complex in Moffett Field, California. All of the residences were vacant and slated for demolition, which allowed the study to be conducted under controlled conditions and unlimited access was available for the installation of sub-slab probes and changing ventilation conditions. All the residences at the study site were demolished in December 2008.

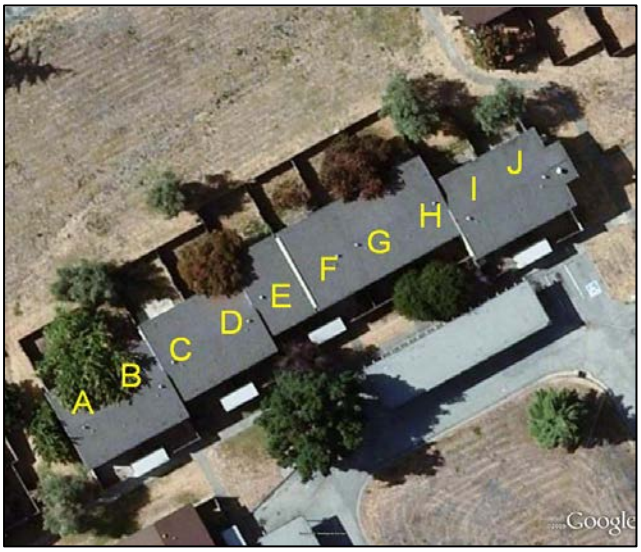

Figure 1 Aerial view of 10-unit building sampled
(GoogleEarth image)

The housing complex, constructed in 1968, consisted of blocks of two-story townhomes with slab-on-grade construction (i.e., no basements). Each multi-family building block consisted of eight to ten units, with adjacent units sharing walls (Figure 1). All units within the block share a common concrete slab foundation, consisting of a slab with footers around the perimeter of the block and between each unit.

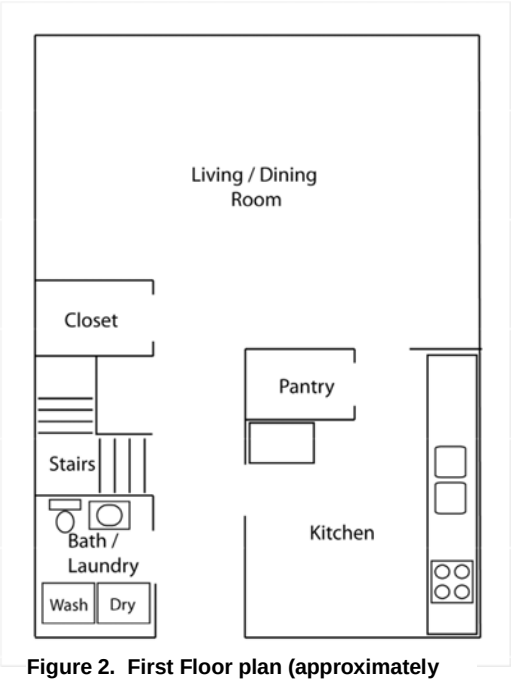

Figure 2. First Floor plan (approximately 500 square feet)

Each unit was approximately 1000 square feet (500 square feet on each of two floors). An example floorplan (first floor) is shown in Figure 2. Adjacent units have a reversed floor plan, so that kitchens or bathrooms are adjacent to each other.

The subsurface below the housing complex consists of interbedded silt, clay, and sand at the margins of San Francisco Bay. Groundwater is 5 to 10 feet below ground surface. The primary contaminant of concern is TCE in the groundwater. TCE concentrations in the shallow groundwater beneath the units tested ranged from 10 to 300 micrograms per liter (µg/L). No source of TCE in the vadose zone has been found.

Sub-Slab Probe Installation and Sampling

Sub-slab probes were installed in eight units, generally four probes per unit. Each probe extended eight inches from the top of the slab to intercept the base fill below the slab. The probes were constructed of stainless steel and brass fittings (Figure 3) and the annular space was filled with quick-set cement grout. Each probe was sampled twice in September 2008. Prior to sampling, stagnant air in the probe system was purged for three purge volumes. Samples were collected as grab samples in small-volume (250 to 500 mL) evacuated stainless steel canisters and analyzed using EPA Method TO-15 by either a commercial laboratory (Air Toxics Ltd.) or the EPA Region 9 Laboratory.

TCE soil gas sample results are shown schematically in Figure 4. In general, the highest sub-slab TCE concentrations were found in the bathrooms. Bathroom TCE sub-slab concentrations ranged from two to nearly nine times higher than the average TCE concentration in the living room.

Given that the sub-slab probe installation, purging, and sampling technique were identical for all probes, the variability in sub-slab concentrations was likely due to the greater number of subsurface utility conduits in the bathroom relative to the living room.

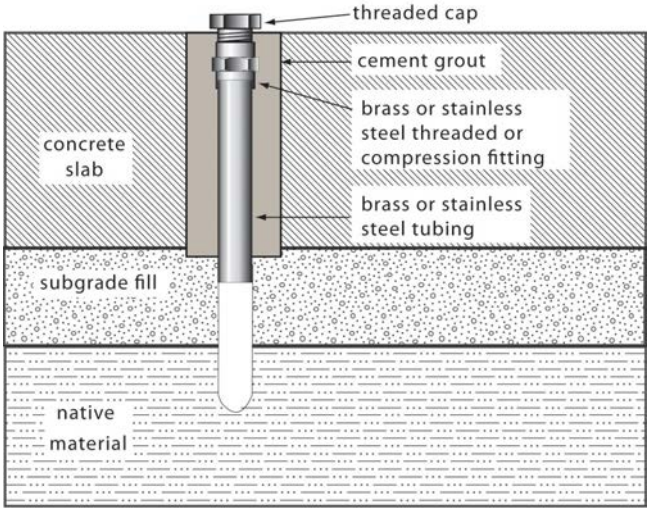

Figure 3. Sub-slab Probe Schematic

In addition to plumbing conduits for the sink and toilet, there were also utility conduits for the adjacent washer and dryer. The kitchen, which also has more subsurface conduits than the living room, had slightly higher sub-slab TCE results compared to the living room, but the effect was not as apparent as the bathrooms.

Potential preferential pathways for vapor migration associated with utility conduits include higher-transmissivity backfill surrounding the utility conduit and penetration of the conduit through the moisture barrier and the slab foundation.

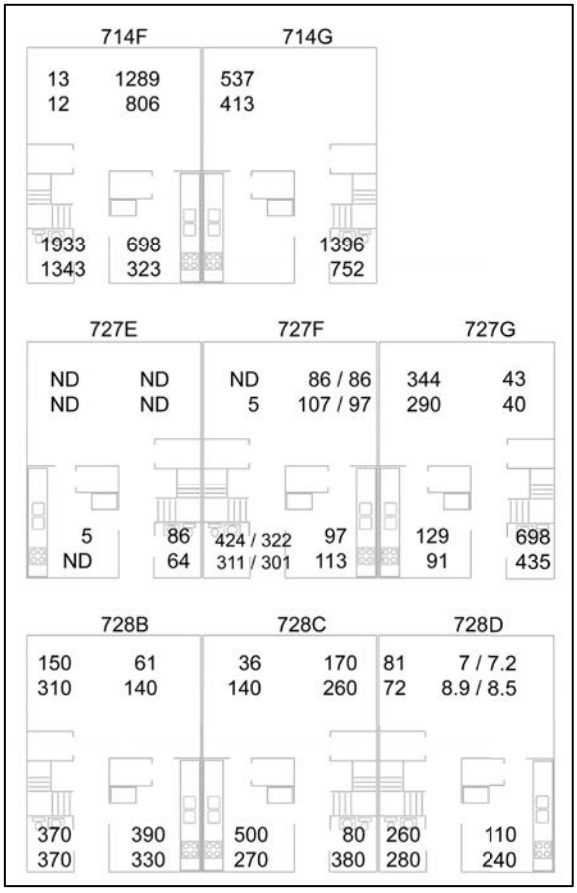

Figure 4 Sub-slab soil vapor TCE concentrations (in micrograms per cubic meter, ug/m3). Top first TCE result is the sub-slab sample collected on 9/16/08; Second TCE result is the sub-slab sample on 9/23/08. x/y samples are field duplicate samples.

Discussion

Sub-slab TCE vapor concentrations varied within each housing unit and were generally highest in the bathrooms of each residence.

Project managers who use sub-slab vapor data as the primary line of evidence in assessing the vapor intrusion pathway should consider collecting data from multiple sub-slab probe locations, and, if feasible, sampling in locations with a high network of utility conduits, such as the bathroom. As this approach is not practical at most sites, project managers may consider using indoor air data as the primary line of evidence for ensuring protection of human health. If indoor air data exceed health protective screening levels, then sub-slab vapor data could then be collected to determine if the indoor air contaminant is related to subsurface contamination.

Acknowledgements: Funding for this research effort was provided by an EPA Regional Applied Research Effort (RARE) grant. EPA Office of Research and Development (ORD) support provided by Dr. Ron Mosley (retired), Dr. Brian Schumacher, Dale Greenwell, Chris Lutes (ARCADIS). Significant technical assistance was provided by Heidi Hayes, Air Toxics Ltd.