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VI Preferential Pathways

Rule or Exception

Jay Clausen, D. Moore, L. Cain, and K. Malinowski

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Abstract

Trichloroethylene (TCE) releases from leaks and spills next to a large government building occurred over several decades with the most recent event occurring 20 years ago. In response to a perceived conventional vapor intrusion (VI) issue a sub-slab depressurization system (SSDS) was installed 6 years ago. The SSDS is operating within design limits and has achieved building TCE vapor concentration reductions. However, subsequent periodic TCE vapor spikes based on daily HAPSITE™ measurements indicate additional source(s). Two rounds of smoke tests conducted in 2017 and 2018 involved introduction of smoke into a sanitary sewer and storm drain manholes located on effluent lines coming from the building until smoke was observed exiting system vents on the roof. Smoke testing revealed many leaks in both the storm sewer and sanitary sewer systems within the building. Sleuthing of the VI source term using a portable HAPSITE™ indicate elevated vapor TCE levels correspond with observed smoke emanation from utility lines. In some instances, smoke odors were perceived but no leak or suspect pipe was identified suggesting the odor originates from an unidentified pipe located behind or enclosed in a wall. Sleuthing activities also found building roof materials explain some of the elevated TCE levels on the 2nd floor. A relationship was found between TCE concentrations in the roof truss area, plenum space above 2nd floor offices, and breathing zone of 2nd floor offices. Installation of an external blower in the roof truss space has greatly reduced TCE levels in the plenum and office spaces. Preferential VI pathways and unexpected source terms may be overlooked mechanisms as compared to conventional VI.

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Preface

This study was conducted for the U.S. Army Corps of Engineers under IMCOM-WEST, Fort Sam Houston, MIPR Customer Order 11415853. The technical monitor was Dr. Jay Clausen.

The work was performed by the Biogeochemical Sciences Branch (Mr. Nathan Lamie, Chief) of the Research and Engineering Division (Dr. George Calfas, Chief), U.S. Army Engineer Research and Development Center, Cold Regions Research Engineering Laboratory (ERDC-CRREL). At the time of publication, the Deputy Director for ERDC-CRREL was Mr. David Ringelberg and the Director was Dr. Joseph Corriveau.

This material was originally presented on 20 March 2019 at the Association for Environmental Health and Sciences Foundation (AEHS) *29th Annual International Conference on Soil, Water, Energy, and Air* in San Diego, CA.

The Commander of ERDC was COL Teresa A. Schlosser and the Director was Dr. David W. Pittman.

VI Preferential Pathways: Rule or Exception

- Dr. Jay Clausen, ERDC-CRREL
- D. Moore, L. Cain, K. Malinowski, USACE NAE
- 20 March 2019

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Background

- 1960 – 1987 - TCE released from various leaks and spills
- 2010 - Vapor Intrusion (VI) detected
- 2012 – 2014 - Carbon Air Purifier's installed in offices
- 2015 – Sub-slab Depressurization System (SSDS) installed
- 2015 – 2018 - SVE Pilot Tests (SVE) conducted at two locations
- 2016 – One-way valves installed on roof drain piping
- 2017 – TCE pumped out of old refrigeration lines in building
- 2018 - Smoke Test conducted and VI utility leaks fixed
- HAPSITE™ portable GC/MS used
- Site Action Level of $8.8 \mu\text{g}/\text{m}^3$ established

Pre-Remedial Contaminant Distribution

- Subsurface soil gas TCE concentrations near main laboratory in excess of 10,000,000 ug/m³
- Sub-slab TCE concentrations up to 5,900,000 µg/m³
- Indoor air sub-basement TCE concentrations, 25 to 91 µg/m³
- Indoor air basement TCE concentrations, 15 to 241 µg/m³
- Indoor air 1st floor TCE concentrations, 0.86 to 4.7 µg/m³
- Indoor air 2nd floor TCE concentrations, 2.5 to 11 µg/m³

TCE Levels Second Floor

Soil Vapor Extraction

Effect of Soil Vapor Extraction on Subslab Vapor

SVE Soil Gas Levels

AOC 2

AOC 9

TCE Levels Second Floor

TCE Levels Second Floor

TCE Levels Second Floor

Smoke Testing

Smoke Testing II of the Main Lab

Smoke Testing

Toilet Seal

Sanitary Sewer Line Above Suspended Ceiling

Open Pipe Beneath Raised Floor

TCE Levels Second Floor

TCE Vapor ($\mu\text{g}/\text{m}^3$) Second Floor 2018

Plenum TCE Levels

TCE ($\mu\text{g}/\text{m}^3$)

TCE Distribution in Plenum

August 14, 2018 - pm

TCE Distribution in Plenum

August 15, 2018 - am

TCE Distribution in Plenum

August 15, 2018 - pm

TCE Distribution in Plenum

August 22, 2018 - pm

TCE Vapor Variability in Room 32A

Current Status

- No rebound of TCE observed at SVE pilot-test locations
- SSDS influent TCE levels below 880 ug/m³ regulatory guideline
- Periodic TCE fluctuations above action levels in second floor north wing offices in late Summer
- Sampling of roof materials in Spring 2019
- Installing carbon air purifiers in the plenum
- Evaluating installing air intakes and exhaust fans in plenum space

Conclusions

- Vapor emanations along utility lines (roof drains, sewer lines, refrigeration lines), elevator shaft, from volatile back diffusion from building materials (concrete, insulation, roofing) and other sources are underestimated and being missed
- Periodic SUMA canister sampling is insufficient for assessing VI
- Extrapolation of VI pathways from residential studies to industrial sites is inappropriate and misleading
- Term VI should be all encompassing not only emanations through sub-slab but emanations from volatile back diffusion of building materials and subsurface preferential pathways (utility lines)

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