Vapor Intrusion Site Characterization Using Multiple Lines of Evidence

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ABSTRACT

This paper describes investigations to determine the likelihood and presence of vapor intrusion associated with Cayuga Groundwater Contamination Site in Cayuga County, New York. Groundwater data collected during the remedial investigation were used to assess the potential for vapor intrusion. This assessment considered multiple lines of evidence such as site hydrogeology, extent of contamination, and the presence of preferential vapor migration pathways.

Hydrogeologic conditions at the investigation area favor downward migration of contaminants. The groundwater system includes a fractured shallow bedrock and deep bedrock zones, separated by an intermediate zone of more competent bedrock. The confining unit is discontinuous and fractured locally, resulting in a hydraulic connection between the shallow and deep zones. Significant vertical hydraulic head differences between the shallow and deep zones and the presence of localized vertical migration pathways resulted in downward migration of contaminants into the deep zone.

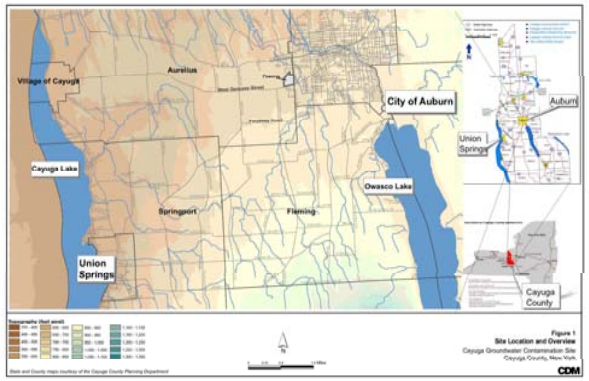
These characteristics of site hydrogeology are consistent with the extent of groundwater contamination. The shallow groundwater downgradient of the investigation area is generally clean, except for sporadic, isolated locations. Most of the contaminant plume occurs only in the deep zone, where it apparently migrated vertically from the shallow zone soon after release. The clean shallow zone may act as a barrier to prevent vapors of chlorinated organic chemicals in deep zone groundwater from reaching the unsaturated zone, and ultimately intruding into overlying buildings. Therefore, the potential for vapor migration into buildings is generally insignificant above most of the plume because of the presence of the clean shallow groundwater barrier.

However, vapor intrusion may occur at some localized areas through two migration pathways. First, areas with high levels of chlorinated organic chemical contamination in the shallow zone. These chlorinated organic chemicals might pose a vapor intrusion threat for overlying properties. Second, in some localized areas, thrust faulting and fracturing may result in an upward hydraulic gradient that supports migration of contaminants into the shallow zone. These vertical fractures may also serve as preferential pathways for vapor migration. Detailed geological cross sections and vertical profiles of chlorinated organic chemical concentrations were used to identify areas where preferential vapor upward migration pathways might occur. Based on geologic and hydrogeologic conditions, areas prone to vapor intrusion were identified to focus soil gas and indoor air sampling efforts.

INTRODUCTION

The Cayuga Groundwater Contamination Site is located in Cayuga County, New York (Figure 1). The site area reflects the generally rural character of Cayuga County, and consists of residential properties intermingled with extensive farmland and parcels of woodlands. Topographically, the study area is located in a glaciated valley of karst terrain and low relief.

A plume of chlorinated organic chemicals in groundwater extends from the city limits of Auburn to the Village of Union Springs approximately seven miles. These chlorinated organic chemicals might pose a vapor intrusion threat for overlying residential and commercial properties.



HYDROGEOLOGY

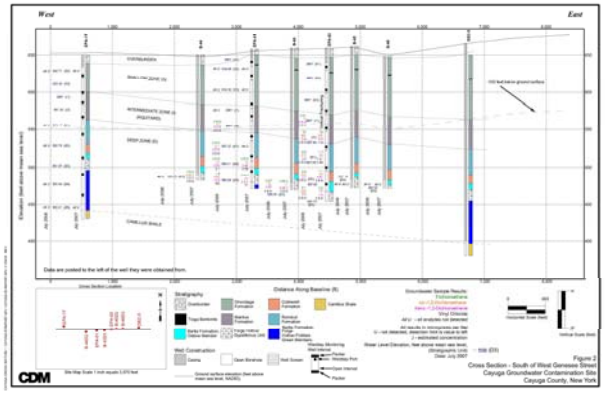
Water-bearing zones at the site

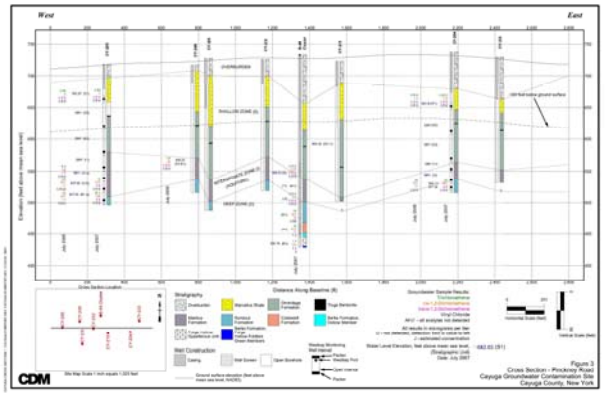
- Shallow aquifer zone consists of overburden glacial deposits and shallow bedrock
- Intermediate bedrock zone consisting of massive and relatively unfractured dolostone
- Deep aquifer zone consists of bedrock formations

The low permeability intermediate zone can impose significant impedance to upward migration of vapors from underlying deep groundwater. However, in some areas of the site, the intermediate confining unit has been breached by vertical fractures. geological cross sections are presented in Figures 2 and 3.

The intermediate confining unit appears to be breached in the vicinity of West Genesee Street through vertical fractures, allowing water to drain from the shallow aquifer to the deep aquifer (Figure 2). The vertical fractures may also act as preferential migration pathways for vapors to migrate from the deep aquifer into the unsaturated zone and eventually reach the ground surface.

In the vicinity of Pinckney Road, thrust faulting has created a pathway for groundwater from the deep zones to migrate to shallower zones (Figure 3).





NATURE AND EXTENT OF CONTAMINATION

Indicator contaminants in groundwater are *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, trichloroethene, and vinyl chloride.

From north of West Genesee Street to Pinckney Road, groundwater flow in the deep zone is toward the south. In this area, exceedances of VOC delineation criteria are seen in the deep intervals. South of Pinckney Road, groundwater flow is to the southwest, toward Cayuga Lake.

The shallow groundwater downgradient of the investigation area is generally clean, except for sporadic, isolated locations. Most of the contaminant plume occurs only in the deep zone, where it apparently migrated vertically from the shallow zone soon after release.

The clean shallow zone may act as a barrier to prevent vapors of chlorinated organic chemicals in deep zone groundwater from reaching the unsaturated zone, and ultimately intruding into overlying buildings.

Therefore, the potential for vapor migration into buildings is generally insignificant above most of the plume because of the presence of the clean shallow groundwater barrier.

CONCLUSIONS

Vapor intrusion pathway is considered complete in the areas along and to the south of West Genesee Street; in the vicinity of Pinckney Road; and at potential groundwater discharge areas in Union Springs. Vertical fracturing in the area south of West Genesee Street could provide preferential pathways through which vapors from the deep bedrock aquifer could migrate to the ground surface. For the rest of the site the vapor intrusion pathway is considered incomplete.

Based on geologic and hydrogeologic conditions, areas prone to vapor intrusion were identified to focus soil gas and indoor air sampling efforts.

REFERENCES

EPA 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from groundwater and Soils (Subsurface Vapor intrusion Guidance).* EPA 530-D-02-004. November.

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