A GIS Based Method to Investigate Contaminant Concentration Distributions in Commerce Street Superfund Site in Williston, Vermont

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SERDP DOD • EPA • DOE

Introduction

The Commerce Street Superfund Site had been contaminated by volatile organic compounds (VOCs) and heavy metals from 1979 to 1986, for the reason that Mitec Systems Corp. discharged an undetermined quantity of rinse water and industrial solvents associated with electroplating operations into a septic leach field. Heavy metals and chlorinate solvents can threaten public and private drinking waters supplies, also cause negative impacts to the environment and human health. It is important to analyze the spatial distribution of different contaminants, in addition to find out the potential source location of contaminants and regions with high contaminant risk.

Methodology

The goal of this project is to explore the groundwater flow pattern, in addition to analyze the plumes of two main contaminants, chlorinated solvents (e.g. PCE, TCE, and cis-DCE) in shallow(<20ft) and deep aquifer (>30ft) and heavy metals (e.g. chromium, cadmium, nickel, copper, and aluminum) in intermediate aquifer (20-30ft). Two different interpolation methods (e.g. Inverse Distance Weighted and Empirical Bayesian Kriging) were applied to investigate their concentration distributions (only list IDW here). In addition, raster calculation is used to determine the regions with high contamination risk, and the categories of different risk level are also analyzed. Here the zero index for each of the contaminants are the Maximum Concentration Limits following EPA standards.

◄ Sequential Reductive Dechlorination
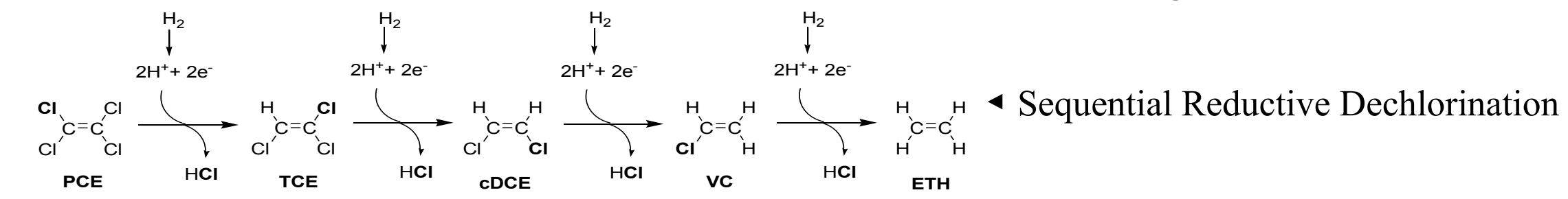
| Hazard Index	PCE conc. (ppb)	TCE conc. (ppb)	DCE conc. (ppb)	Al conc. (ppb)	Cd conc. (ppb)	Cr conc. (ppb)	Cu conc. (ppb)	Ni conc. (ppb)
0	≤5	≤5	≤5	≤1000	≤5	≤100	≤1000	≤100
1	>5	5-5000	5-5000	>1000	>5	>100	>1000	>100
2	-	>5000	>5000	-	-	-	-	-

Groundwater Flow
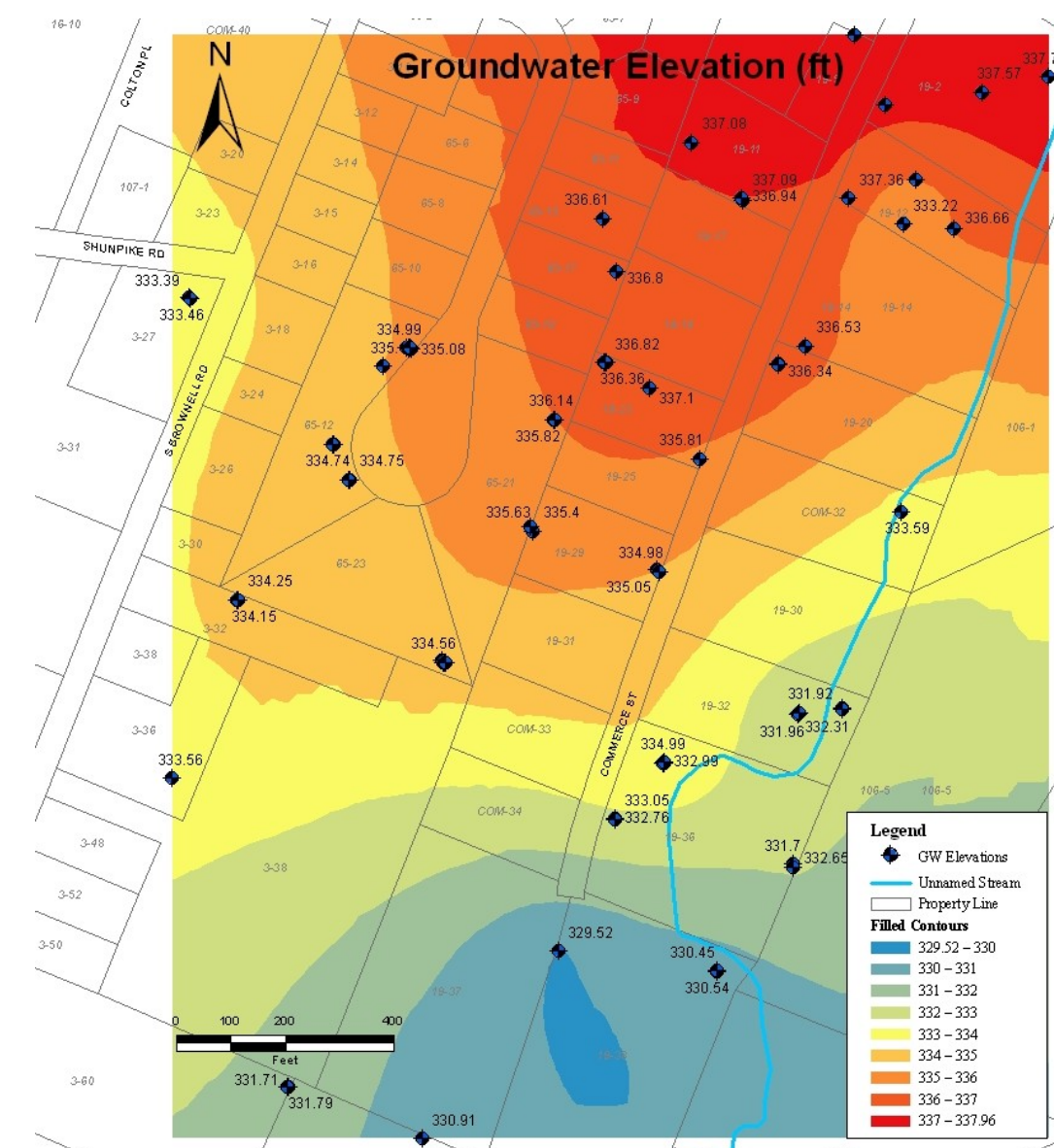
◄ The groundwater flow beneath the study area is from the north to the southeast and southwest. There is a groundwater divide that runs generally parallel to Commerce Street. This is in consistent with the surface elevation data that the peak values appear along the Commerce Street.

Results

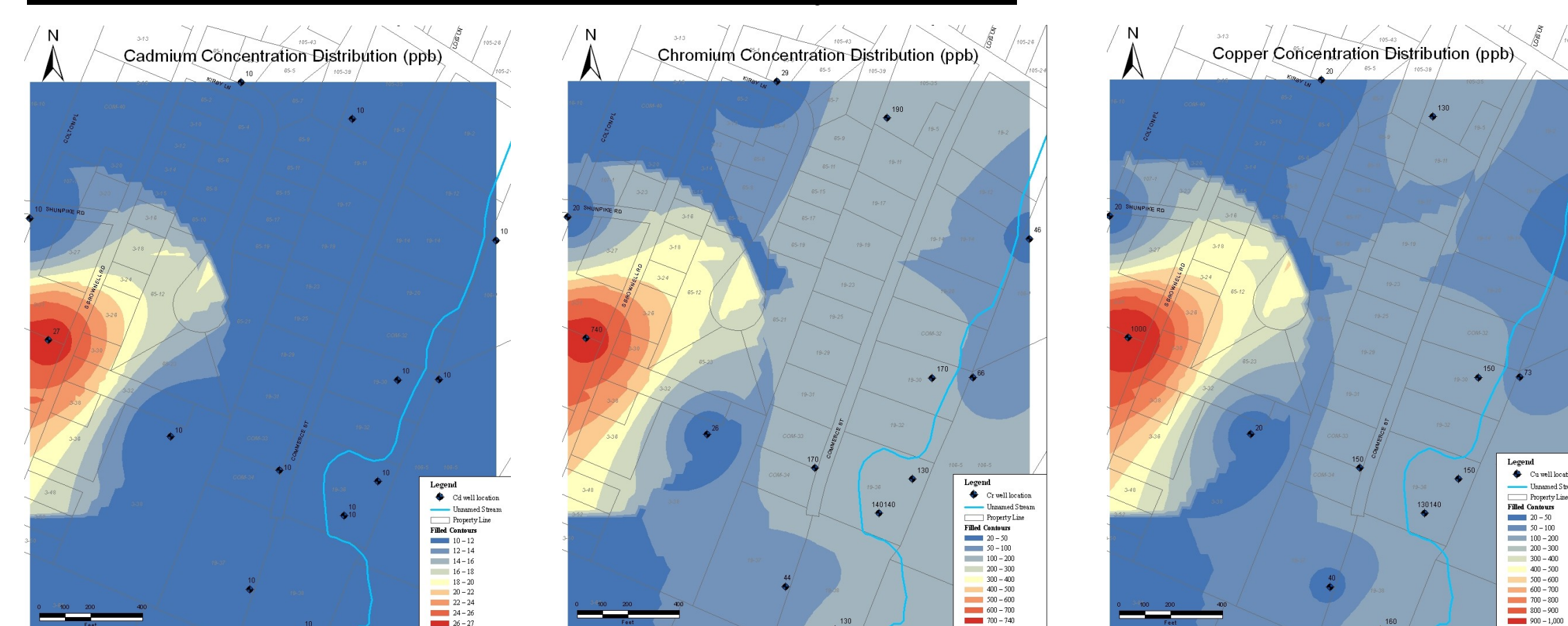### Concentration Distribution of Chlorinate Solvents:
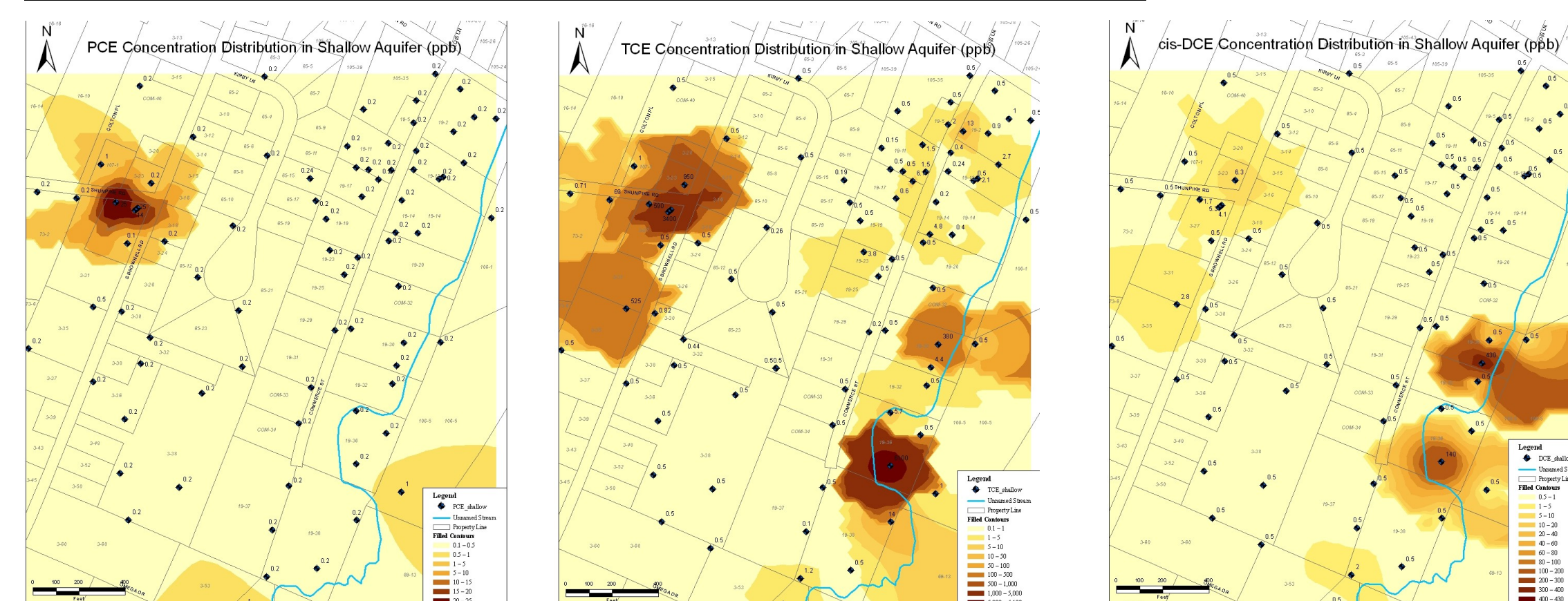
▲ These three figures show the PCE, TCE and DCE concentration distributions in shallow aquifer. As can be seen, the source of PCE is mainly located near Shunpike Road and S Brownell road, which is a residential area. The source location of TCE and DCE is near the brook.
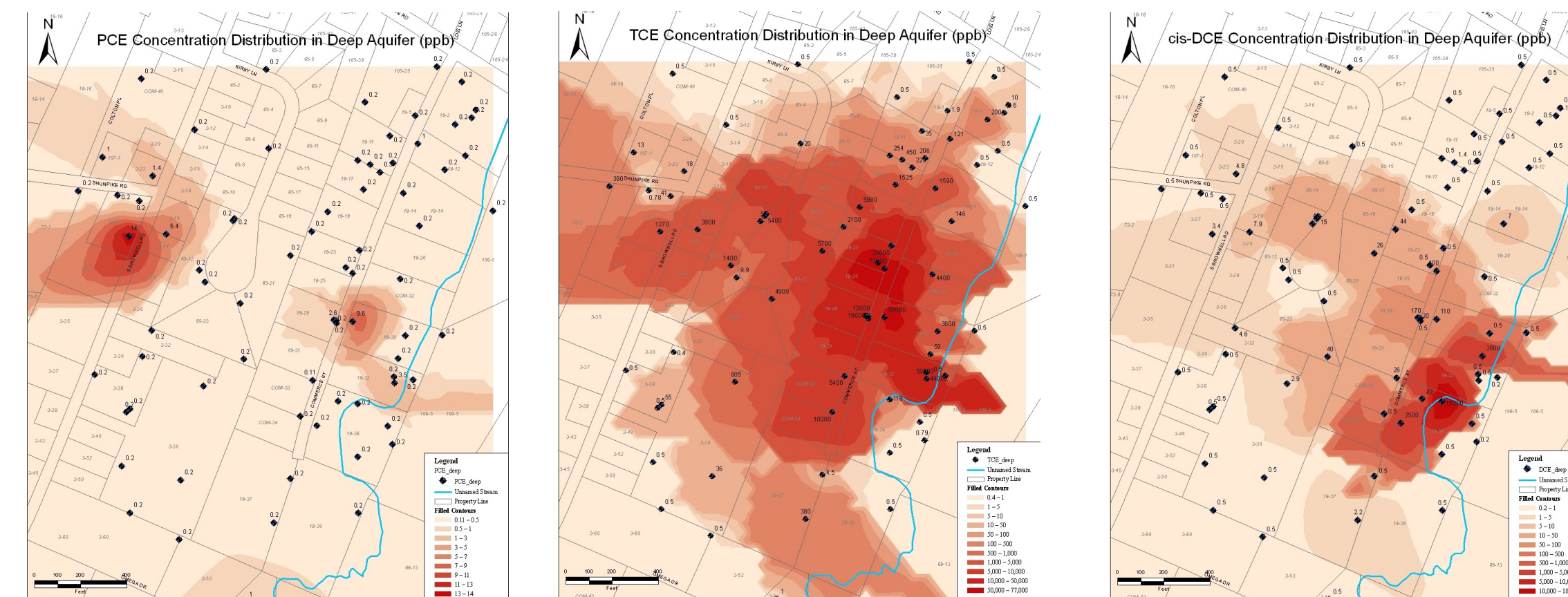
▲ These three figures show the PCE, TCE and DCE concentration distributions in deep aquifer. As can be seen, the source locations of the contaminants are consistent with the shallow aquifer. However ,the concentrations values of each contaminants are much larger than the values in shallow aquifer, which represent the vertical movement of chlorinated solvents.

### Concentration Distribution of Heavy Metals:

These five figures list concentration distributions of heavy metals of chromium, cadmium, nickel, copper, and aluminum, respectively.

As can be seen, the source location of heavy metals is mainly at the southwest corner in this site, which is also a residential area. The plumes also follow the groundwater flow.

Risk Analysis
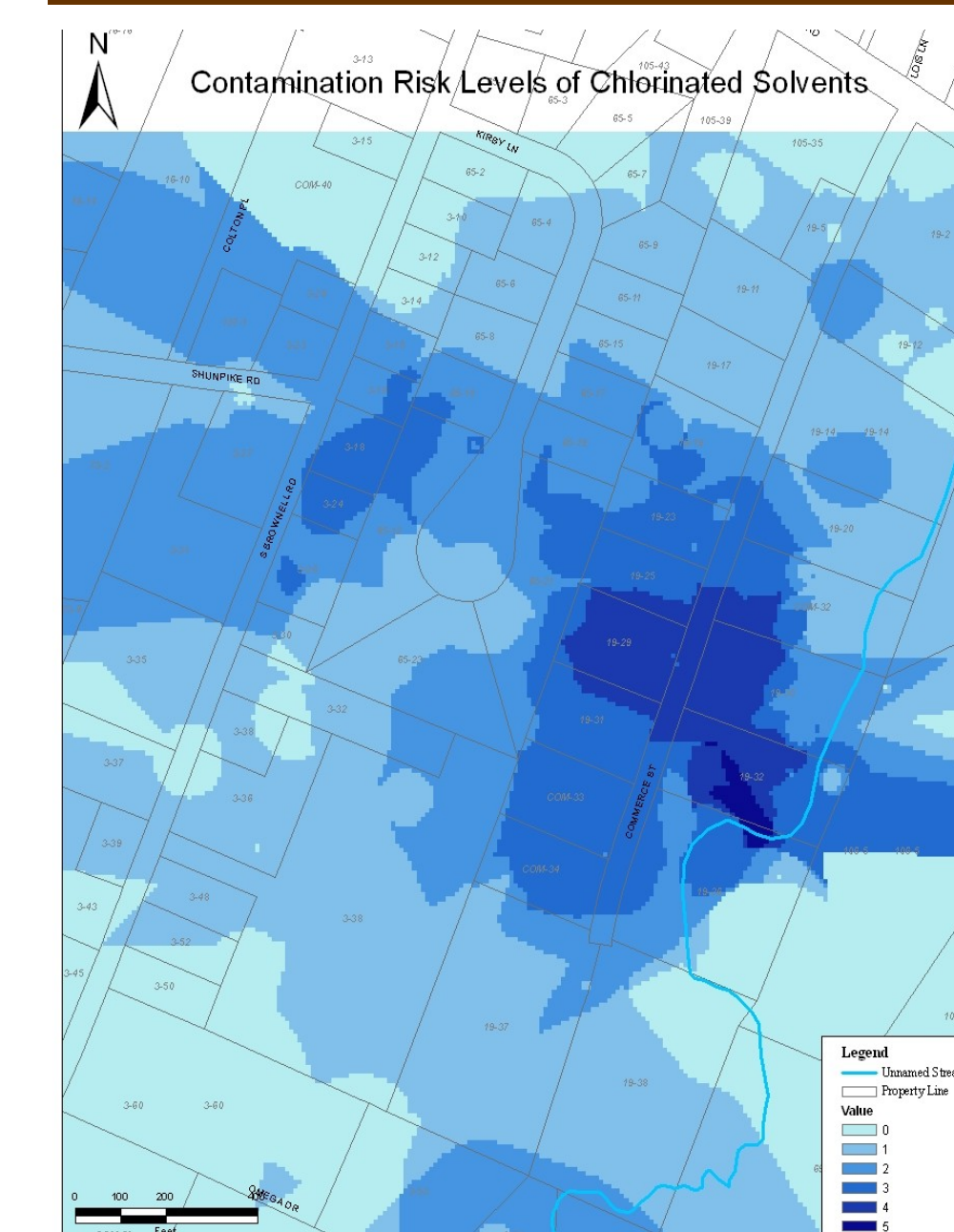
◄ The hazard index levels, which represent the risks of contamination by chlorinated solvents. This is obtained by adding the concentrations of PCE, TCE, and DCE according to their concentration categories. As can be seen, the region with high risk of chlorinated solvents contaminants is mainly at the southeast corner of this site, especially the property with the code of 19-32, which is an industry area.
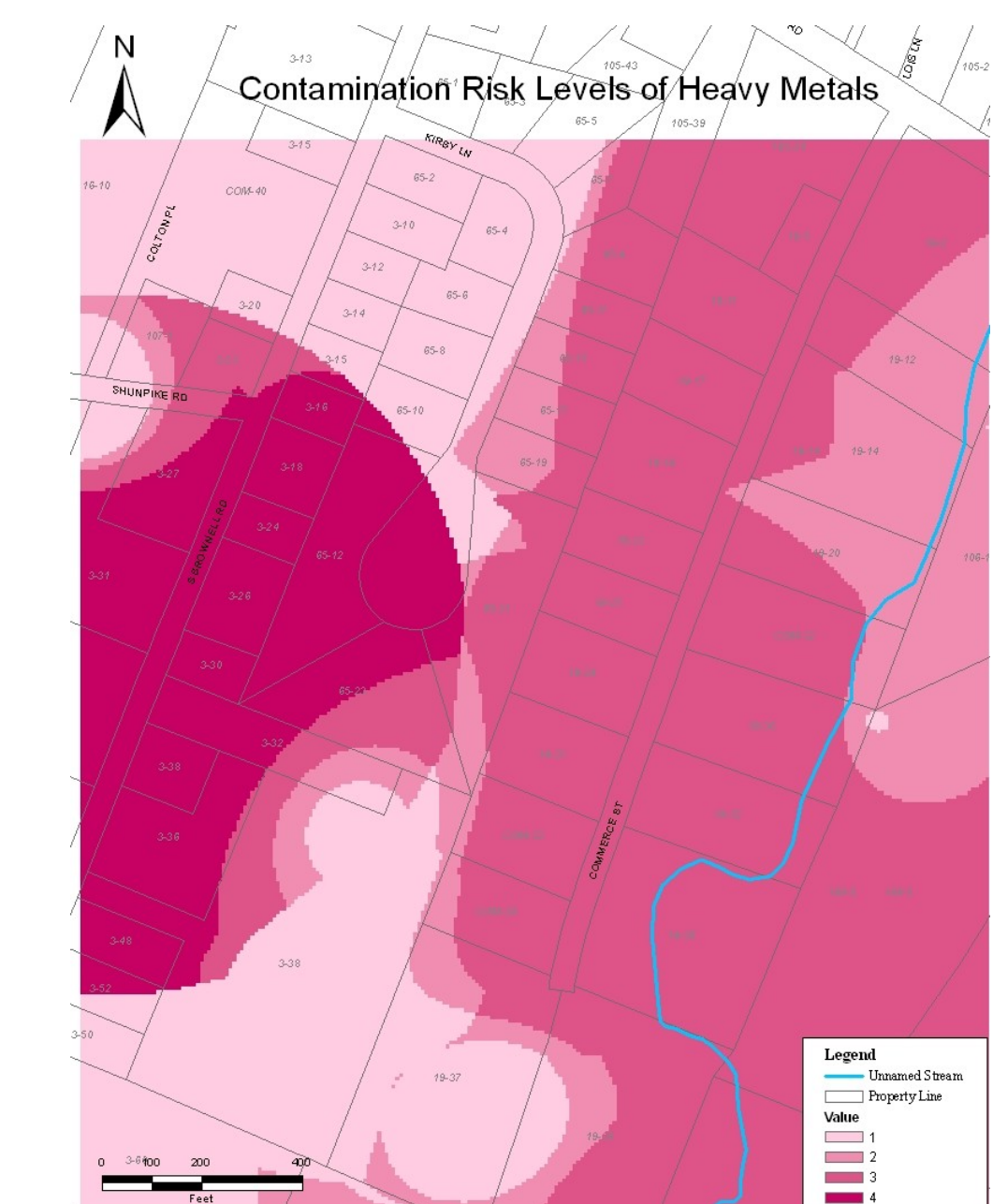
► This figure shows the hazard index levels of contamination considering heavy metals mentioned before. Here, the concentration levels of Cd are all above EPA limit, so the hazard index for Cd in the whole site is 1. However, the concentrations of Cu are below EPA limit, so the hazard index for Cu is 0. As can be seen, the highest risk of heavy metals contamination is at the southwest corner of the site, which means there are at least two sources to cause the contamination, which is different from the source of chlorinated solvents.

Conclusions

1. With the interpolation method, the spatial distributions of different kinds of contaminants can be obtained.

2. Through the analysis of spatial distributions of chlorinated solvents, the source location of PCE is different from the source location of TCE and cis-DCE. In addition, the secondary contaminated region of TCE and cis-DCE is the result of the dechlorination of PCE into TCE and cis-DCE.

3. The spatial distribution of heavy metals reveal that the source location of heavy metals is at the southwest corner of this site, which is also a different source from the sources of chlorinated solvents.

4. With the raster calculation and map overlay, we can determine the risk levels of different kinds of contaminations. Especially, if the region of high risk of contamination is residential area, some remediation methods should be done to decrease the concentrations of contaminants.

Coordinate System: NAD_1983_StatePlane_Vermont _FIPS_4400_Feet

Data Source:

Vermont Center for Geographic Information website;

Nobis Engineering, Inc.