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NRMRL
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

Source Control by Hydrogeological Isolation: Application of the Ankeny Moat

Introduction to the Problem

Complete source removal of petroleum spills is virtually impossible; petroleum residuals, such as BTEX (benzene, toluene, ethylbenzene, and xylenes), may contaminate ground water. One possible solution is to isolate the petroleum residuals with a drainage system that surrounds the source zone in order to control the flow of ground water around the source and protect the water's purity.

Background

A diesel spill at a gas station has been releasing BTEX into the ground water for a number of years. The site has a shallow, perched aquifer separated from a deeper aquifer by a clay layer. The ground water flows from the northwest through the site toward a creek a half-mile away.

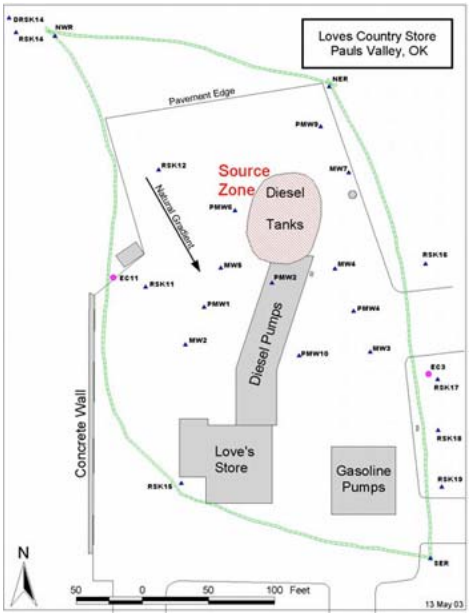

Figure 1: Site Map

Objectives

- Characterize the site hydrology and soil composition
- Design a moat and a drainage system of interconnected French drains to reduce the water flow through the source zone by completely surrounding the source zone
- Monitor and assess the resulting change in the hydraulic gradient and geochemical properties of the site after the moat is installed

Approach

- Use hydraulic conductivity and electrical conductivity tests to characterize the soil profile of the site.
- Measure water levels to determine the hydraulic gradient and direction through the site.
- Use the site data and surface traffic patterns to design the depths, high hydraulic conductivity regions, and locations of a series of interconnected French drains (Figure 1). Each drain line will be made of porous polyethylene pipe with an average pore size of 40 microns
- Use lateral drilling to install the lines without having to dig a trench and disrupt the normal functions of the station. A pilot hole will be drilled and the drain, which is encased inside a reusable outer sheath, will be pulled back through the hole. The drain will then be anchored, while the sheath is pulled out of the ground. Intersecting drain lines will be connected in pits dug where the drains overlap. Risers were installed at the three connection points to allow for measurement of constituents within the different sections of the moat. These measurements will allow establishment of hydraulic connectivity within the moat. Water levels and site geochemistry will be measured regularly to determine the effect of the moat and the connected series of drain lines on the hydraulic gradient of the site to verify that the ground water flow through the source zone is reduced.

- Determine whether the moat is delivering nutrients to the downgradient side of the moat to assist in the natural attenuation of the BTEX

Accomplishments (February 2003)

- Completed the characterization of the site using hydraulic conductivity and electrical conductivity measurements
- Designed the moat to be placed around the spill source zone, and diesel tank and gasoline tank pits
- Installed the moat at the bottom of the perched aquifer (approximately 8 feet deep)
- Conducted water level monitoring, and geochemical and BTEX measurements for a year since installation. The water levels in the three risers (northwest riser, northeast riser, and southeast riser) stabilized to the same level when rain raised the water table (Figure 2). The ground water flow through the source zone has been reduced by approximately 50 percent, as seen by the reduction in the hydraulic gradient across the site (Figure 3). The electron balance shows that there are more electron acceptors (6.64 milliequivalent per liter [meq/L] in the southeast riser) than electron donors (3.23 meq/L, BTEX, methane, and total organic carbon) due to the moat bringing sulfate from upgradient of the source. The situation immediately downgradient of the source in MW3 is reversed, with 0.23 meq/L of electron acceptors and 1.35 meq/L of electron donors.

Near- Future Tasks

- Continued periodic monitoring of the water levels and sampling for the geochemical parameters and BTEX contaminants in the wells

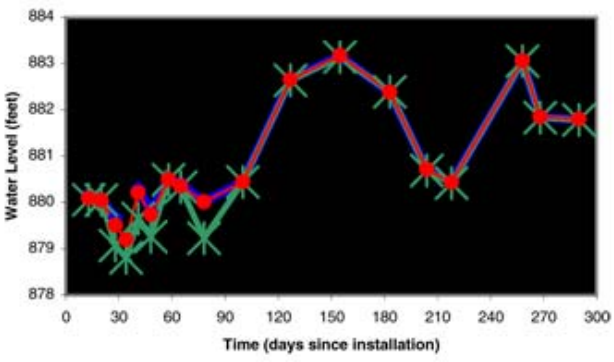

Figure 2: Riser Water Levels. blue – NWR, green – NER, and red – SER.

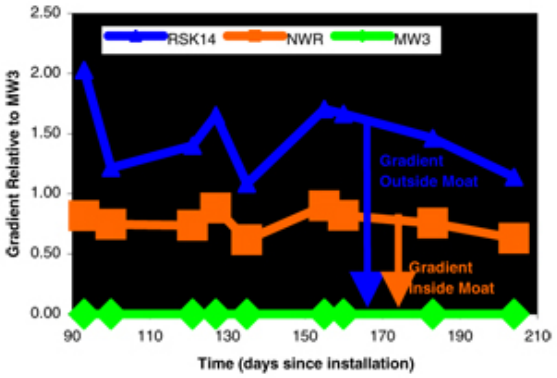

Figure 3

Investigators

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