INNOVATIVE STRATEGIES FOR DNAPL CONTAINMENT AND DEGRADATION GAINESVILLE, FLORIDA

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ABSTRACT

For this former wood treating facility, simple demonstrated containment technologies were applied in combination with innovative engineering to develop a cost-effective remediation system for migration control and degradation of dense non-aqueous-phase liquid (DNAPL) in ground water.

Multiple DNAPL plumes totaling 7 acres in size occur in shallow terrace deposits in several areas of the site. A conventional pump-and-treat containment system is currently in use at the site. A long-term system was designed to take advantage of the natural vertical containment provided by a shallow clay layer and the natural attenuation capacity within the terrace deposits. Iterative 3-dimensional migration modeling was performed to design several U-shaped "biotreatment containment walls" (BTCWs). Each of the BTCWs is designed to be a slurry wall extending from the surface to the clay layer. The walls are configured to prevent migration of DNAPL while allowing ground water "flushing" within the containment areas. The iterative modeling resulted in a flow that will result in a low flux of compounds of concern out of the containment area that will be mitigated through natural attenuation. This system is planned for installation in 2002. Cost savings compared to the existing pump-and-treat system will be approximately $3.6 million (present worth) over 30 years.

BACKGROUND

The site consists of approximately 90 acres within the city limits of Gainesville, Florida. Wood treatment activities had occurred on the site since the early 1900s. The DNAPL that occurs at the site is primarily creosote from wood treatment activities. The creosote DNAPL in shallow soil and groundwater was resulting in plumes of dissolved constituents of concern (COC) that were migrating offsite until a conventional pump-and-treat containment system was installed. The conventional pump-and-treat containment system encompasses approximately 3,200 feet of site perimeter, with an average well spacing of approximately 250 feet. The existing pump and treat containment system can effectively contain COC and prevent offsite migration, but the effectiveness of the system is reliant on long-term operations and maintenance and is not cost effective. Based on the quantity of DNAPL estimated to be present at the site, the conventional pump-and-treat containment system would have to be maintained indefinitely. A more effective strategy was needed that would eliminate the need for long-term operations and maintenance activities, thereby increasing long-term reliability of the system and reducing long-term costs. In response to this need, a system was designed to take advantage of the natural vertical containment provided by the clay layer and the natural attenuation capacity within the saturated portion of the terrace deposits.

DESIGN

The site is located in an area of relatively low topographic relief where the shallow subsurface consists of an approximately 20 to 30 foot thick sandy layer of terrace deposits overlying a thick laterally continuous dense clay. Ground water occurs in the terrace deposits at depths ranging from about three to 15 feet below the ground surface. The terrace deposits consist of fine to medium grained sand with trace amounts of silt and clay. The terrace deposits are permeable and the average groundwater migration rate beneath the site is estimated to be approximately 125 feet per year. Multiple creosote DNAPL plumes cumulatively totaling approximately 7 acres in size occur in the terrace deposits in three general areas of the site. The clay beneath the terrace deposits is approximately 40 feet thick with permeabilities on the order of 10^{-6} to 10^{-8} centimeters per second (cm/sec), providing an effective barrier to downward migration.

Iterative 3-dimensional ground water migration modeling was performed to design several U-shaped "biotreatment containment walls"(BTCWs), one each around the individual DNAPL-impacted areas of the site and totaling approximately 5,000 linear feet. Each of the BTCWs are founded in the clay layer. The walls are configured to prevent migration of DNAPL while allowing ground water "flushing" within the containment areas. Groundwater flow into the containment area provides oxygen and nutrients to enhance biodegradation. Groundwater flow out of the containment areas prevents ground water mounding that could otherwise cause surface seeps, and also carries dissolved COC out of the containment area. The iterative modeling was used to determine a flow configuration that will result in a flux of COC out of the containment area that is low enough to be mitigated through natural attenuation prior to reaching the downgradient property line.

Modeling was performed using a particle tracking methodology to iteratively redesign the alignment of the BTCWs until a configuration was developed that adequately contained naphthalene dissolving from the DNAPL. Evaluations indicate that naphthalene controls the design. Other constituents are less mobile or of limited enough distribution so as to be within the limits of naphthalene migration.

For this site, the BTCWs will be bentonite slurry walls constructed using conventional trench-and-slurry-backfill methodology. The walls will be located to avoid existing operational facilities at the site. The walls will be molded around existing underground lines that are not practical to move. A structural surfacing will be provided over the BTCWs at road crossings. The site will continue to operate during construction of the BTCW, with construction phasing and traffic management to minimize disruption to operations.

The presence of the continuous dense clay layer at shallow depth below the site results in a high probability of effective containment. The BTCW will function more effectively than a conventional continuous subsurface barrier because:

- The BTCW is designed for continued and enhanced natural degradation. Conventional barrier wall systems contain high concentrations of constituents which may only slowly degrade anaerobically within the containment area. The BTCWs allow some of the impacted water to migrate into cleaner, more oxygenated ground water outside the wall, enhancing the rate of degradation.

- The BTCW does not require active pumping that is needed to control the hydraulic head within a continuous barrier wall system. Instead of having a head buildup within the containment area, the BTCWs are designed with openings that prevent groundwater from mounding enough to daylight at the surface. A BTCW system requires no ongoing operations and maintenance, other than monitoring to confirm that is it performing as designed.

CONSTRUCTION SCHEDULE AND COST SAVINGS

This BTCW system is planned for installation at the Gainesville site in 2002. It is expected that long-term cost savings compared to the existing pump-and-treat system will be approximately $3.6 million (present worth) in the first 30 years.

The biotreatment containment wall remediation system designed for this site will provide a long-term solution that will be reliable without routine maintenance, and at a significantly reduced cost compared to the existing system. It relies on known technology and basic principles of groundwater flow to contain COC, while allowing and enhancing biodegradation within the containment area.