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"Sodium Persulfate and Hydrogen Peroxide Injections Achieve Ground-Water Cleanup"

The California Regional Water Quality Control Board (RWQCB), Los Angeles Region, oversees remediation of a 2.8-acre area known as the "Former Sta-Lube" site in Rancho Dominquez, CA. Cleanup technologies employed at this site since 1997 include SVE, P&T, and soil excavation with offsite disposal. In 2005, another excavation and addition of in-situ chemical oxidation (ISCO) quickly addressed a previously unknown DNAPL zone serving as a continued source of dissolved contamination.

Industrial activities at the site from 1968 until 1986 included the manufacture of paint, varnish remover, fuel additives, degreasers, and petroleum-based lubricants. Site investigations indicated VOC-contaminated soil and ground water, with methylene chloride as the primary chemical of concern. Leakage of methylene chloride from a former UST resulted in a dissolved plume estimated at 200 feet long and 80 feet wide as of 1995. Ten years later, the plume had shrunk to 80 by 30 feet, most of which was located under the remaining building, which continues to operate for administrative purposes. The maximum concentration of methylene chloride detected in ground water was 3,000 mg/L.

The site is located within the Central Groundwater Basin, which is part of the Los Angeles Coastal Plain. Near-surface sediment comprises primarily fine-grained silt and clay to a depth of approximately 45 feet below ground surface (bgs). Ground water is encountered at approximately 40 feet bgs. The upper aquifer extends approximately 140 feet bgs, and is separated from a lower (450-700 feet bgs) aquifer by several clay-lens aquitards. The aquitards limit vertical migration of contaminants to the lower aquifer, a high-quality drinking water source.

A P&T system operated from 1997 until 2003 to treat the dissolved-phase ground-water plume. From early 2000 until late 2001, an SVE system supplemented with hot-air injections treated vadose-zone soil. Concentrations of methylene chloride in pumping wells had decreased to below 100 µg/L, and both soil and ground water nearly attained closure from the RWQCB. However, concentrations rebounded significantly, suggesting DNAPL presence. Hence, operation of each system was suspended.

Results of a membrane interface probe survey indicated that methylene chloride DNAPL was trapped in sandy stringers in a clay zone located 40-48 feet below the building. To

remove DNAPL, the area was excavated in 2003 to a depth of 48 feet using large-diameter augers. More than 266 yd^3 were excavated and disposed offsite.

The Los Angeles RWQCB's efforts to accelerate dissolved-phase cleanup were initiated in 2005 after soil excavation/disposal and six years of SVE and P&T operations. The primary cleanup goal set at that time was attainment of methylene chloride concentrations below 50 µg/L in ground water. Based on the results of a more detailed site investigation identifying additional DNAPL directly below the facility's building, ISCO was selected as a remedy enhancement.

A total of 23 ISCO injection wells were installed at the site, of which 16 were placed inside the building and 7 outside the building, each with an estimated 8- to 12-foot radius of influence. Approximately 7,700 gallons of 22% sodium persulfate solution were injected over six days in mid 2005, followed by injection of 12,044 gallons of 17.5% hydrogen peroxide over 14 days to activate the persulfate. Downhole thermocouples monitored subsurface temperature to ensure a temperature of 120-160°F for optimum generation of hydroxyl radicals with minimal decomposition of the hydrogen peroxide. Logistical challenges include using angled wells to minimize disruption of business operations and operating the wells safely within the building. Injection flows were optimized to control the reactions and to minimize the potential for treated ground water and vapor to migrate to the ground surface through existing soil crevices. An additional 16 injection wells surrounding the 23 chemical injection wells were used for hydraulic control by injecting (dripping) tap water to prevent outward migration of the injected chemicals. Two vapor control/extraction wells were also installed and operated during the chemical oxidation to prevent vapor migration into the industrial/warehouse building.

ISCO application resulted in 94-97% reduction in methylene chloride concentrations within four months, and to concentrations below the 50 µg/L cleanup goal within five months (Figure 2). In particular, one well experienced a concentration decrease from 15,000 to 18 µg/L. Most recent results of quarterly monitoring indicate that methylene chloride concentrations are below 33 µg/L. Accordingly, the Los Angeles RWQCB has initiated closure of the Former Sta-Lube site.

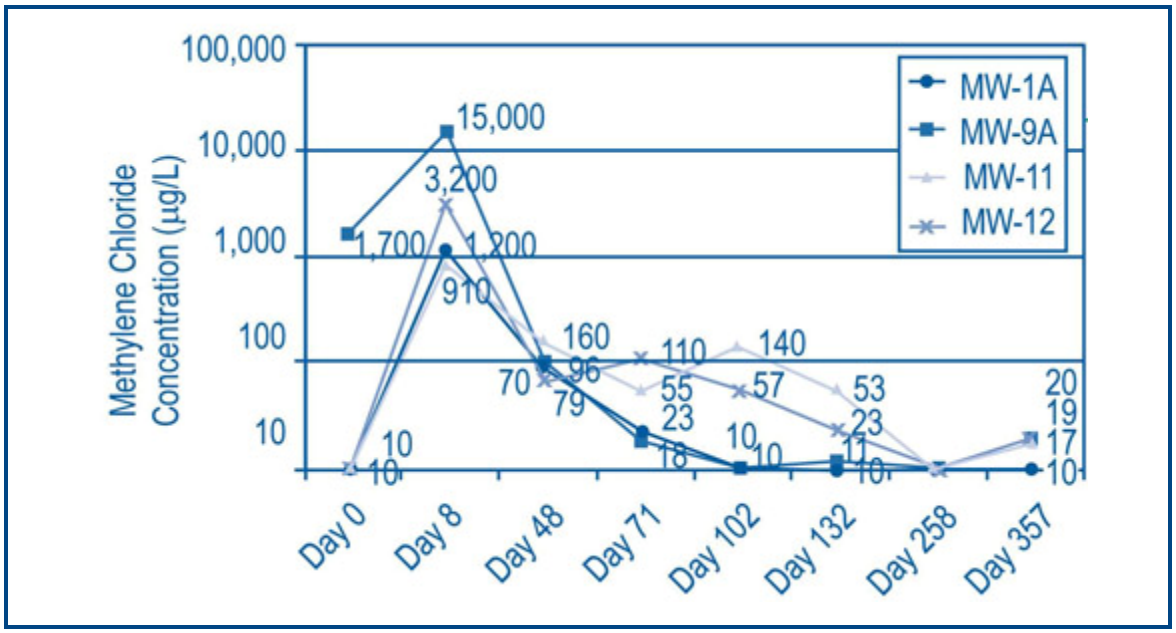

Figure 2. Although three of the four ISCO monitoring wells showed slight rebound at different times (likely due to back diffusion from clay), methylene chloride concentrations in all four wells remained steadily below 50 mg/L one year after the injections.

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