Former Sta-Lube Site

Soil Vapor Extraction—Pump and Treat—Excavation—In Situ Chemical Oxidation

Site Name: Former Sta-Lube Site
Site Location: Rancho Dominguez, California
Technology Used:

- Soil Vapor Extraction (SVE)
- Pump and Treat (P&T)
- Large-Diameter Auger Excavation with Offsite Disposal
- In Situ Chemical Oxidation (ISCO) (Using Catalyzed Hydrogen Peroxide to Activate Sodium Persulfate)

Regulatory Program: California Regional Water Quality Control Board (RWQCB), Los Angeles Region
Project Duration: June 2005 to December 2008 when monitoring was discontinued and monitoring wells were abandoned.

Site Information: The site encompasses 2.8 acres. From 1968-1986, Sta-Lube, Inc. manufactured paint, varnish remover, and fuel additives and blended and packaged hand cleaners, greases, and petroleum-based lubricants.

Contaminants: Past industrial activities at the site used a variety of chemicals, including petroleum hydrocarbon derivatives and solvents such as methylene chloride. Site investigations indicated that soil and groundwater were contaminated with volatile organic compounds, and methylene chloride was the main contaminant of concern. A past release of methylene chloride from a leaking underground storage tank (UST) caused extensive contamination. In 1995, the size of the dissolved plume measured 200 ft long by 80 ft wide. By 2005, the size of the plume had been reduced to 80 ft long by 30 ft wide, most of which was under the building. The highest concentration of methylene chloride detected in the groundwater was 2,600 mg/L.

A membrane interface probe (MIP) survey later indicated that methylene chloride dense non-aqueous phase liquids (DNAPL) were trapped in sandy stringers within the clayey soil underlying the building.

Hydrogeology: Fine-grained sediments (silts and clays) are found beneath the Sta-Lube site to a depth of approximately 45 ft below ground surface (bgs). The depth to the water table is approximately 40 ft bgs. Using a MIP, an 8-ft thick clay zone with thin sand stringers (4 to 8 inches) was delineated between 40 to 48 ft bgs, while coarse sand is found from 48 ft to over 130 ft bgs.

The groundwater beneath the Sta-Lube site correlates regionally with the Gaspur Aquifer. The bottom of the Gaspur Aquifer is approximately 140 ft beneath the Sta-Lube site. Beneath this aquifer, several clay-lens aquitards limit vertical migration of the contaminant to the Silverado and Sunnyside Aquifers, which are at depths of approximately 450 to 700 ft bgs. These deeper aquifers are considered high-quality drinking water aquifers.

The California Water Company has indicated that the closest active drinking water well is located 1,750 ft to the southwest of the Sta-Lube site. The well screen is set at 301 to 650 ft bgs and penetrates the Silverado and Sunnyside Aquifers. The groundwater flow direction in the upper saturated zone is towards the southwest placing the well downgradient of the site. However, the Sta-Lube plume is located at 40 to 60 ft bgs, which is the upper 20 ft of the saturated zone beneath the site.

Project Goals: After six years of SVE, P&T, and a large-diameter auger excavation, the overall goal of implementing ISCO was to quickly attain closure of the site from the Los Angeles RWQCB. The cleanup goal was to attain concentrations less than 50 µg/L of methylene chloride in groundwater (MCL=5 µg/L).

Cleanup Approach: Starting in 1997, a P&T system was operated at the Sta-Lube site to treat the dissolved-phase plume. The P&T system operated until 2003. An SVE system supplemented with hot air injection was operated at the site from May 2000 until October 2001. Concentrations of methylene chloride from the pumping

wells were below 100 µg/L in groundwater, and the soil and groundwater were close to attaining closure from the Los Angeles RWQCB. However, when the systems were turned off, the concentrations of methylene chloride rebounded significantly, suggesting the presence of DNAPL.

A supplemental site investigation conducted using a MIP for high resolution characterization revealed DNAPL source zones in sandy stringers trapped within clayey zones at depths of 40 to 48 ft. To remove the DNAPL, these source zones were excavated to a depth of 48 ft using large-diameter augers. The 266 yd^3 of contaminated soil was staged and disposed of offsite. Despite these efforts, groundwater contamination levels still remained high (Table 1). Further investigation revealed methylene chloride had migrated into the clayey soil beneath the building and was slowly seeping out and contaminating the groundwater.

Table 1. Groundwater Contaminant Concentrations Measured June 14, 2004

Contaminant	Concentration Range (µg/L)
Acetone	ND – 220
Benzene	ND - 6.7
Toluene	ND - 34
Bromochloromethane	ND - 110
1,1-DCA	ND - 27
1,1-DCE	ND - 89
trans-1,2-DCE	ND - 73
Bromoform	ND - 16
Dibromochloromethane	ND - 11
Chloroform	ND - 88
Methylene Chloride	ND – 18,000
1,1,2,2-TCA	ND - 25

ND = non-detect

On December 15, 2004, the Los Angeles RWQCB approved ISCO using catalyzed hydrogen peroxide activation of sodium persulfate (Klozür®) for groundwater remediation.

Activated sodium persulfate is a strong oxidant that creates sulfate radicals, which are effective in treating dissolved recalcitrant contaminants. The catalyzed hydrogen peroxide (a Fenton's type reaction) attacks contaminants directly with the hydroxyl radicals that are produced. The Fenton's reaction is a highly exothermic reaction that helps strip the sorbed contaminants from the soil and convert them to the dissolved phase.

A total of 23 application wells were installed at the site, with an estimated radius of influence of 8 to 12 ft. Sixteen wells were installed inside and seven were installed outside the building (Figure 1). The target groundwater remediation zone was 40 to 48 ft below grade surface.

Figure 1. ISCO Application Wells

Courtesy JAG Consulting Group

Approximately 7,700 gallons of 22% sodium persulfate solution were injected over the course of six days. This was followed by an injection of 12,044 gallons of 17.5% hydrogen peroxide for 14 days to activate the persulfate. Downhole thermocouples monitored the temperature underground to ensure a temperature of 120-160°F for optimum generation of hydroxyl radicals with minimal decomposition of the hydrogen peroxide.

Logistical challenges included the use of angled wells to minimize disruption of business operations in the building and safely performing injections inside an active facility. The reaction of catalyzed peroxide produces hydroxyl radicals, heat, and oxygen which tend to force treated groundwater and vapor up to the ground surface via conduits (e.g., soil crevices, abandoned borings, utility lines, etc.). Therefore, the flow of the injectants had to be optimized to control the reaction.

Project Results: Monitoring results indicated that ISCO reduced methylene chloride levels by 94% to 97% within four months following treatment and below the 50 µg/L cleanup goal within five months (Figure 2). The most significant reduction observed was a decrease from 15,000 to 18 µg/L in one well. Quarterly monitoring indicated groundwater concentrations of methylene chloride below 20 µg/L and the Los Angeles RWQCB issued a no further action letter on December 30, 2008. Monitoring was subsequently discontinued and the monitoring wells were abandoned.

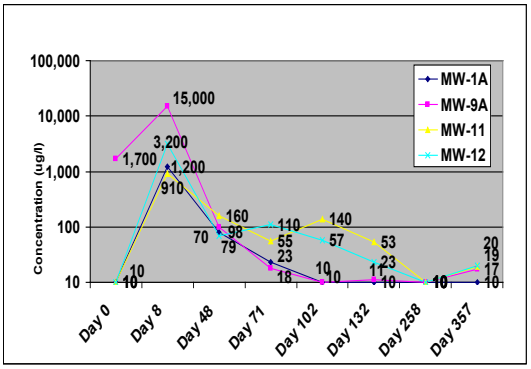

Figure 2. Methylene Chloride Concentrations in Groundwater During ISCO

Courtesy JAG Consulting Group

Sources:
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Cronk, Gary. 2006. Optimization of a chemical oxidation treatment train process for groundwater remediation" Presentation at the Battelle 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds. May 25, 2006. Monterey, CA. http://jagconsultinggroup.com/uploads/Full_Paper_-_Cronk_Battelle_2006.pdf

California Regional Water Quality Control Board, Los Angeles Region. Letter from Executive Officer, Jonathan S. Bishop, to Judi Proetel of Sta-Lube, Inc.

FMC Environmental Solutions. Klozur™ Resource Center. Project Description In-Situ Chemical Oxidation, Activated Persulfate Treatment of Methylene Chloride Chemical Plant in Los Angeles, CA. http://www.envsolutions.fmc.com/Portals/fao/Content/Docs/Remediation%20of%20Methylene%20Chloride%20Plume%20Using%20H2O2%20Catalyzed%20Persulfate_MECX.pdf

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