C3 Case Study:

Chlorinated Solvents: Methylene Chloride and TCE

Long Beach, California

Site History

Industrial operations were conducted on this property since early 1940's and included operations of manufacturing, testing and repair. Environmental activities included chemical storage and mixing and fuel storage and testing in support of manufacturing operations. Operations were discontinued in 2002 and demolition activities began in 2005. Numerous environmental site assessments and remediation have been conducted at the subject remediation site since mid 1980s. Remedial activities within the project treatment area pertaining to this study included solvent and jet fuel underground storage tank removal, jet fuel and solvent impacted soil excavation and free product removal.

Project Overview

Location:
Long Beach, CA

Duration:
700 days

Contaminants:
Methylene Chloride, Acetone, Isopropanol & TCE

Process Flow:
400 scfm

Removal Efficiency:
>99% for all COCs

VOC Mass Recovered:
Approximately 92,000 lbs

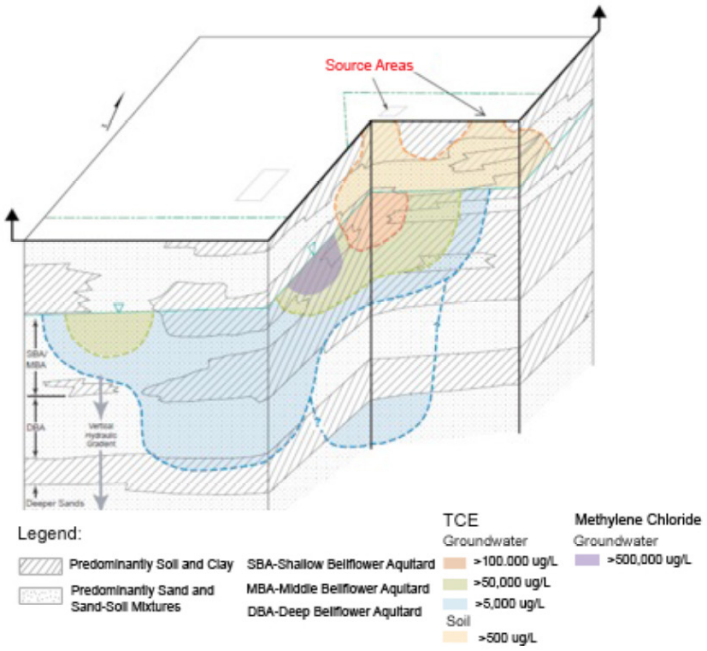

Figure 1. Conceptual Site Model illustrating the geology and contaminant distribution

Site Geology

The geology and hydrogeology of the site can be summarized as intercalated sands and silty sands separated by competent silt and clay horizons. The geological formations present beneath the site are illustrated in Figure 1 Conceptual Site Model. Groundwater is present at the site at approximately 35 feet below ground surface (ft bgs). MeCL and TCE impacts to soil and groundwater beneath the site through the heterogeneous geology and Bellflower Aquitard.

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Project Description

Phase I began with refrigerated condensation (C3) in order to achieve high mass removal rates to reduce lifecycle costs and time of remediation. The first two years (Phase I) resulted in recovery of over 92,000 pounds of mixed chlorinated solvents in the form of NAPL. The VOC constituents consisted primarily of MeCl, TCE, acetone, and isopropanol.

Phase II involved the installation of additional SVE wells in the source area and surrounding low-concentration VOC areas, and implementation of a dual-phase extraction system to treat source area groundwater. The vapors from both the vacuum extraction as well as the groundwater air stripping system from the source were treated using a thermal oxidation system. The vapors from the SVE wells in the surrounding low concentration VOC areas were treated using GAC. A thermal oxidation system was selected in Phase II instead of a GAC system due to the presence of MeCl in the source area, which is not effectively absorbed by GAC. Phase II was used to manage long term venting.

Phase III involved using a GAC system to manage diffusion limited asymptotic removal rates.

This case study review demonstrates the benefits of a phased approach, scalability in sizing systems, provides insight into off-gas treatment selection criteria for high concentration VOC or NAPL sites, and presents some available metrics and approaches for consideration of sustainability.

Vapor Treatment System

The vapor extraction was initially accomplished using existing SVE wells installed at approximately 50-foot intervals and located within the estimated confines of source area. Each well was dual-nested, with two shallow screened intervals between 10- to 20-feet bgs and 25- to 35-feet bgs respectively. The extraction system was subsequently expanded after 9 months of operation to add seven new dual-nested SVE wells and to expand the capabilities of the system.

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Vapor Treatment

The vapor treatment system consisted of the following:

- Two SVE treatment units, each consisting of two skid-mounted extraction/compression units. Each SVE treatment unit was capable of producing a maximum airflow rate of 200 scfm for a combined treatment capacity of 400 scfm.
- Two refrigeration condensation (C3) mobile units, with regenerated absorbers.
- A 2,000-gallon double-walled aboveground storage tank for storing accumulated VOC condensate.
- Two 2,000-pound Granular Activated Carbon (GAC) adsorption vessels operated in a lead-lag (series to meet the air quality permit requirements.
- One 2,000-pound permanganate-impregnated zeolite media vessel to remove traces of vinyl chloride, if present, in the effluent from the C3 systems.

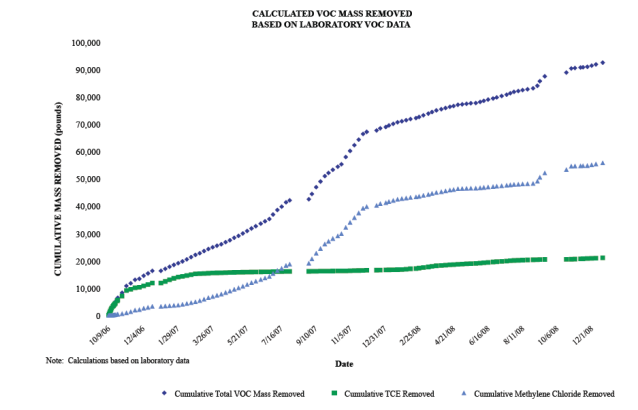

Figure 2. Cumulative mass removed for total VOCs, TCE, and MeCl based on laboratory analytical data

Performance Evaluation

Phase I operation of the GEO system resulted in near 100% removal efficiency for VOCs, including TCE and MeCl. The GEO system removed approximately 92,000 pounds of VOCs (including 21,000 pounds of TCE and 56,000 pounds of MeCl). These quantities were calculated by averaging influent vapor concentrations collected from monthly sampling and assuming that these average concentrations were constant between the two sampling events. The calculation for VOC mass removed is equivalent to approximately 1,800 gallons of TCE and 5,100 gallons of MeCl. Removal efficiency and VOC mass removal by the SVE system were calculated for total VOCs, TCE, and MeCl, using laboratory analytical data and system flow rate measurements.

Figure 2 illustrates the total mass removed over time based on laboratory data. The total condensate removed, condensed water and VOCs extracted from soil vapors and transferred to the AST by the C3 G.E.O. units since start up was 16,763 gallons. The actual volume of removed condensate differs from the calculated VOC mass removal volume (6,900 gallons) primarily due to water that is also condensed by the C3 units adding to the total actual volume recovered in the condensate. The system ran for 16,881 hours (approximately 700 days). The SVE system was shut off on December 19, 2008, due to low influent VOC concentrations in preparation of Phase II.