Elimination of Potential Vapor Pathway and Remediation of VOCs at a 90-acre Residential Development Site in Oxnard, California

Summary

A 90 acre parcel, historically used as an oil field waste disposal facility, has been transformed into 300 residential units and a resource protection area for endangered plants. Volatile organic compounds (VOCs) including 1,2 dichloroethane (1,2-DCA), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) were historically discharged with the oil field waste materials and were present in soil and groundwater at concentrations that posed concerns for residential vapor intrusion and water quality protection. LFR, remedial engineer and contractor for the site, implemented remedial measures which included:

View from site

1. Excavation of three source areas,
2. Excavation of the upper saturated zone over the VOC groundwater plume, and
3. Backfilling the source areas and upper saturated zone with a reactive mixture of Daramend® Reagent and native sand.

In addition to limited pumping and treatment, long term mitigation of vapor pathway concerns were addressed by placing the Daramend-sand mixture (intended as a "reactive blanket" as termed by Charlie Robinson, P.E., project manager for LFR) over exposed areas containing concentrations of dissolved VOCs. VOCs migrating into the backfilled source areas or the reactive blanket will be degraded via *in situ* chemical reduction (ISCR) processes.

In addition, dissolved organic carbon and dissolved iron produced by the Daramend will stimulate the dechlorination of adjacent residual VOCs in groundwater over the next five to seven years. A less pervious soil was placed above the "reactive blanket" to perch groundwater and create an additional soil and hydraulic barrier to augment the "reactive barrier".

This redundant remedial strategy may eliminate the requirement for installation of vapor barriers on the future residential buildings.

Challenge

Soil and groundwater in three main areas were affected by numerous VOCs (Figure 1). The areas were named the 'left eye', 'right eye', and 'mouth' as can be visualized on the map. The VOCs present on site prior to soil excavation comprised chloroethenes, chloroethanes, and chloromethanes, including up to 1,330 mg/L 1,2-DCA, 215 mg/L cis-1,2-DCE, 5.7 mg/L VC, 6.6 mg/L trichloroethene (TCE), and 15.5 mg/L methylene chloride (DCM).

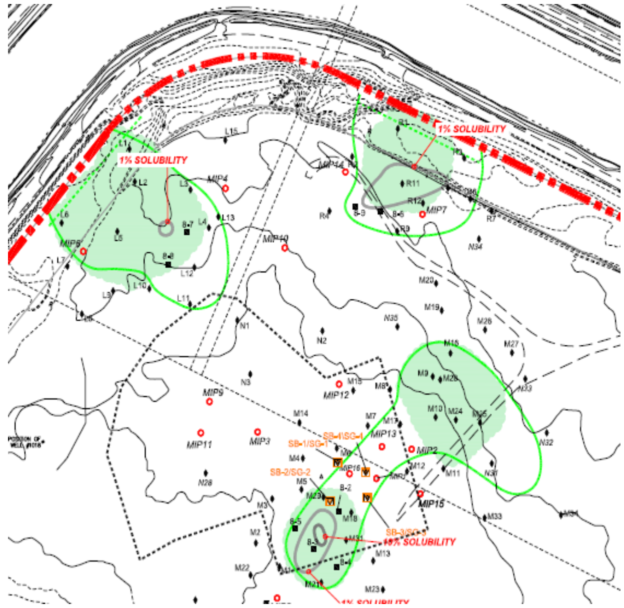

Figure 1. Areas requiring treatment.

Another significant electron acceptor present at the site was sulfate at concentrations as high as 2,690 mg/L. The site is bordered by a canal on one side, which connects to the Pacific Ocean. Mitigation of these soil and groundwater impacts as well as addressing vapor pathway concerns were required prior to the construction of residences.

Solution

Uncontaminated sand above the water table was removed. Daramend was blended into this sand at a rate of 0.8% by mass as this material was stockpiled. Each area requiring treatment was dewatered prior to excavation. The source areas were excavated to three feet below groundwater. The excavated affected soils were treated on-site using *ex situ* soil vapor extraction. Once the excavation was completed, the Daramend-sand mixture was loaded into dump trucks and transported to the excavation where a bulldozer provided final placement of the material. This reactive material was brought up to the natural groundwater elevation, above which a three-foot clayey soil layer was placed to collect infiltrating groundwater and re-establish a downward gradient.

Stockpile of Daramend - sand mixture

Loading Daramend-sand mixture from the stockpile

Backfilling excavation

Backfilling excavation

After backfill completion, the affected areas were pumped for approximately two months to collect two to three pore volumes of potentially affected groundwater for surface treatment and discharge.

Backfilled 'right eye'

Results

The results of a nine-year monitoring program indicated that concentrations of all the monitored chlorinated compounds were substantially reduced, see Figure 8. For example, vinyl chloride was reduced from 25 ppb to less than the detection limit of 0.5 ppb. The concentration of 1,2-DCA, one of the most recalcitrant chlorinated solvents, was also reduced from over 9 ppb to less than the 0.5 ppb detection limit. Total chlorinated VOCs were reduced from over 77 ppb to less than 2 ppb.

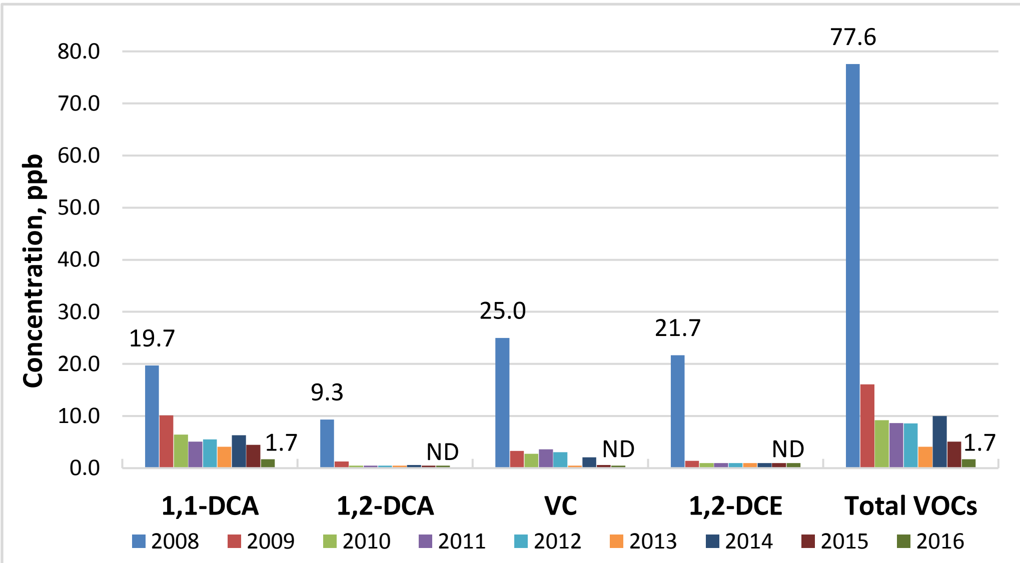

Figure 8. Nine year post-excavation data of chlorinated solvent removal

Conclusion

A multiple approach treatment process can be used for mitigating VOCs in soil and groundwater for construction projects. The approach used, combining excavation, on-site treatment, and *in situ* treatment using a low application of Daramend reagent, provided a novel approach for this site. The results indicate very good contaminant removal and long term performance at a reagent cost of only $13/ton of treated soil.