

## Former Aerospace Manufacturing Facility

### In Situ Thermal—In Situ Chemical Oxidation

**Site Name:** Former Aerospace Manufacturing Facility

**Site Location:** Connecticut

**Technology Used:**

- In Situ Thermal (Recirculated Hot Water)
- In Situ Chemical Oxidation (ISCO) (Sodium Persulfate)

**Regulatory Program:** State Voluntary

**Remediation Scale:** Full

**Project Duration:** November 2010 to present

**Site Information:** The site is a vacant industrial property. There are a number of hotspots on the site. This case history addresses releases from a former degreaser pit.

**Contaminants:** The principal contaminant in the source zone is 1,1,1-trichloroethane (TCA), which occurs as a dense non-aqueous phase liquid (DNAPL). The size of the source zone was estimated to be approximately 5 feet of saturated thickness and 1,000 square feet with visible DNAPL over approximately 337 square feet.

**Hydrogeology:** The site is underlain by up to 15 feet of sand and fill material, followed by a clayey silt layer. Groundwater occurs at approximately 10 feet below ground surface (bgs).

**Project Goals:** The remedial objective was to eliminate residual or DNAPL areas in the source zone as indicated by a reduction in the volatile organic chemical concentration to below 1% of the aqueous solubility of TCA, or less than 13.3 mg/L.

**Cleanup Approach:** TCA hydrolyzes to two stable end products: acetic acid and 1,1-dichloroethene (DCE). Hydrogen chloride is formed in the process. The ratio of acetic acid to DCE is dependent on pH and temperature, with production of DCE increasing directly with pH and temperature (Kollig et al. 1990). Temperature also affects the rate of hydrolysis.

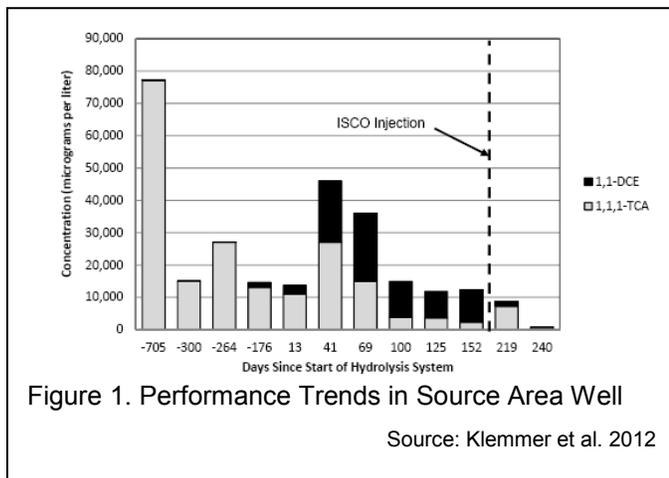
ISCO was considered at the site but was ruled out as a standalone treatment because of the presence of DNAPL (where its effectiveness is inhibited by its ability to only treat dissolved phase contaminants) and due to the fact that TCA is not easily oxidized. Therefore, considering TCA's susceptibility to hydrolysis at elevated temperatures, a decision was made to combine heat with sodium persulfate for the remedy. Heat activated sodium persulfate is capable of degrading both TCA and DCE (Liang et al. 2003).

In situ heating was accomplished by circulating extracted groundwater through an on demand water heater then re-injecting the heated water into the source area. The target temperature was 70° C (Klemmer et al. 2012). The heated water was intended to accelerate hydrolysis and promote dissolution of the DNAPL. Injection of the heated water began November 10, 2010 and lasted for 152 days. During the operation the groundwater temperature ranged from 60° to 71° C. The pH also fell from an average of 6.9 to 4.5 indicating the production of acid during the hydrolysis.

Following the shutdown of the recirculation system, the subsurface temperature was monitored until the temperature dropped below 40° C (approximately 30 days). At this point a total of 10,000 gallons of 60 g/L sodium persulfate solution was injected into nine wells. The subsurface was allowed to cool, because at temperatures higher than 40° C, the oxidation kinetics can be so fast that the oxidant may be spent before distribution is achieved (Klemmer et al. 2012).

**Project Results:** After 100 days of operation, the TCA concentrations were reduced to below the remedial target range. The single injection of persulfate also was successful in reducing both the DCE and remaining TCA in the source area

(Figure 1). There was slight rebound but not to levels above the 13.3 mg/L target concentration. The source zone area investigation and remediation was marked closed by the state.



**Sources:**

Klemmer, Mark, Jackie Saling, David Selger, and Donald Malone. 2012. Remediation of 1,1,1-Trichloroethane via Sequential Thermally Enhanced Hydrolysis and In Situ Chemical Oxidation. Remediation of Chlorinated and Recalcitrant Compounds—2012.

Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012).

Kollig, Heinz, J. Ellington, E. Weber, and N. Wolfe. 1990. Pathway Analysis of Chemical Hydrolysis for 14 RCRA Chemicals. EPA 600-M-89-009.

<http://babel.hathitrust.org/cgi/pt?id=mdp.39015041375117;view=1up;seq=1>

Liang, Chen Ju, Clifford J. Bruell, Michael C. Marley, and Kenneth L. Sperry. 2003. Thermally Activated Persulfate Oxidation of Trichloroethylene (TCE) and 1,1,1-Tri-chloroethane (TCA) in Aqueous Systems and Soil Slurries. Soil and Sediment Contamination: An International Journal, Volume 12, Issue 2.

Suthersan, Suthan, John Horst, Mark Klemmer, Don Malone. 2012. Temperature-Activated Auto-Decomposition Reactions: An Under-Utilized In Situ Remediation Solution. Groundwater Monitoring & Remediation, Volume 32, Issue 3, pages 34–40.

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