# Provect-IR™ - Former Dry Cleaners Site - Durham, NC

## Project Summary

Soil and groundwater at a former dry cleaner site in Durham, NC were impacted by tetrachloroethylene (PCE) due to historical releases. In April 2011, a standard version of Provect-IR™ ISCR reagent (without the methane inhibitor) was applied to three open-rock wells from ca. 30 to 40 ft bgs to create a pilot-scale permeable reactive barrier (PRB) treatment zone *ca*. 15 ft up-gradient of existing monitoring well MW-26 (**Figure 1**) which was screened from 27 to 37.5 ft bgs. A single inflatable TMA 350 packer system was used to inject the slurried reagent.

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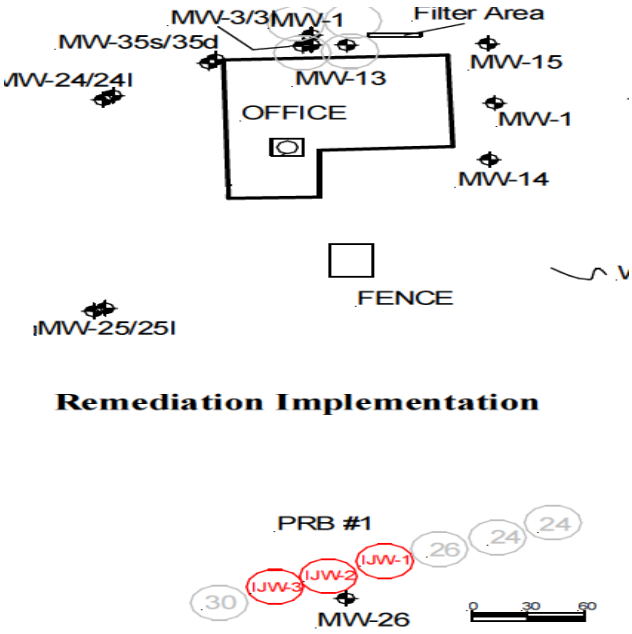



**Figure 1.** Site map showing three injection points (IJW-1, 2 and 3) to create a pilot PRB proximal to monitoring well MW-26.

## Pilot Test Results

Nine months after the injection event (January 2012), total CVOC concentrations were reduced from 2,540 µg/L to 71.2 µg/L, a 97% reduction (**Figure 2**). More specifically, there was >99% reduction in PCE (from 2,400 µg/L to 6.2 µg/L) without the Stoichiometric accumulation of catabolic intermediates that is often observed when using non-ISCR reagents.

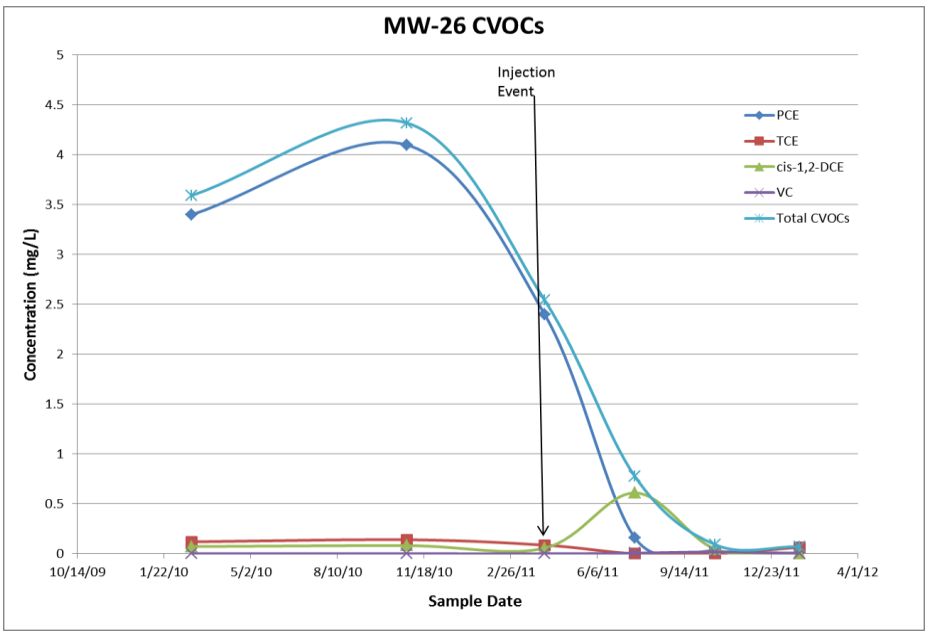



**Figure 2.** Concentrations (mg/L) in Groundwater vs. Time at MW-26 before and after in-situ injection event.

## Full Scale Remedial Action

In December, 2012 a total of 10,100 USG of solution containing *ca*. 10,815 lbs of "Provect-IR" (without the methane inhibitor) were injected throughout 5 treatment areas via 64 injection points **(Figure 3**The DPE injections were performed at depths of 15-30' bgs; approximately 150 USG of solution were injected in each point. The injections in the wells across the site (IW) were implemented at depths between 5' and 45' bgs; approximately 175 USG of a dilute Provect-IR solution were injected in each well. The pressure of the pre-injection pathway development was approximately between 100 and 150 psi, while the pressure of the post-injection pathway development was around 50 psi. ). Subsequent performance monitoring used data collected from 8 Eight monitoring wells (MW-2, MW-3, MW-4, MW-9S, MW-21, MW-26, MW-40 and MW-46).

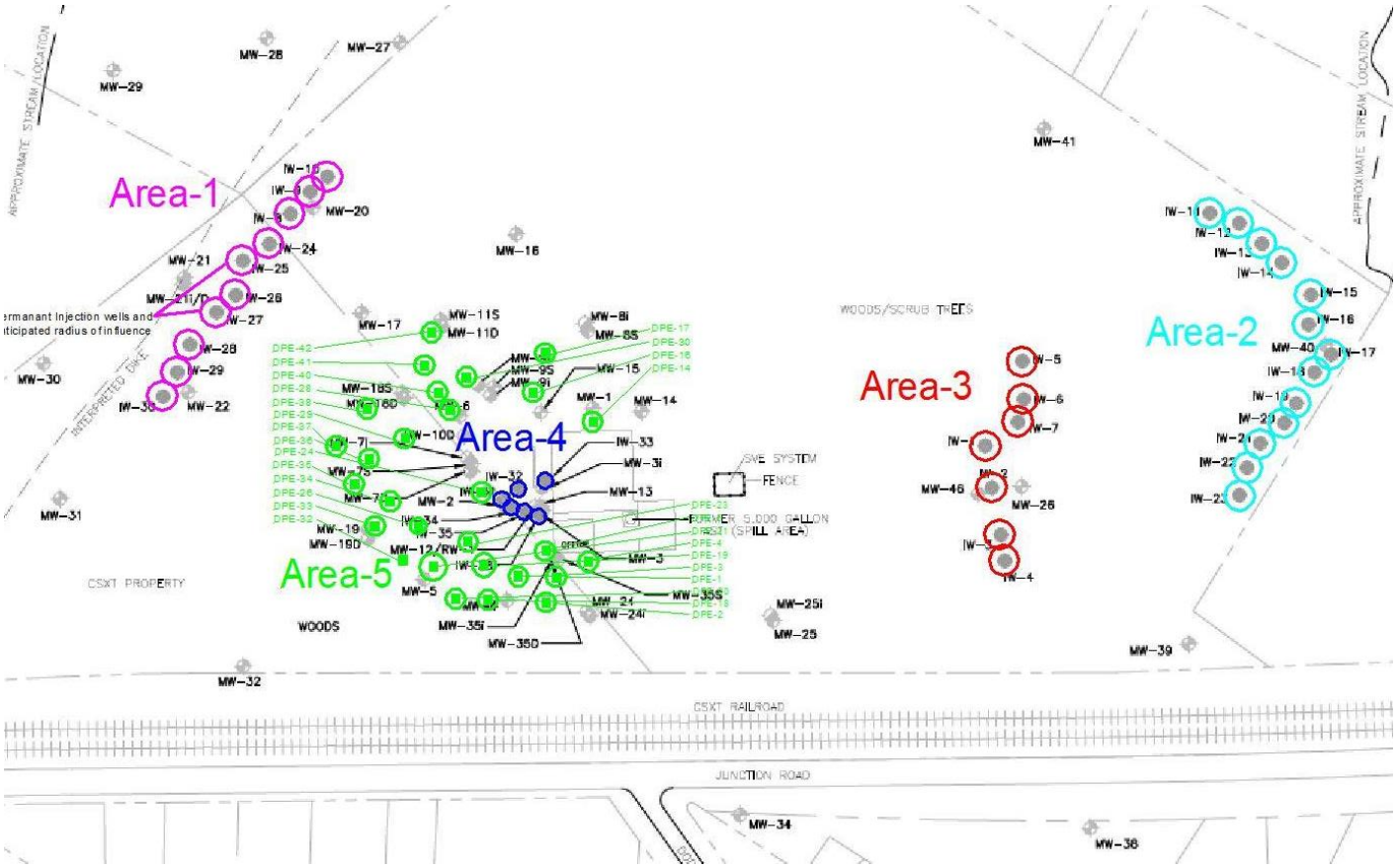



**Figure 3. Overview of "Provect-IR" treatment areas.**

## Full-Scale Application Results

Data from MW-46 located within Area 3 are presented herein as representative of treatment performance. This treatment zone was designed as permeable reactive barrier located immediately downgradient from a suspected PCE source area and encompassed monitoring wells MW-26 and MW-46.

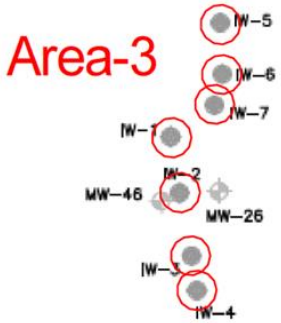



**Figure 4. Wells and injection points in Area 3.**

## MW-46 Data

*Field Parameters and Geochemical Data:* The field parameters and the geochemical data for monitoring well MW-46 are presented in **Table 1**. The pH values remained neutral throughout the treatment process ranging between 7.05 and 9.29 (suspect value) pH units. The ORP values, sulfate and ferrous iron values confirmed that aquifer conditions were mostly reducing. Finally dissolved gases and especially methane have remained elevated as of March 2014, indicating that acetogenic, dehalorespiring and methanogenic bacteria are all active in the vicinity of MW-46 (**NOTE**: The Provect-IR formulation used in 2012 did NOT contain the methane inhibitor).

**Table 1.** Field Parameters and Geochemical Data for MW-46.

| MW-46 | | | | | | |
|---|---|---|---|---|---|---|
| **Sampling Date** | 10/10/2012 | 03/28/2013 | 07/10/2013 | 09/17/2013 | 12/03/2013 | 03/11/2014 |
| **D.O. (mg/L)** | 0.22 | 0.16 | 0.69 | 0.16 | 0.74 | 1.31 |
| **ORP (mV)** | -90.9 | -58.2 | +11.1 | -23.9 | -126.0 | -53.0 |
| **Conductivity (µs/cm)** | 888 | 666 | 740 | 741 | 780 | 745 |
| **pH** | 7.08 | 7.05 | 7.94 | 9.29 | 7.14 | 7.29 |
| **Sulfate (mg/L)** | 0.438 | <0.25 | 0.212 J | 2.95 | 0.288 | <4 |
| **Total Iron (mg/L)** | 1.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.4 |
| **Dissolved Iron (mg/L)** | 1.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.4 |
| **Methane (µg/L)** | 1,970 | 7,840 | 8,460 | NA | 5,420 | 15,000 |
| **Ethane (µg/L)** | 12.3 | NA | 26.6 | NA | 7.0 | 28.0 |
| **Ethene (µg/L)** | 30.7 | NA | 8.7 | NA | 1.5 | <3.8 |

NA: Not Analyzed

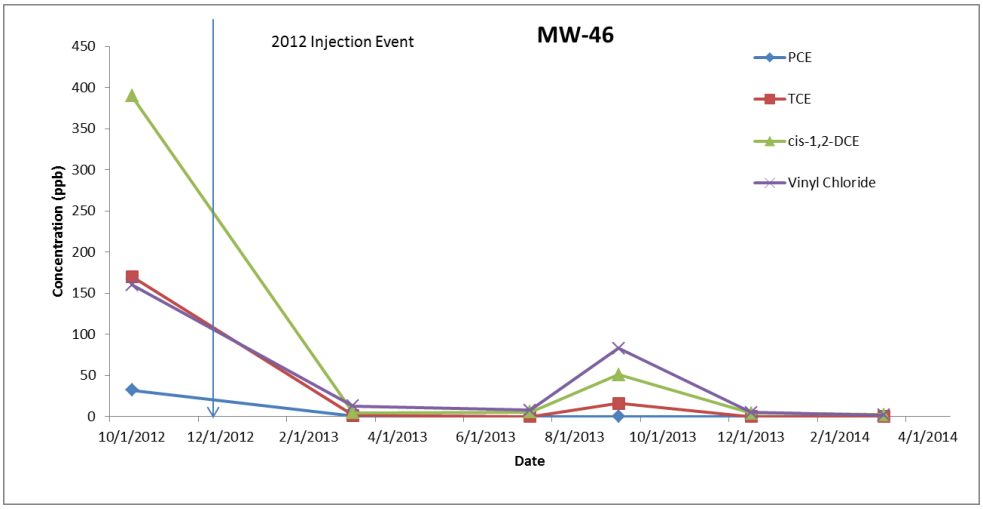
*CVOC Data:* The concentrations of all CVOCs decreased significantly within 3 months from the time of the injection event, and the PCE concentration has remained below the analytical detection limit of 0.5 ppb since the July 2013 sampling event. The concentrations of the potential daughter compounds TCE, cis-1,2-DCE and vinyl chloride have all continued to decrease as well. The TCE concentrations have been < analytical detection limits, while *cis*-1,2-DCE and vinyl chloride concentrations have decreased by 99.4% and 99%, respectively, since the baseline sampling event (**Table 2**). The CVOC concentrations immediately proximal to treated areas have, in general, not reflected rebound (**Figure 5**).

**Table 2.** CVOC Data for MW-46.

| MW-46 | | | | | | |
|---|---|---|---|---|---|---|
| **Sampling Date** | 10/10/2012 | 03/28/2013 | 07/10/2013 | 09/17/2013 | 12/03/2013 | 03/11/2014 |
| **PCE (µg/L)** | 32 | 1.2 | <0.7 | <0.7 | 0.44 J | <0.5 |
| **TCE (µg/L)** | 170 | 1.3 J | <0.28 | 16 | <2.8 | 0.36 J |
| **cis-1,2-DCE (µg/L)** | 390 | 4.7 J | 5.6 | 51 | 4.4 J | 2.2 |
| **Vinyl Chloride (µg/L)** | 160 | 13 | 8 | 83 | 5.1 | 2.1 |

## Conclusion

**Figure 5.** CVOC concentration changes in MW-46.




In general, performance monitoring data from December 2012 through March 2014 showed that "Provect-IR" led to a significant decrease in PCE and total CVOC concentrations in seven of the eight monitoring wells located within and proximal to the treated areas. Although the concentrations of *cis*-1,2-DCE and vinyl chloride showed some transient increases commonly associated with enhanced reductive dechlorination, or ERD (and less so with *in situ* chemical reduction, or ISCR), these catabolites were not produced in Stoichiometric amounts. Significant changes in groundwater levels were observed to correlate with transient but notable increase in the concentrations of the targeted compounds, indicating the presence of residual sources that were not fully addressed. Supplemental treatment using Provect-IR is presently being contemplated.