REGENESIS®

Closure Moves Forward at Former Dry Cleaner Site

Cost-Efficient Advanced Colloidal Technology Approach Remediates PCE Plume

Highlights

Site Type:
Dry cleaner in a mixed commercial and residential neighborhood

Project Driver:
Vapor intrusion into nearby buildings and offsite groundwater impacts

Contaminants:
PCE up to 6,950 micrograms per liter (µg/L) and its breakdown products: trichloroethene (TCE), cis-1,2-dichloroethene (cis-DCE), and vinyl chloride (VC)

Treatment:
Enhanced reductive dechlorination (ERD) of contaminants under anaerobic conditions

Technologies:
3-D Microemulsion (3DME), Bio-Dechlor INOCULUM® Plus (BDI+), liquid ferrous-iron amendment

Geology:
Glacially deposited sand and silty sand in primary contaminant flux zones, with an underlying silty clay layer

Summary

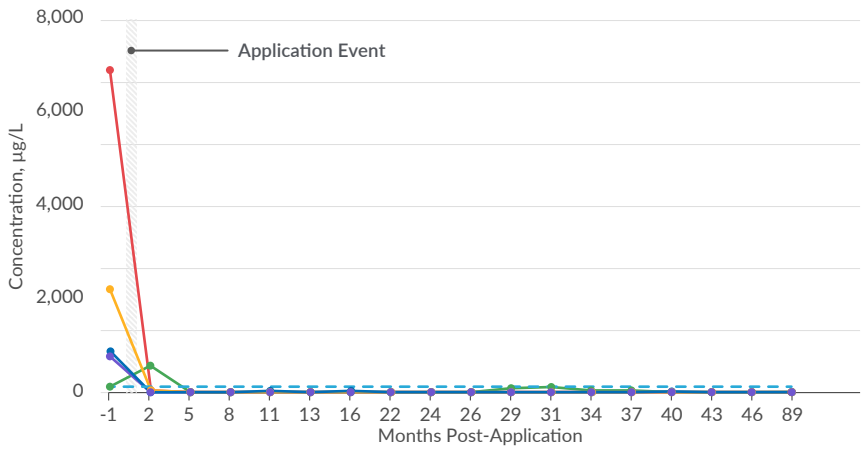
A former drycleaners site in Central Indiana employed a comprehensive remediation strategy to address on and offsite soil and groundwater contamination caused by chlorinated solvents, primarily perchloroethylene (PCE) and its byproducts. Using an enhanced reductive dichlorination (ERD) approach, the team strategically applied 3-D Microemulsion®, Bio-Dechlor INOCULUM® Plus (BDI), and a soluble ferrous iron substrate to the groundwater plume to facilitate enhanced reductive dechlorination of these contaminants, transforming them into harmless byproducts. This proven treatment substantially reduced the groundwater plume, leaving only low-level residual contamination that is effectively managed through institutional controls. Following these results, a site closure request under the state's Voluntary Remediation Program (VRP) is currently under review by the Indiana Department of Environmental Management (IDEM).

Results

- **Site closure (pending)**

PCE in Performance Monitoring Wells

PCE in performance monitoring wells compared to the vapor intrusion groundwater screening level (VIGWSL or action level). Only wells that previously exceeded the VIWGSL are shown.



Background

The former dry cleaner operated at the site from 1971 to 2013, using PCE as the solvent throughout this period. PCE was delivered directly to the dry-cleaning machines without the use of storage tanks, leading to incidental releases over the decades. Numerous phases of subsurface investigations revealed contamination in the soil and groundwater, leading to a vapor intrusion risk for a few neighboring properties.

Multi-Faceted Remedial Approach Implemented to Address Soil, Groundwater and Vapor Intrusion

Enviroforensics, a leading environmental consulting firm based in the Midwest US, implemented a multi-remedy approach by: conducting soil removal to remove high-concentration hotspots, installing a soil vapor extraction system to treat vadose zone soils, and installing sub-slab depressurization systems to mitigate vapor intrusion at two offsite properties. Additionally, an Environmental Restricted Covenant (ERC) was recorded for the site, stating that groundwater cannot be used for potable water and that the property's land use must remain commercial.

50,000+ Square Foot Groundwater Plume

PCE had migrated into the groundwater, forming a plume encompassing a 50,000-plus-square-foot area. The contaminants migrated through a zone of glacially deposited sand and silty sand, which was underlain by a silty clay aquitard. The highest contaminant concentrations were present south of the dry-cleaning operation and under the town's main roadway. Although the plume primarily contained PCE, lower concentrations of breakdown products, including TCE, cis-DCE and VC, were also detected.

Groundwater Remediation

Strategy and Cleanup Objective

Enviroforensics specified enhanced reductive dechlorination or ERD as the most practical and economically viable method to effectively treat the large chlorinated solvent plume. Enviroforensics strategy was to significantly and quickly reduce the magnitude and extent of the CVOC plume while demonstrating plume stability through post-remediation monitoring. This approach was chosen over other technologies since it could be applied to both high-concentration source mass and lower-concentration dissolved mass in the plume, was easy to implement, and was likely to succeed since some PCE reduction was already occurring.

The applicable cleanup goal for PCE in groundwater was based on the vapor intrusion groundwater screening level (VIGWSL) for commercial land use, which was 110 µg/L.

Superior 3-D Microemulsion Performance Compared to EVO Verified

3-D Microemulsion Performance Advantages

- Treats both high-concentration source zones and low-concentration dissolved plume areas effectively
- Easy to deploy with minimal site disturbance
- Self-distributes through the plume, outperforming EVOs where direct injections aren't possible

Enviroforensics conducted a comprehensive 90-day pilot study to refine the Enhanced Reductive Dechlorination (ERD) strategy prior to the full-scale application. The study employed an *in situ* microcosm setup within an onsite well, focusing on comparing the effectiveness of two specific amendments: 3-D Microemulsion and Emulsified Vegetable Oil (EVO).

The results revealed a significant decrease in perchloroethylene (PCE) levels and an increase in dechlorinating bacteria populations, underscoring the efficacy of ERD in site remediation. **Notably, 3-D Microemulsion outperformed EVO in the pilot study, demonstrating enhanced capability in boosting dechlorinating bacteria populations and rapidly reducing PCE concentrations.** This led to its selection for full-scale remediation efforts.

An additional advantage of 3-D Microemulsion over EVO is its capacity to gradually diffuse through the plume post-injection. This characteristic has proven particularly beneficial at sites where physical access is restricted by buildings or roadways, influencing the decision in favor of 3-D Microemulsion for the remedy selection.

Full-Scale Application Details	
Treatment Area	22,800 square feet
Injection Depth	4 to 14 feet below ground surface
Materials Injected	3-D Microemulsion, CRS*, BDI Plus
Total Volume Injected	>20,000 gallons
Injection Points	92
Injection Method	Direct-push technology

*CRS has since been replaced by our sulfidated zero valent iron technology - S-MicroZVI®

Full-Scale Implementation

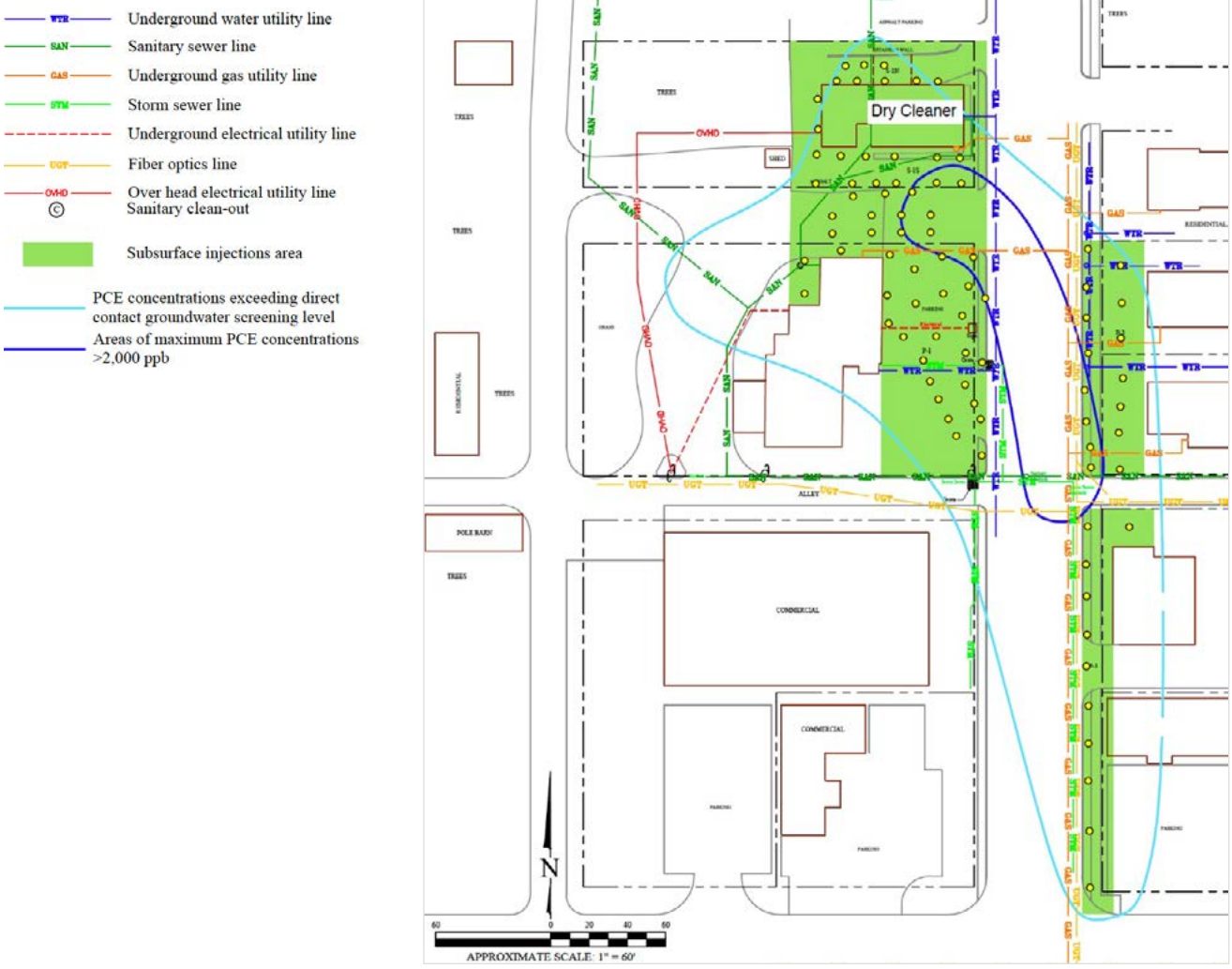
In areas where urban infrastructure limited physical access, 3-D Microemulsion was strategically applied at key locations within the plume core. Natural groundwater flow facilitated the dispersion of the 3-D Microemulsion beyond the initial treatment zone, as illustrated in Figure 1. To accelerate the degradation of chlorinated ethenes, the soluble iron amendment and BDI+, a bacterial culture harboring *Dehalococcoides sp.*, were simultaneously injected. This co-application leveraged both biological and chemical reduction processes for more efficient contaminant breakdown.

Injection points were established using a hydraulic-powered direct-push drill rig, which inserted drive rods into the depths of the contaminated saturated zone. As the rods were retracted from approximately 14 to 4 feet below ground surface (bgs), 3-D Microemulsion and CRS were injected. Separately, BDI mixed with de-oxygenated water was administered at these points to ensure thorough mixing and distribution.

Additionally, targeted soil excavation was undertaken on the north side of the dry cleaner building and adjacent to a sanitary sewer line gap. This was aimed at removing shallow impacted soils within the vadose zone to mitigate further contaminant migration into the dissolved phase plume.

Figure 1 Site Plan

Site plan showing 3-D Microemulsion and CRS injection locations



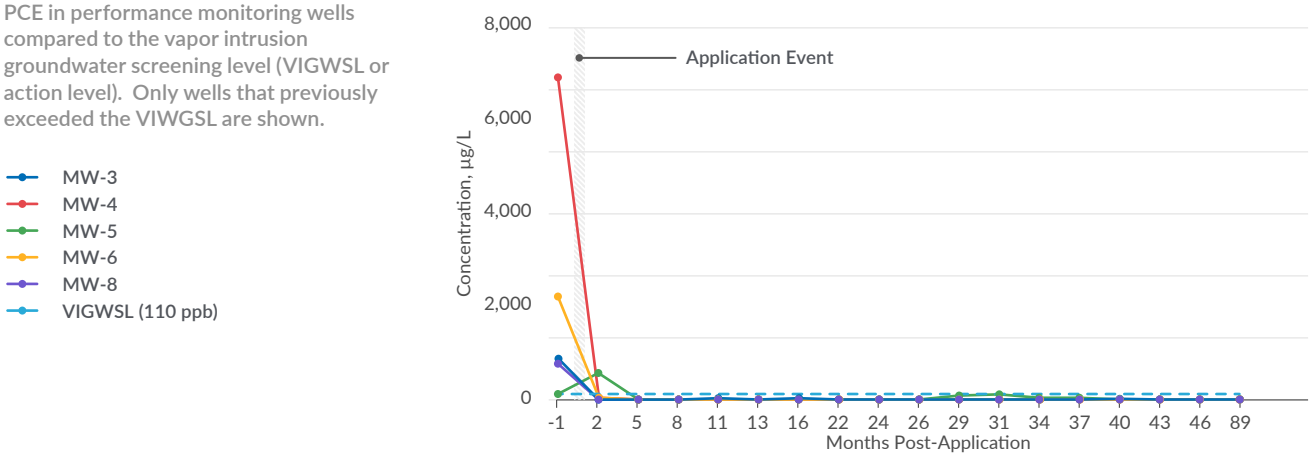
Results and Conclusion

Following the advanced colloidal technology combined remedy, PCE concentrations were reduced below the VIGWSL cleanup goal. Except for one slight exceedance above the VIGWSL in MW-5 approximately 2.5 years post-application, these reductions have been sustained for over six years (Figure 2). Based on these results, the remediation has achieved the site cleanup objectives and Enviroforensics has requested site closure from IDEM through the VRP.

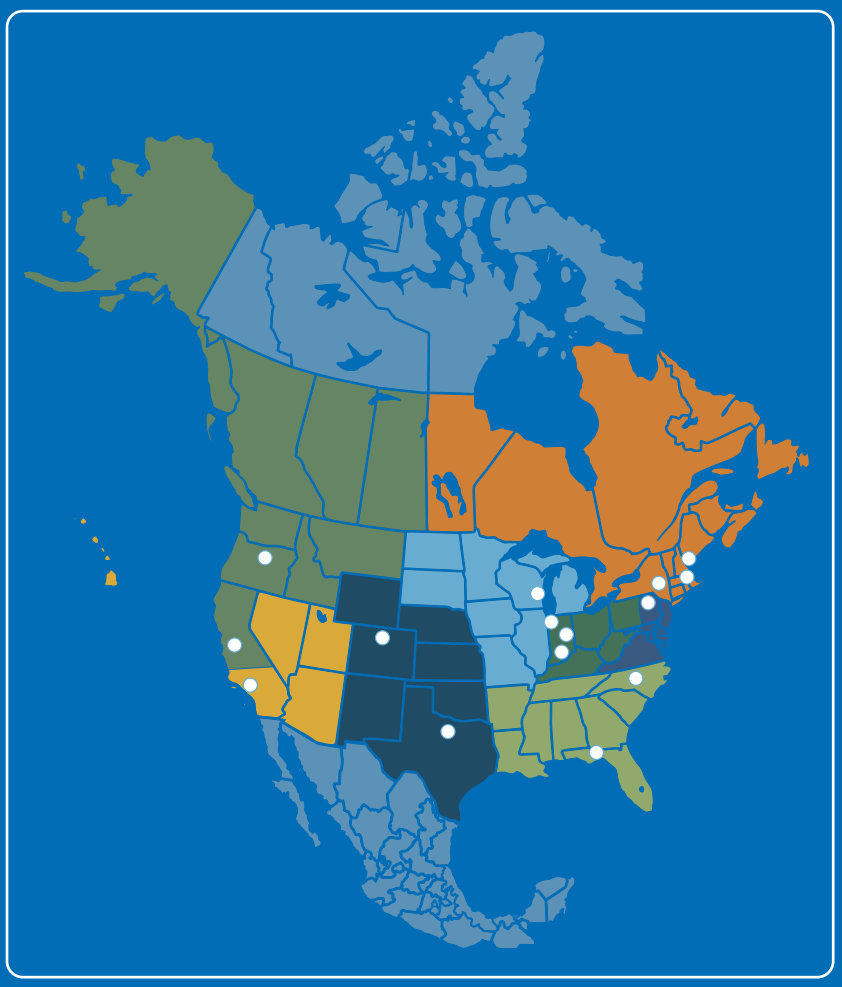
Figure 2

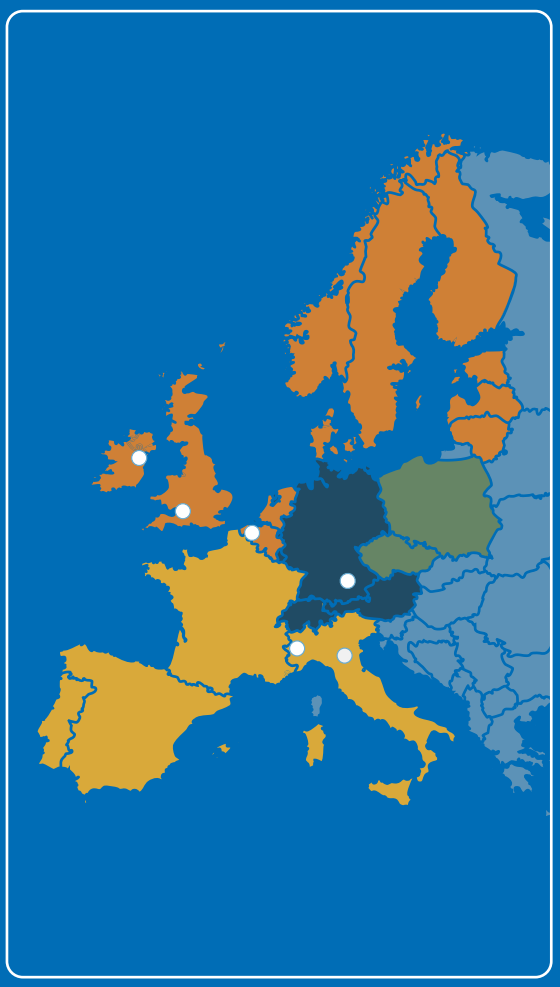
PCE in Performance Monitoring Wells

PCE in performance monitoring wells compared to the vapor intrusion groundwater screening level (VIGWSL or action level). Only wells that previously exceeded the VIWGSL are shown.



We're Ready to Help You Find the Right Solution for Your Site





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