

PLUMESTOP ARRESTS PCE IN FAST MOVING AQUIFER

CASE STUDY:

Permeable Reactive Barrier Provides
Sustaining Results for PCE Plume



REGENESIS®



Overview

PlumeStop Permeable Reactive Barrier Provides a Cost-Effective Approach to Treat a PCE Release at Former Dry Cleaning Site

Project Summary

Plume Size	1,400 feet in length
Fast-Moving Aquifer	1,560 ft/year
Geochemistry	Highly Aerobic
Area Zoning	Mixed-Use
Injection Accessibility	Limited



PlumeStop effectively treated the plume in the well-oxygenated, sand and gravel lithology

99% Reductions met and sustained

The installation of a fixed, permeable reactive barrier has allowed for indefinite treatment with 99% reductions met and sustained

A former dry-cleaning site in Martinsville, Indiana, had a perchloroethylene (PCE) release which contaminated the community’s groundwater with concentrations in excess of 370 parts per billion (ppb). The sand and gravel aquifer created a challenging problem due to the high flow regime, with a groundwater velocity of approximately 1,560 ft/year and oxygenated geochemistry which had limited natural attenuation. The property owner, interested in the potential sale of the site, engaged Wilcox Environmental Engineering (Wilcox), a regional environmental consulting firm based in Indianapolis. The PCE plume stretched over 1,400 feet and extended through the surrounding ‘mixed-use’ residential area, limiting accessibility for the remediation efforts. As a result of the plume’s location, the community was made aware of remediation efforts from the start and Wilcox communicated the remedial approach from the site assessment through to the pilot test. In order to provide assurance to the community, Wilcox promptly and clearly communicated with the residents and evaluated their homes for possible vapor inhalation risk as a result of the PCE release.

In order to prevent additional migration of PCE-impacted groundwater, Wilcox worked with REGENESIS® to create an *in situ* remedy compatible with the challenging aquifer and residential settings. After a thorough evaluation of possible technologies, Wilcox determined that PlumeStop® Liquid Activated Carbon™ in combination with HRC® and BDI Plus® could prevent the plume from migrating and would work in the well-oxygenated, sand and gravel lithology.

The combined remedial approach would enable the installation of a fixed permeable reactive barrier to capture and biodegrade the migrating plume. The team designed a pilot test using PlumeStop to prove the effectiveness of the technology in the specific site geology.

After a successful pilot test and four monitoring events, Wilcox and the site owner decided to implement a full-scale application using PlumeStop.

Background

Uniquely Challenging Site Conditions



From 1987 through 2011, the site operated as a dry cleaner, resulting in a PCE contaminant release in the groundwater. Presently, the site operates as a pick-up and drop-off dry cleaner, but does not conduct dry-cleaning activities on site. The site is located in a 'mixed-use' area where both commercial and residential properties reside. Due to the proximity of the plume to the residences, the community was included in communicating remediation efforts from the start of remedial efforts. Wilcox provided clear and prompt communication, offering assurance to concerned residents. Wilcox also evaluated vapor intrusion (VI) risk in their homes beginning in 2015. This included local sampling and installing poly diffusion bags to screen out some residences. They evaluated VI for over 20 residents, collected samples, and at one house installed a sub-slab depressurization system. There were no concerns regarding water ingestion because the community is connected to a municipal water supply.



Timeline

Pilot Study Employing a PlumeStop Permeable Reactive Barrier Was Proven Effective and a Full-Scale Implementation is Planned



- **1987-2011**

Site operated as a dry cleaner



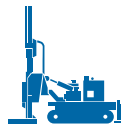
- **2014**

Wilcox began working with site owners to develop an effective plan to mitigate risk from the PCE plume



- **2015**

Wilcox evaluated vapor intrusion risk for nearby residences and provided safe and effective measures to mitigate any VI exposure



- **July-August 2018**

Conducted pilot test to demonstrate efficacy of permeable reactive barrier and to prove the success of the combined remedy of PlumeStop, HRC and BDI Plus



- **October-December 2018**

Four rounds of post-injection monitoring performed



- **Spring 2020**

Full-scale implementation of combined remedy

Treatment

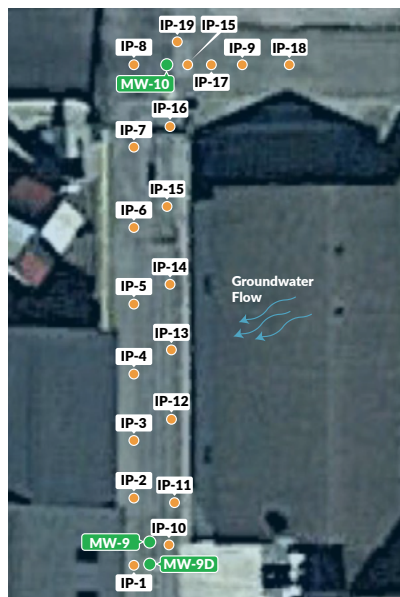
A Combined Remedy Approach Leads to Rapid and Promising Results

Site Details

Seepage Velocity	1,560 ft/yr.
Contaminants of Concern	PCE
Concentration	330 ppb
Treatment Interval	9-16 ft. bgs
Total Direct Push Points	35
Total Amount of Remedial Solution	6,100 gal.

Prior to implementation, Wilcox conducted a design verification testing (DVT) program to refine the site conceptual model and optimize the subsequent remedial design for the emplacement and dose of the reagents. The DVT effort entailed a Membrane Interface Hydraulic Profiling (MiHPT) survey and extensive aquifer testing program across the entirety of the plume. During July and August of 2018, Wilcox and REGENESIS conducted a PlumeStop pilot test in order to demonstrate the viability of the combined technologies. During the pilot test injection, the site location proved challenging as injections had to take place in an alley between busy service streets, with relatively tight access points.

Wilcox and REGENESIS communicated with the nearby community throughout the application process in order to address noise and driveway access. During the pilot test, 4,000 lbs. of PlumeStop, 400 lbs. of HRC, and 18 liters of BDI Plus were injected using a direct push method under low pressure into 35 injection points. In addition, a secondary co-reagent was applied to optimize distribution of the PlumeStop within the tight confines of the injection area and aquifer setting.



Map depicting injection locations



Workers applying amendments at IP-10 in July 2017

Results

Immediate Contaminant Reduction Provides Stakeholder Assurance



BIO-DECHLOR INOCULUM



HYDROGEN RELEASE COMPOUND



99% reduction of PCE ~30 days after the application in key monitoring wells



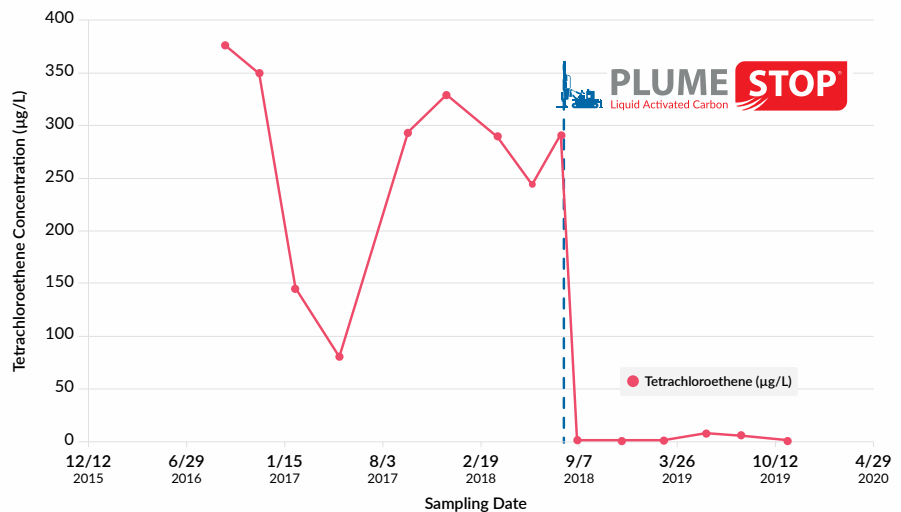
PRB application highly successful approximately 1 year after installation



Demonstration of PRB leading to full-scale treatment in Spring 2020

Following the PlumeStop application, Wilcox monitored the results for four monitoring events. The pilot test's successful results proved that PlumeStop would work quickly in these site conditions and would sustain positive results over the long term. This was a key component to provide assurance to the nearby community, the property owner, and the insurance company. After thorough post-injection monitoring and successful results, Wilcox has planned a full-scale application to begin in early 2020. Consistent with the pilot test application, the full-scale application utilizes an approach with minimal disruption of the community. Full-scale application, planned for the Spring of 2020, is designed to treat the entirety of the plume to below regulatory standards for decades, based upon contaminant retardation models developed by REGENESIS.

MW-09 PCE Concentrations Over Time



Within 30 days of the injection, the PCE concentration decreased from 291 µg/L to non-detect. Additional post-injection monitoring further demonstrates the effectiveness of the PlumeStop pilot test.



The Consultant About Wilcox



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Wilcox Environmental Engineering, Inc. is a unique assembly of engineering and science-based professionals passionate about providing impeccable service and quality resources. Their founding vision in 1994 to provide innovative, comprehensive, cost-effective solutions for each project stands true today. Since their inception, Wilcox has successfully partnered with a wide base of clients spanning industrial and commercial sectors to address each unique environmental, regulatory, and health and safety need.



Jeremy Kinman, Associate Technical Director at Wilcox

Jeremy Kinman is an Associate Technical Director for Wilcox Environmental Engineering, Inc. based out of Speedway, Indiana with more than 19 years of experience in environmental consulting with a focus on contaminated property management. Jeremy's diversified professional experience includes mentorship of project staff, hydrogeologic data analysis and interpretation, conceptual site model analysis, human risk assessment, vapor intrusion investigation and remediation, client relations management, health and safety management, and overseeing quality assurance processes. Jeremy is also responsible for overseeing and training staff, making sure the best practices are applied providing technical oversight on compliance and management concerns, and engaging and assisting government officials with regulation, policy and rule interpretation. Jeremy also serves as the President of the Board of Directors for the Professional Geologists of Indiana (PGI).

Technology Used

PlumeStop, BDI Plus, and HRC



PlumeStop® Liquid Activated Carbon™ is an innovative groundwater remediation technology designed to address the challenges of excessive time and end-point uncertainty in the *in situ* remediation of groundwater contaminants. PlumeStop is composed of very fine particles of activated carbon (1-2µm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material behaves as a colloidal biomatrix binding to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation.

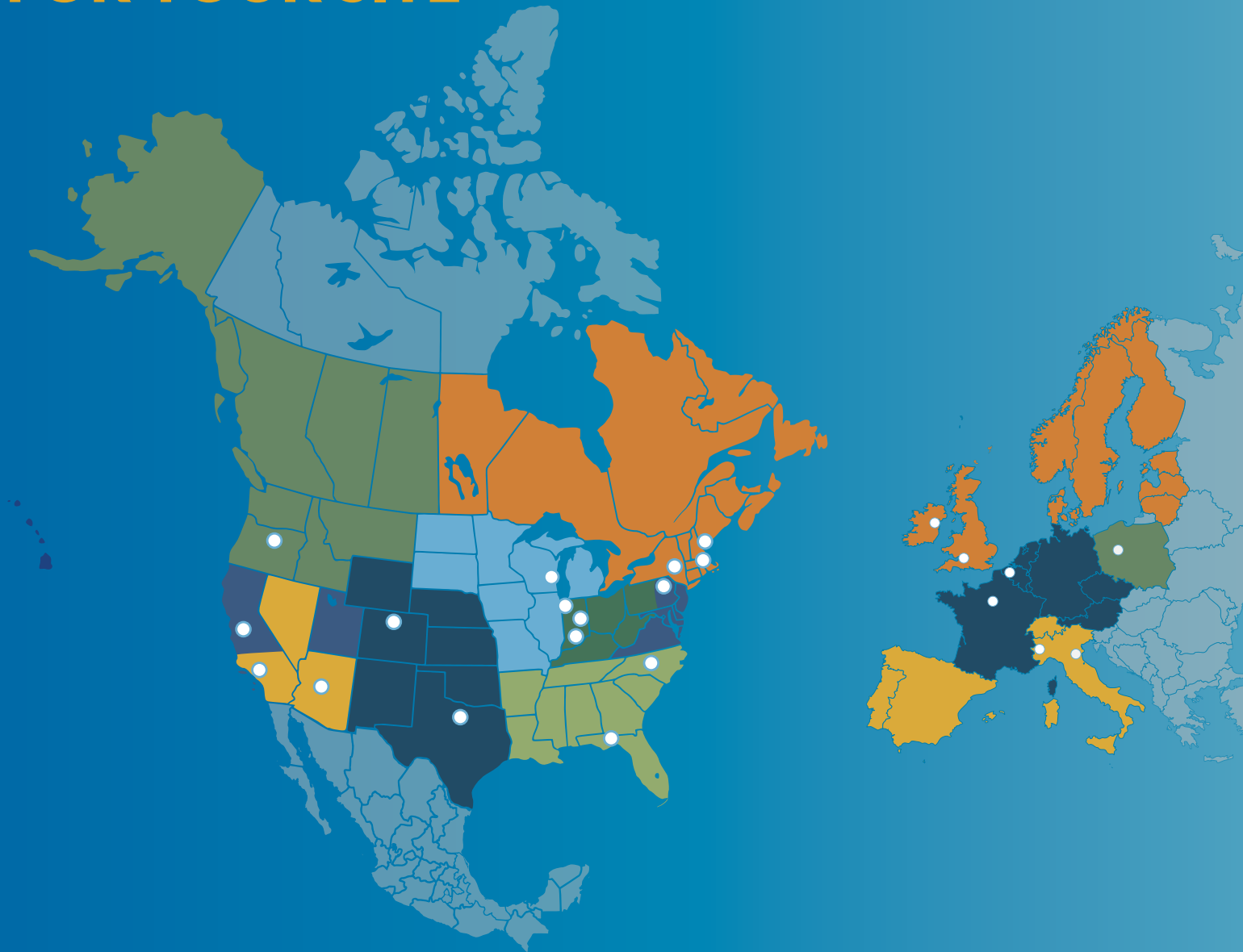


BDI Plus is designed for use at sites where chlorinated contaminants are present and unable to be completely biodegraded via the existing microbial communities. BDI Plus is an enriched, microbial consortium containing species of the bacteria *dehalococcoides sp.* (DHC) which is capable of completely dechlorinating contaminants during *in situ* anaerobic bioremediation processes. BDI Plus has been shown to stimulate the rapid dechlorination of chlorinated compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC).



HRC is an engineered, hydrogen release compound designed specifically for enhanced, *in situ* anaerobic bioremediation of chlorinated compounds in groundwater or highly saturated soils. Upon contact with groundwater, this viscous, poly-lactate ester material becomes hydrated and subject to microbial breakdown producing a controlled release of hydrogen for periods of up to 18-24 months on a single application. HRC enables enhanced anaerobic biodegradation by adding hydrogen (an electron donor) to groundwater and/or soil to increase the number and vitality of indigenous microorganisms able to perform the naturally occurring process of enhanced reductive dechlorination.

WE'RE READY TO HELP YOU FIND THE RIGHT SOLUTION FOR YOUR SITE



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