

# COMBINED AMENDMENT APPROACH TREATS CHLORINATED SOLVENTS

**CASE STUDY:**  
**Remediation Allows for  
Development in Downtown  
Jacksonville, Florida**





## Overview

# Remediation Sped Up Development of Site in Jacksonville, FL



Combined remedy approach ensured effective remediation.

A formerly undeveloped site in downtown Jacksonville was impacted with chlorinated solvents in the groundwater and metal-impacted soils. The site required remediation prior to moving forward with development. Ryan Companies US, Inc. (Ryan) was under contract to purchase the property from the site owner and was seeking an expedited closure of the site prior to completion of construction. Ryan plans to develop the site with a nine-story office building and an associated nine-level parking deck. Site rehabilitation through remediation and regulatory closure is being sought through Florida Department of Environmental Protection (FDEP) voluntary cleanup.



Successful ZVI application in Florida.

The historic release of chlorinated solvents is believed to have originated from a former dry cleaning operation. Pre-remediation sampling reported perchloroethylene (PCE), trichloroethylene (TCE), Cis-1,2-dichloroethylene and vinyl chloride (VC) above applicable groundwater cleanup target levels (GCTL) in five of the screen point samples. The highest concentrations were found in the southwest portion of the site.





FDEP Voluntary Cleanup program provided tax credits making the remediation and redevelopment possible.



Remediation allowed the undeveloped block to be developed into a nine-story office building in a growing area of downtown Jacksonville.

Environmental engineering and consulting firm Terracon evaluated a variety of remedial technologies as well as existing site conditions to determine the most appropriate application for the site. Terracon selected multiple technologies from REGENESIS to treat the chlorinated solvent groundwater plume. The remedial amendments included PlumeStop, zero-valent iron (ZVI), Bio-Dechlor Inoculum Plus (BDI Plus), and Hydrogen Release Compound (HRC).

REGENESIS Remediation Services (RRS) employed *in situ* enhanced sorption, chemical reduction, anaerobic bioremediation, and enhanced biodegradation to meet remediation goals. These remedial approaches are designed to foster the rapid reduction of chlorinated solvent compounds through abiotic and biological pathways while minimizing the potential for daughter product formation. PlumeStop provides a very large sorption surface which results in the immediate reduction of chlorinated solvent concentrations while at the same time concentrating contaminants to allow for more efficient and controlled remediation through destructive technologies like ZVI. As contaminants are degraded to non-toxic and non-sorptive end products, the PlumeStop sorption surface regenerates. HRC provides a controlled release of hydrogen to stimulate anaerobic bioremediation. BDI Plus is added to provide a live microbial culture that is used to degrade intermediate daughter products resulting from reductive dechlorination, including dichloroethene and vinyl chloride.







## Background

# Combined Remedy Approach Leads to Rapid Results



The 1.5-acre site is owned by the City of Jacksonville (COJ) and is an undeveloped block in downtown Jacksonville. The site is currently used as a parking area and includes several trailers that were used as field offices during construction of the new Federal Courthouse. The site contains paved and unpaved areas.



The FDEP Brownfields Voluntary Cleanup Tax Credit (VCTC) Program provides tax credits to encourage cleanup of Brownfield sites. The site is located in a designated Brownfield area and this program made the remediation and redevelopment of this site possible. The site will be developed into a nine-story office building with a nine-story parking garage.

## Timeline

# Remediation Allows Development Of Vacant Lot In Jacksonville, Florida

- **September 2004**

Phase II Environmental Site Assessment (ESA) conducted. Site initially monitored due to former dry cleaning operations

- **February 2018**

Site Assessment Report includes additional sampling points

- **April 2019**

Supplemental Site Assessment Report fulfilled additional recommendations from the FDEP in order to achieve site assessment requirements

- **June & September 2019**

Two rounds of Natural Attenuation Monitoring (NAM) were conducted

- **October 2019**

Remedial Action Plan (RAP) is submitted to the FDEP

- **December 2019**

Injection application took place through direct push borings

- **January 2020**

Initial Post-Active Remediation Monitoring (PARM) conducted

- **April 2020**

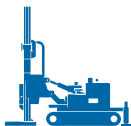
Quarterly PARM

*Note: Remedial efforts taking place prior to September 2019 were performed by the previous environmental consultant.*



## Treatment

# Cost-Effective Application of Proven Technologies Achieves Site Goals to Help Move Development Forward



The RRS team applied the remedial amendments with a proprietary injection trailer system, using up to three injection points at a time, saving time and money. RRS mixed the remedial chemistries in the trailer and injected through direct push borings drilled with a leading 1.5” retractable stainless-steel injection screen (2- and 3-foot length). Mixing water was provided on-site by a nearby fire hydrant. RRS used a dual-batch mixing system with 300-gallon tanks and pumped product using a positive displacement electrically powered pump. PlumeStop and the ZVI were mixed in 300-gallon tanks, while BDI Plus was introduced to the injection system via a slipstream method, preventing any contact with the atmosphere. Prior to drilling, each point was hand cleared to five feet by the drill team.

HRC injections were completed using a double diaphragm pump and injected through expendable tip injection tooling. Each HRC injection point received 1.75 gallons of product followed by 3.5 gallons of water and corresponded with a previously injected PlumeStop point.







## Treatment Process

**10,000** Pounds of PlumeStop

**1,700** Pounds of ZVI

**18** Liters of BDI-Plus

**680** Pounds of HRC



The treatment was applied over a period of 9 days, using direct push injection via a series of 30 injection points.

A series of 30 injection points were advanced using direct push technology (DPT). The injection points were located in proximity to existing monitoring well MW-2I which is located in the southwest corner of the site. The injections were conducted utilizing a bottom-up approach beginning at approximately 32-feet bgs injecting at 2 to 4-foot intervals up to a depth of approximately 18-feet bgs.

A total of 14,542 gallons of PlumeStop, ZVI, and BDI Plus were applied, with a total of 10,000 pounds of PlumeStop and 1,700 pounds of ZVI mixed and applied to the injection area. 18 liters of BDI Plus were applied via slipstream to the injection area. A total of 680 pounds of HRC was applied. The injection process took nine days to conduct.



*Note: The ZVI Product used on this site was a precursor to REGENESIS S-MicroZVI.*

## Technology Used

### PlumeStop, BDI Plus, HRC, ZVI



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 allowing for 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.



S-MicroZVI is a concentrated aqueous suspension of colloidal zero-valent iron formulated for compatibility with PlumeStop. S-MicroZVI is a sub-micrometer zero-valent iron metal alloy powder suspension engineered for *in situ* remediation. When applied to the subsurface it imparts an *in situ* chemical reduction (ISCR) mechanism that allows for the destruction of chlorinated ethenes (i.e. TCE) via abiotic degradation pathways. This unique mechanism allows for the traditional reduction pathway to be circumvented, minimizing the formation of daughter species such as vinyl chloride. The ZVI Product used on this site was a precursor to REGENESIS S-MicroZVI.

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## Results

### Remediation Efforts Speed Development of Future Nine-Story Office Building

Following the remedial activities, post active remediation monitoring (PARM) rounds were conducted and groundwater samples were collected from six (6) existing monitoring wells. These include four intermediate downgradient wells (MW-2I-source well; MW-1I, MW-8I, and MW-9I), one upgradient well (MW-5I), and one deep well (MW-2D-vertical delineation well).

It is anticipated that Ryan’s construction schedule will allow for another quarterly monitoring event in April 2020. Following the completion of the foundation of the proposed office building (anticipated to be completed in September 2020), replacement wells (MW-1IR, MW-2IR, and MW-2DR) will be installed within the slab in October 2020. The proposed replacement PARM wells will be constructed at the same screen interval and depth as the monitoring well it is replacing. Quarterly PARM sampling are anticipated to resume in October 2020 following the installation of the replacement wells.





## About Terracon

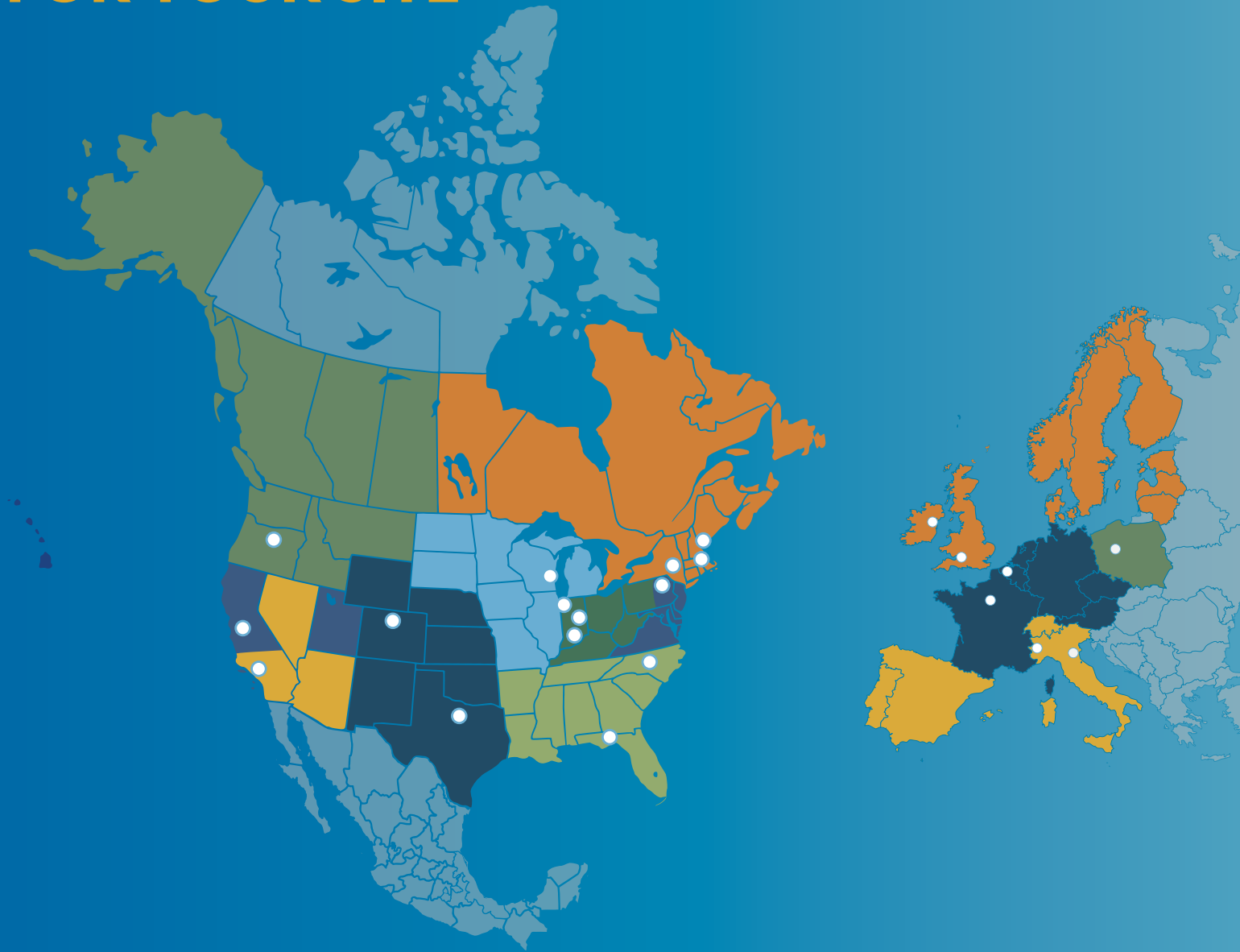
**Terracon**

Negotiating the complexities of environmental issues can be challenging and time consuming. From the most basic property assessment, to complex industrial compliance issues, Terracon's services are designed with the client in mind. Terracon's professionals have a thorough understanding of local conditions and regulations, and know how to effectively manage the potential risks presented by hazardous materials and chemical releases that have impacted a site, saving lenders and property owners time and money.

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