

The background of the slide features a scenic landscape with a dense forest covering a hillside that slopes down towards a calm body of water. A small house is visible on the left side of the shoreline. The entire image is overlaid with a semi-transparent blue filter. Abstract, flowing white and light blue shapes are layered over the background, creating a sense of movement and depth.

SIGNIFICANT REDUCTION IN VOCs ACHIEVED AT RAIL SITE

**CASE STUDY:
Successful Application of
PlumeStop and AquaZVI
Protects Property Boundaries**

HIGHLIGHTS



First application of PlumeStop® and AquaZVI™ globally.



Despite wintry weather conditions at the Rail Site in Northern Quebec, the amendment delivery and distribution was successful.



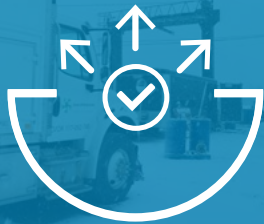
Over 95% decrease in dissolved and saturated soil VOC concentrations.



Thorough data analysis including ISMs and CSIA confirmed definite contaminant degradation.

OVERVIEW

Groundwater contamination was caused by discrete releases of chlorinated solvents at a Rail Site in the Province of Quebec. After brief, yet thorough site-specific research, WSP identified contaminant mass flux in discrete narrow transmissive lenses within a silty unit. A pilot test was conducted at the Site to assess the applicability of a brand-new technology that optimizes delivery of amendments using hydrocolloids. The pilot test would determine the applicability of a passive treatment barrier using PlumeStop and AquaZVI.



“A Combined Remedy Approach was chosen because it optimizes for the highest treatment efficiency at the lowest possible cost...”

A combined remedy approach was chosen because it optimizes the use of colloidal activated carbon and zero valent iron, allowing for the highest treatment efficiency at the lowest possible cost. The pilot test was conducted in early November. In order to confirm the effectiveness of the combined remedy and that degradation was occurring on the sorbed phase, WSP constructed *in situ* microcosms (ISMs) using aquifer material which were deployed before the amendment injection, with the amendment successfully applied under low pressure, despite wintery conditions. After conducting the pilot test, data for samples collected within the treatment barrier indicated significant contaminant concentration decreases in groundwater and saturated soil.

PLUME STOP
Liquid Activated Carbon

Aqua ZVI™

BACKGROUND

Rail Site operations led to discrete releases of petroleum hydrocarbons and chlorinated solvents, primarily between the 1950s and 1990s. The contaminant levels posed the greatest concern to downgradient residential wells. Prior to the pilot test, an in-depth investigation was conducted which included a membrane interface probe (MIP) survey. A MIP is a high-definition logging tool that measures volatile contamination along with soil electrical conductance and lithology. The results from this investigation provided actionable data for a treatment alternative. Specifically, key findings showed that the bulk of the mass was laterally narrow and limited to thin interbedded transmissive zones 8 to 15 meters bgs and that the aquifer consisted of heterogeneous silt and sand. Based on the data gathered, WSP chose to conduct a pilot test using PlumeStop and AquaZVI to treat the chlorinated ethanes and ethenes and their reductive daughter products in the groundwater. This remedy operates through three basic steps: The hydrocolloidal amendments are efficiently delivered; PlumeStop adsorbs the contaminants and limits their transport; and destruction is completed by co-application of AquaZVI, HRC and HRC Primer which stimulated degradation along both biotic and abiotic degradation pathways.



PROJECT TIMELINE

1950s:

Operations Began at the Rail Site



1970s-1990s:

Chlorinated Solvents Are Used Onsite

2005:

Release Is First Identified



2005-2016:

Various Investigations By Other Firms

2016:

MIP Survey and Other Focused Site Characterization Studies Are Conducted



2017:

Pilot Test is Conducted

PLUME STOP
Liquid Activated Carbon

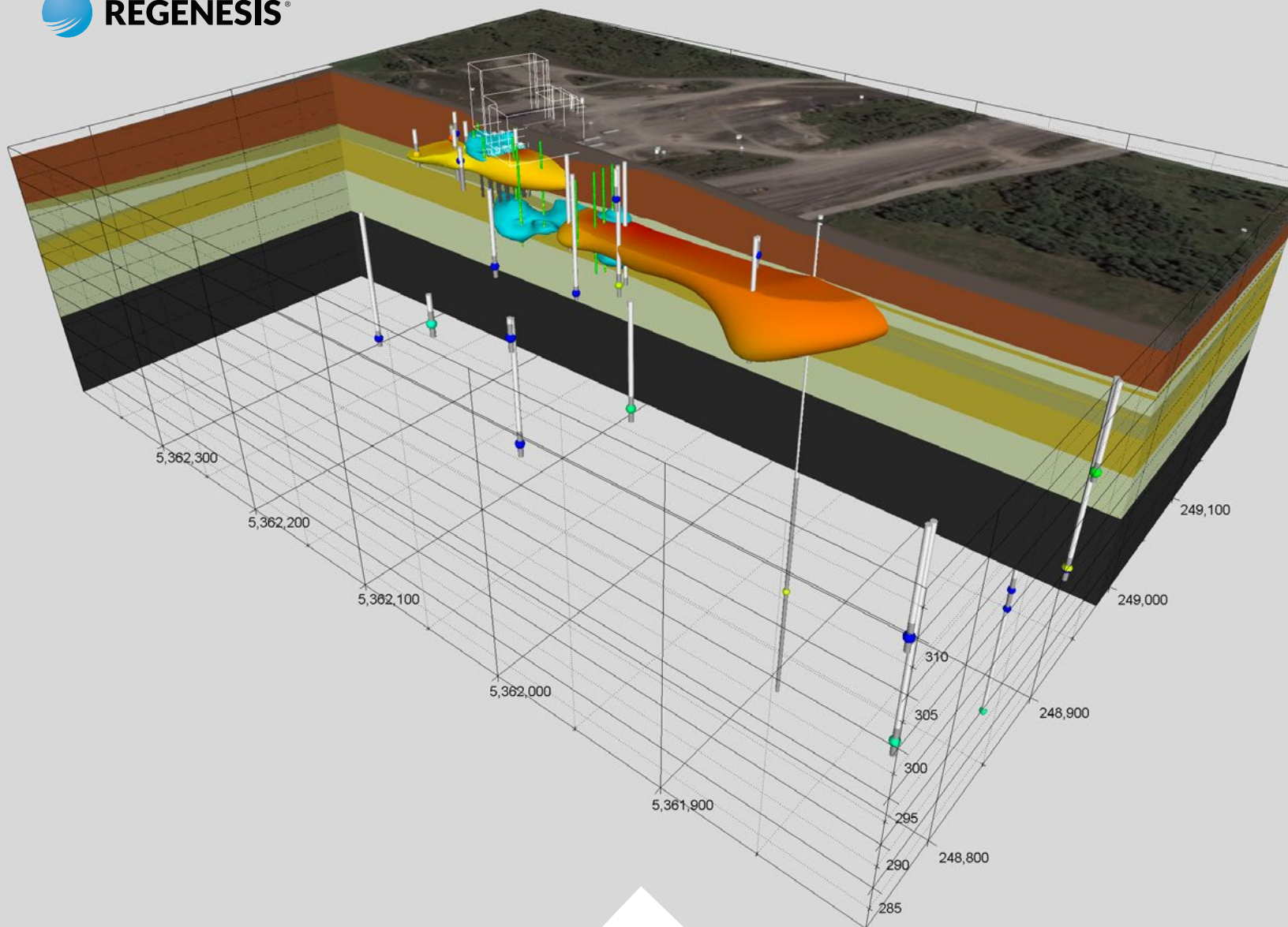
Aqua ZVI

HRC HYDROGEN
RELEASE
COMPOUND

2018:

Data Collected Showed Significant Decreases in VOCs in the Treatment Barrier





PILOT TEST:

This pilot test was chosen for its ability to stimulate multiple *in situ* degradation pathways using a single application of a multi-component, multi-functional amendment formulation. The pilot test was conducted 30 meters south of the facility's main building. Twenty injection points were completed along a 30-meter line to depths of 8 to 15 meters bgs. Four monitoring wells were installed, one each 10 meters upgradient and downgradient of the treatment barrier, and two within the treatment barrier. The combined remedy amendment, designed to stimulate both biotic and abiotic pathways, included AquaZVI, PlumeStop, HRC Primer (a fermentable electron donor), and HRC.

AquaZVI™

PLUME STOP®
Liquid Activated Carbon

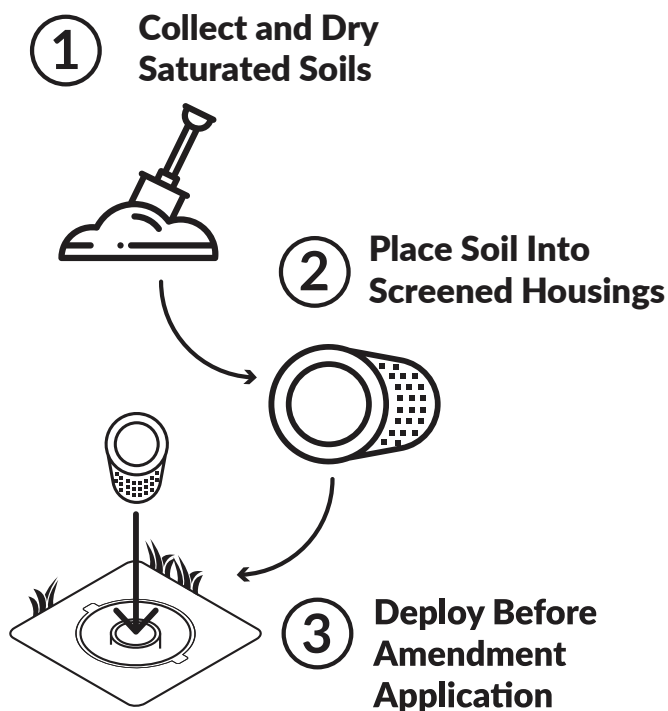
HRC
HYDROGEN
RELEASE
COMPOUND

To confirm that degradation was occurring on the sorbed phase, prior to the amendment application, WSP constructed aquifer material *in situ* microcosms (ISMs), which were made of dried aquifer material placed into 1-inch diameter well screens. Several were deployed in each well prior to the amendment application so that periodic retrieval could be performed for analysis. The goal of the ISM samplers was to quantify degradation on the PlumeStop particle because sorption would limit their ability to assess degradation from aqueous phase samples alone.

APPLICATION DETAILS:

The application consisted of 1,900L of PlumeStop, 800L of AquaZVI, 250L HRC Primer, and 250L of HRC. These were applied under low pressure at 20-40 PSI. Delivery and distribution of the amendment went well especially considering wintery weather conditions in early November. After the application, WSP observed immediate indications of distribution with the amendment and geochemical shifts observed in the two monitoring wells within the barrier.

In Situ Microcosms (ISMs)



Products Applied:

PlumeStop:



Qty: 1,900 Litres
Applied at 20-40 PSI

AquaZVI:



Qty: 800 Litres
Applied at 20-40 PSI

HRC (Primer):



HYDROGEN
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Qty: 250 Litres
Applied at 20-40 PSI

HRC:



HYDROGEN
RELEASE
COMPOUND

Qty: 250 Litres
Applied at 20-40 PSI



RESULTS

Groundwater samples collected within the barrier showed a strong geochemical shift compared to baseline conditions and significant contaminant concentration decreases. Additional advanced diagnostic data including compound specific isotope analysis (CSIA), was collected. CSIA is an analytical method that measures the ratio of stable isotopes of a contaminant which provides direct and definitive evidence of contaminant degradation. The results from the CSIA, as well as the ISM data, demonstrated definitive degradation, not just partitioning. Overall, the amendment distribution was successful, dissolved VOC concentrations decreased by over 95%, and there was contaminant destruction on the activated carbon. The pilot test was successful in demonstrating site-specific applicability of this combined-remedy.

“...dissolved VOC concentrations decreased by over 95%...”



ABOUT THE ENVIRONMENTAL CONSULTANT

WSP is one of the world's leading engineering professional services consulting firms. They are dedicated to their local communities and propelled by international brainpower. Their reputation is built on helping clients worldwide mitigate risk, manage and reduce impacts, and maximize opportunities related to health and safety, sustainability, climate change, energy, water and the environment. They engineer projects that will help societies grow for lifetimes to come. Their 5,000 multidisciplinary environmental experts are part of their 36,000 talented people in more than 500 offices across 40 countries. Visit www.wsp.com for more information.



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TECHNOLOGY



PlumeStop is an *in situ* technology that rapidly reduces dissolved-phase plumes. PlumeStop behaves as a colloidal matrix binding to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation. The benefit to PlumeStop's dispersive properties is its ability to sorb contaminants, quickly removing them from the mobile phase while providing a high surface area matrix which proves favorable for microbial colonization and growth.

Key Benefits:

- *In Situ* remediation technology that rapidly reduces dissolved-phase plumes in days/weeks
- Distributes widely under low injection pressures
- Colloidal biomatrix completely biodegrades contaminants in-place
- Achieves stringent groundwater clean-up standards
- Provides a long-term means of addressing matrix back-diffusion
- Eliminates excessive time and end-point uncertainty associated with groundwater remediation



AquaZVI is composed of colloidal, sulfidated zero-valent iron (ZVI) particles suspended in an aqueous medium with environmentally-acceptable, proprietary dispersants. The passivation technique of sulfidation, completed through proprietary processing methods, provides unparalleled reactivity with chlorinated hydrocarbons like PCE and TCE, and increases its stability and longevity *in situ* by minimizing undesirable side-reactions. In addition to superior reactivity, AquaZVI is designed for easy handling that is unmatched by any ZVI material on the market.

Key Benefits:

- Micron-scale, zero-valent iron suspended in a colloidal solution allows for easy handling and application on-site.
- Micron-size particles flow through soil pores dispersing outward without the need for fracturing or mechanical mixing in the subsurface.
- Outperforms commodity iron 30-40 times.
- Creates an anoxic and highly reducing environment, providing ideal conditions for sequential enhanced anaerobic biodegradation to destroy chlorinated contaminants.

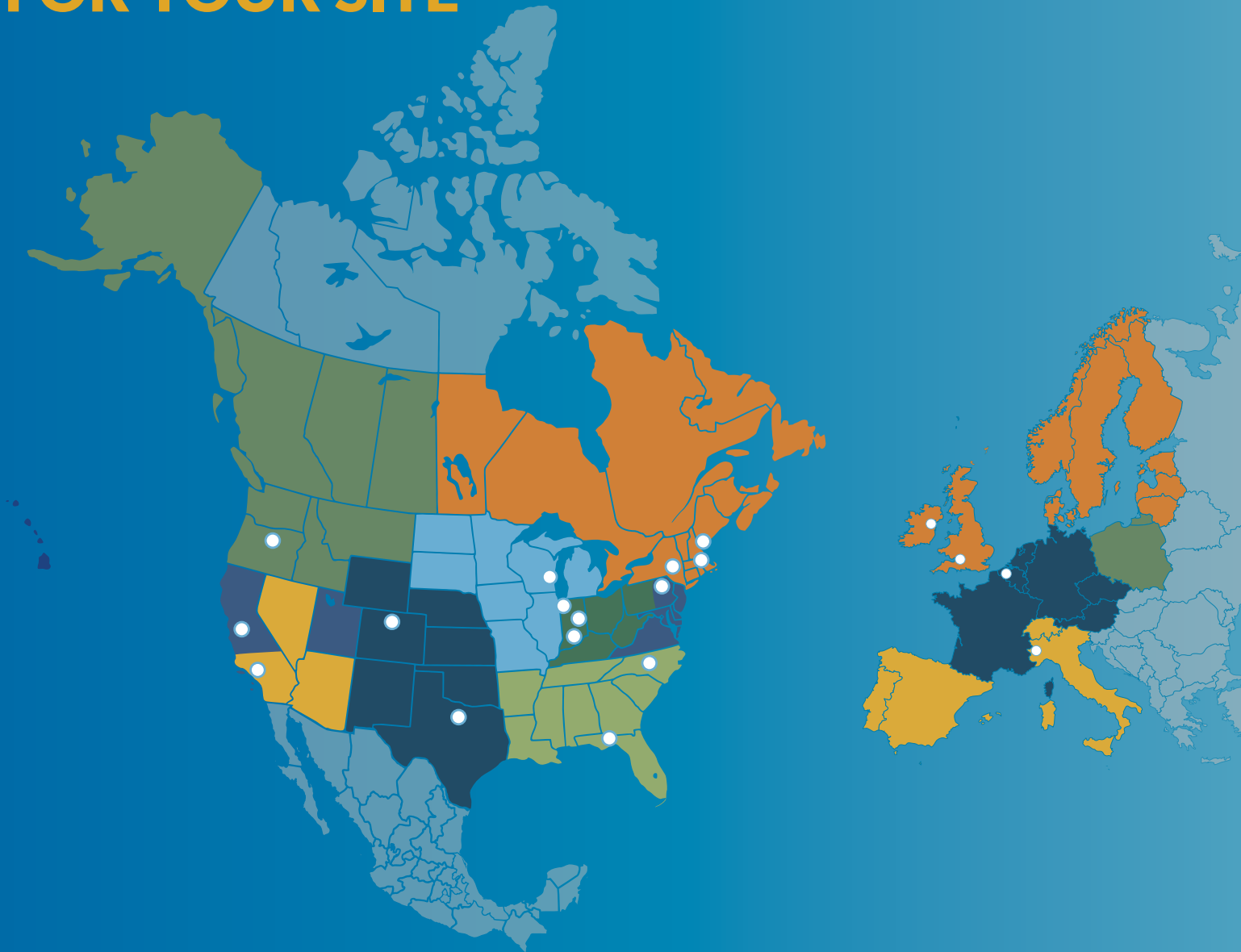


HRC is an engineered, hydrogen release compound designed specifically for enhanced, *in situ* anaerobic bioremediation of chlorinated compounds in groundwater or highly saturated soils. Upon contact with groundwater, this viscous, poly-lactate ester material becomes hydrated and subject to microbial 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.

Key Benefits:

- Provides controlled-release lactic acid to promote reducing conditions and optimize the anaerobic enhanced reductive dechlorination process
- Highly viscous to viscous versions stay in-place where injected for highly targeted treatment
- A viable, long-term source of staged-release hydrogen, on the order of 2-5 years from a single application
- Highly compatible with anaerobic bioaugmentation approaches using Bio-Dechlor INOCULUM PLUS
- Clean, low-cost, non-disruptive application
- No on-going operations and maintenance needed
- Faster and often lower cost than natural attenuation approaches

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



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