

OVER 8 MILLION CUBIC FEET OF GROUNDWATER TREATED IN 13 DAYS

**CASE STUDY:
ERD Treatment Completed in Almost
Half the Time Expected**





Introduction

Addressing the Challenge of *In Situ* Bedrock Remediation

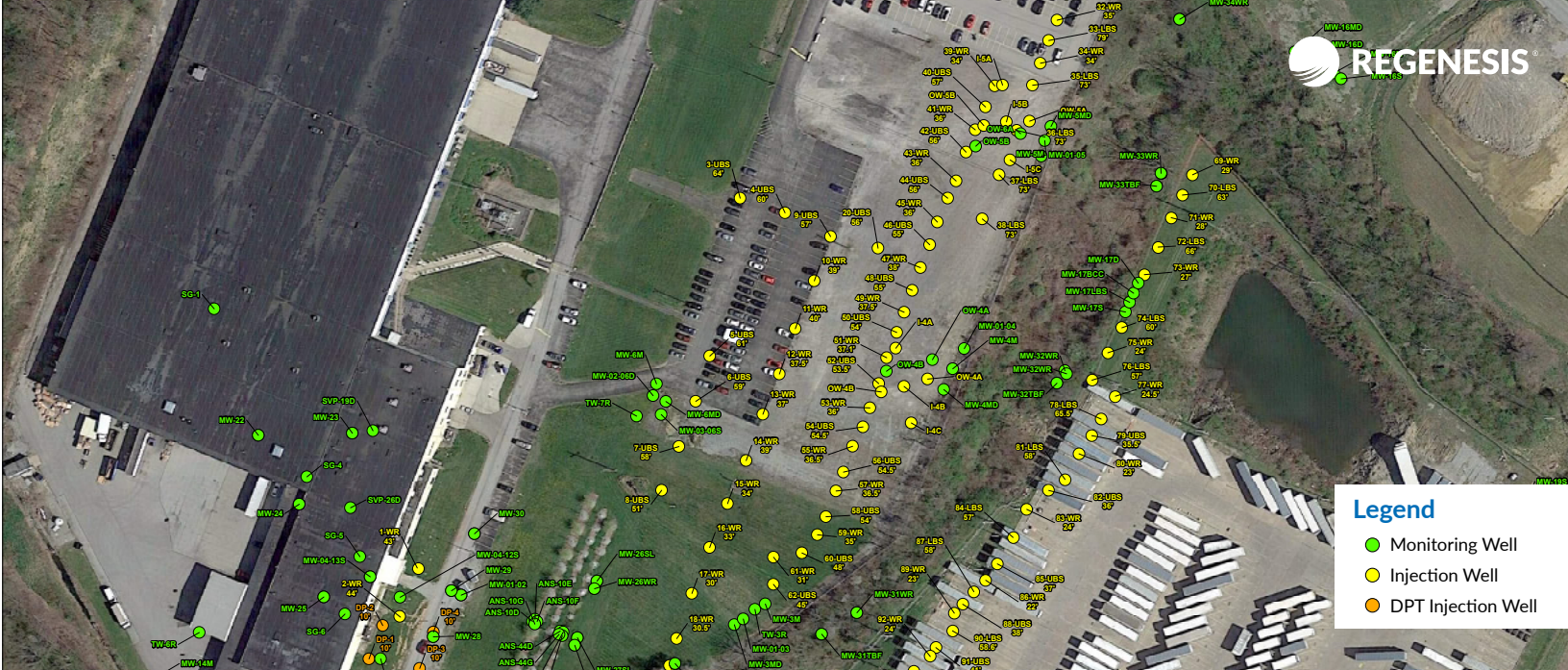
A challenge to conducting *in situ* remediation treatment in bedrock is that it is costly to install remediation injection wells, especially as the vertical treatment interval and depth increase. Thus, it is desirable that a minimum number of wells be installed to complete a full treatment, requiring the wells to be spaced apart widely. On large plumes, this extended spacing can severely limit the treatment effectiveness for Enhanced Reductive Dechlorination (ERD) approaches that utilize emulsified vegetable oils (EVOs), lactate-based products, or blends of these.

EVO materials are hydrophobic and do not further distribute after pumping. Consequently, very large volumes of make-up water are needed to distribute the material during pumping and achieve full coverage. In contrast, lactate-based substrates are more hydrophilic and distribute readily; however, they perish quickly, usually within a few months. In either case, or if a blended formulation of EVO and lactate elements is used, the final hydrogen distribution footprint will be limited, resulting in treatment gaps.



3-D Microemulsion is an engineered micellar suspension that self-distributes long after injection while at the same time supplying a controlled release of hydrogen for three years or longer to fuel the ERD process.

3-D Microemulsion's unique formulation covers a gap in the market for treating contaminated bedrock or other extensive plumes that require full treatment.



Remediation Design Approach

A Collaborative Remedial Design Approach Included a Network of Strategically-Placed Injection Wells

8,000,000 Cubic Feet

8 Million Cubic Feet of CVOC Impacted Groundwater Treated

Civil & Environmental Consultants, Inc. (CEC) and REGENESIS® collaborated on the remedial design, which consisted of 102 injection wells with most of the wells arranged in a series of staggered transects across the primary direction of the plume movement. A few injection wells were installed at strategic locations in the plume and upgradient. Following extensive hydrogeologic characterization, wells in the transects were installed with open-hole sections in the bedrock, and each well matched to one of three bedrock treatment zones delineated by CEC: Woods Run, Upper Portion of the Buffalo Sandstone, and Lower Portion of the Buffalo Sandstone. The maximum vertical extent of treatment in the bedrock ranged from 5 to 93 feet bgs. Additionally, the design included ERD substrate injection through four (4) direct push injection points in unconsolidated soils near the source area.

88,000 Gallons of Remedial Amendments Applied

88,000 Gallons of ERD Remedial Amendments Applied In Less Than 13 Days using novel, innovative tooling and application approach.

The total treatment area considered for product dosing estimation was approximately 500,000 square feet, and a total volume of approximately 88,000 gallons was specified for the ERD treatment. Well-specific volumetric loadings were determined to provide distribution of the reagents across the transects. These loadings were based on the spacing of the injection wells within each transect and unit, estimated porosities within these units, and also taking into account the self-distributing nature of these reagents, which will allow for further propagation via chemical diffusion and natural groundwater advection.

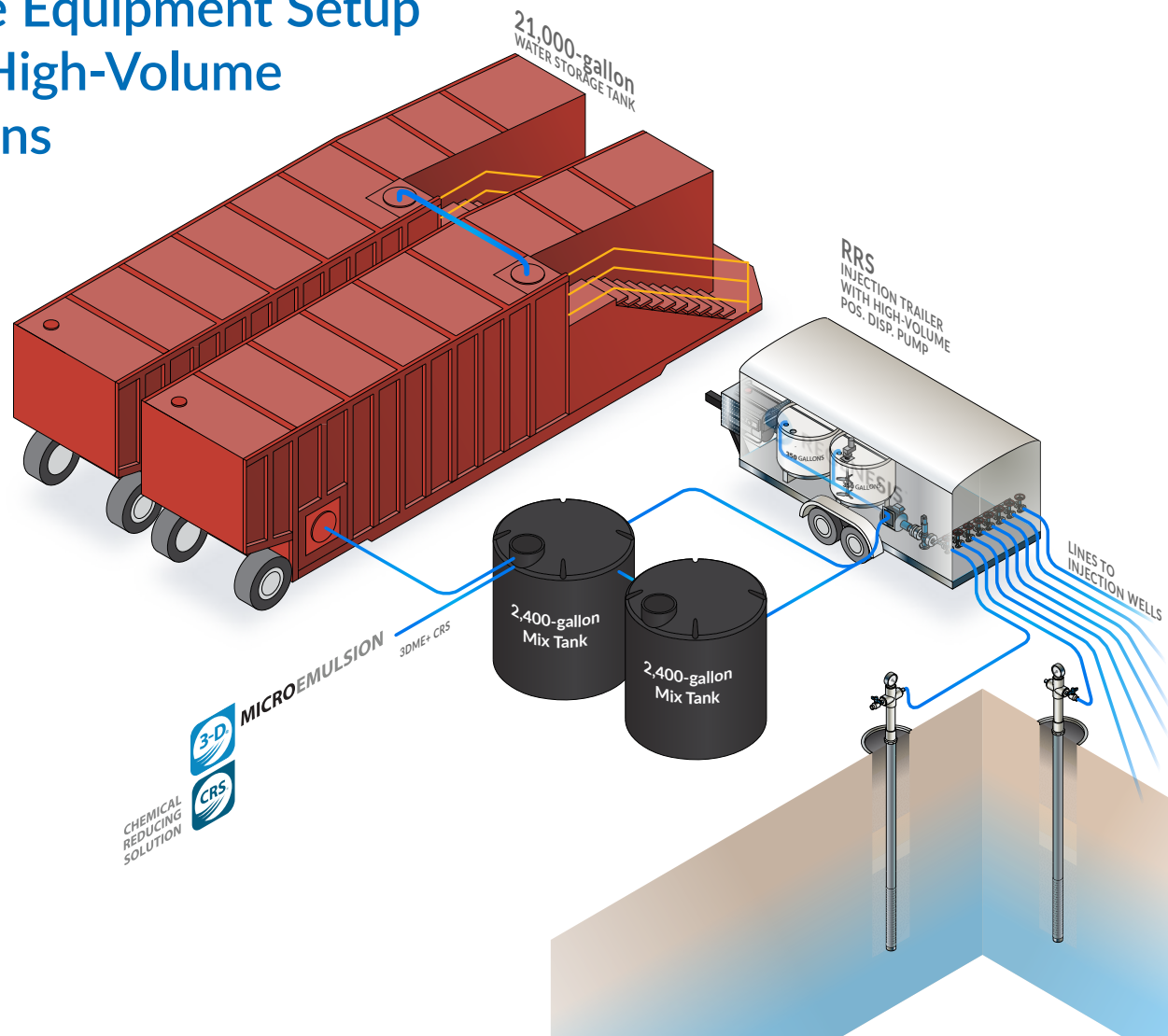
Remedial Application

Innovative Approach Used Proprietary Tooling, a Truck Outfitted with a Mobile Injection/Delivery System Cuts Application Time by almost Half

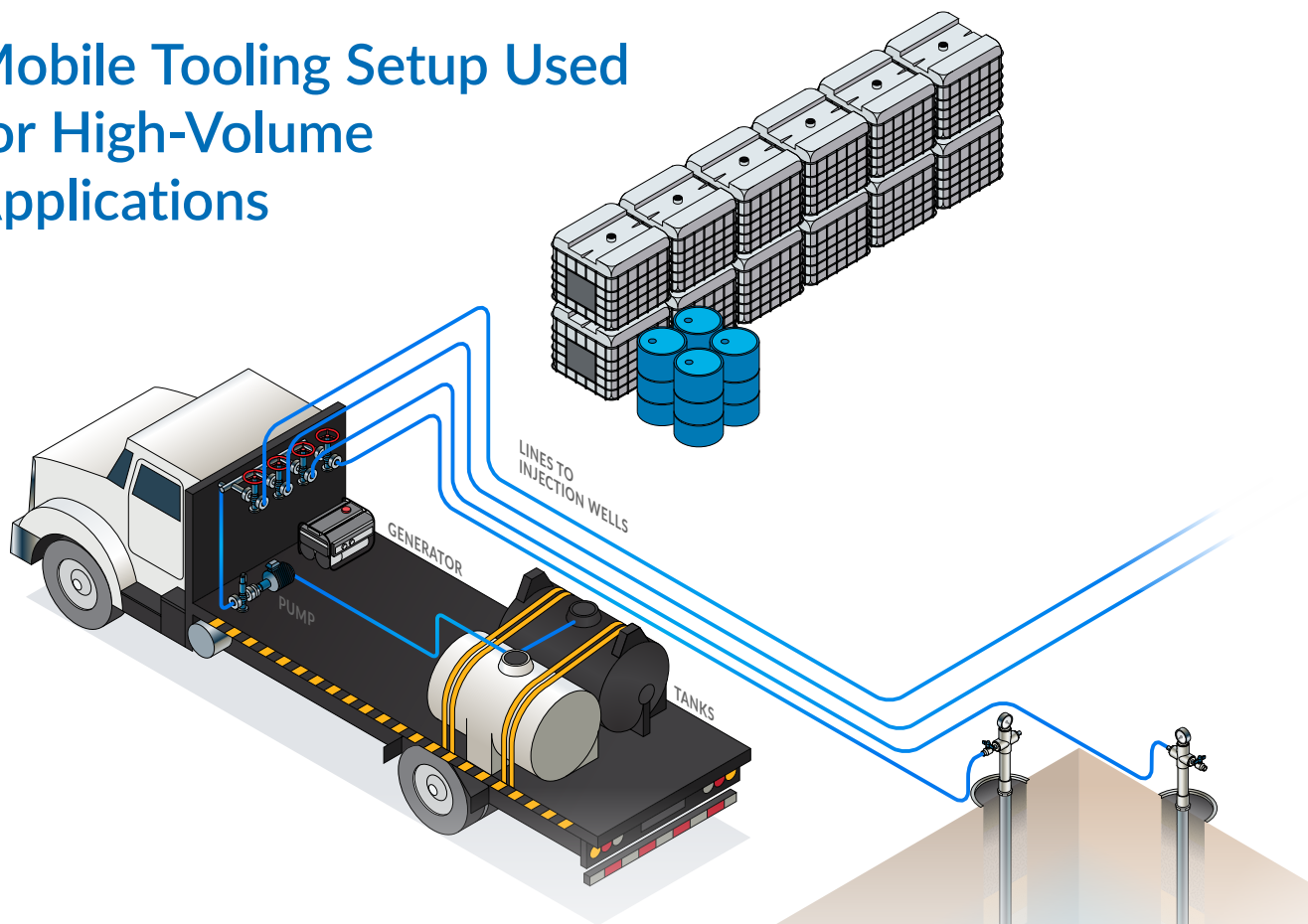
REGENESIS Remediation Services (RRS) began the application in May 2020 and completed it in less than 13 days, averaging nearly 7,000 gallons of fluid volume injected per day at this active facility. In total, more than 260,000 combined pounds of 3-D Microemulsion, Chemical Reducing Solution (CRS) and Bio-Dechlor INOCULUM Plus (BDI Plus) were injected for ERD treatment of the CVOCs.

The extensive injection well network and large injection volume required RRS to develop an innovative injection process and containment design. Two 21,000-gallon frac tanks were delivered to the site to hold deoxygenated water used for mixing and to chase product injections. Mixing for the main high-flow system was performed in two large polyethylene tanks that were constantly recirculated to ensure a homogenous mixture.

Innovative Equipment Setup Used for High-Volume Applications



Mobile Tooling Setup Used for High-Volume Applications



40% Faster

The project was completed more than 40% faster than originally scheduled.

10 Acres. 13 Days.

Remedial amendments were distributed through the ten acre treatment area in just thirteen days.

Additionally, a mobile, truck-mounted system was also built for injection into the wells located in the outer extents of the treatment area. The high-flow system used an electrically powered, multi-diaphragm, positive-displacement pump for injection while the mobile truck-mounted system used a hydraulically powered progressive cavity pump. Both systems were equipped with a pressure activated bypass system that reroutes fluid to the mix tanks if downhole pressure reaches unsafe levels. All product was stored in a secured area on-site and mixed in an adjacent area utilizing secondary containment.

RRS successfully completed the application following all special safety precautions warranted by the COVID-19 pandemic. The application was completed in almost half the scheduled time, which resulted in significant cost savings to the project. Performance results are pending as the project is in the early monitoring phase.



Summary

Enhanced Reductive Dechlorination (ERD) Approach Using Injection Well Network was Completed to Address Large-Scale Voluntary Remediation Site with Fractured Bedrock Lithology

8,000,000 Cubic Feet

8 Million Cubic Feet of CVOC Impacted Groundwater Treated

88,000 Gallons of Remedial Amendments Applied

88,000 Gallons of ERD Remedial Amendments Applied In Less Than 13 Days using novel, innovative tooling and application approach.

A large-scale enhanced reductive dechlorination (ERD) treatment of chlorinated volatile organic compounds (CVOCs) was applied in a fractured bedrock aquifer at a voluntary remediation site in Pennsylvania. CEC teamed with REGENESIS to design and implement this high-volume application to treat more than 8,000,000 cubic feet of CVOC-contaminated groundwater. RRS completed the injection of 88,000 gallons of ERD remedial amendments in less than 13 days, finishing the project on time and on budget in the Spring of 2020, during the COVID-19 pandemic. These amendments were applied across an expansive bedrock injection well network, encompassing more than 10 acres and spanning two hydrogeologic zones.



The highly-distributable ERD mixture included a site-specific, engineered formulation of 3-D Microemulsion, CRS, and BDI Plus. This symbiotic ERD amendment blend is designed to promote biological and abiotic reduction of the CVOCs. At the same time, self-distributing features result in a continued distribution after injection allowing for an effective, full-plume treatment with fewer injection wells needed.



About The Consultant

Civil & Environmental Consultants, Inc.



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Civil & Environmental Consultants, Inc. is an engineering and environmental consulting firm with more than 1,000 team members and 26 offices nationwide. Headquartered in Pittsburgh, Pennsylvania, CEC is consistently ranked among the top firms on *Engineering News-Record's* annual lists of the Top Design Firms and Top Environmental Firms.

With a focus on protecting human health and the environment, CEC identifies practical remediation technologies for hazard mitigation, negotiates with regulators, and implements remedial plans to obtain site closure certifications. CEC works with commercial and industrial clients, as well as community and economic development agencies to assess, remediate, and redevelop properties and Superfund sites. Using advanced statistical analysis and computer groundwater modeling, CEC can provide solutions to contamination problems.



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