INJECTION OF A REDUCTIVE DECHLORINATION COMPOUND AT THE X-749 AREA OF THE DOE PORTSMOUTH GASEOUS DIFFUSION PLANT

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ABSTRACT

Starting in April of 2004, Reductive Dechlorination is being implemented at the X-749 South Barrier Wall TCE (Trichloroethylene) Contamination site at the DOE PORTS facility. Reductive Dechlorination is an *in situ* remediation to biologically degrade volatile organic compounds in groundwater. Periodic monitoring from groundwater monitoring wells installed along the barrier wall will be used to evaluate the progress of remediation at this site.

The Portsmouth Gaseous Diffusion Plant (PORTS), a uranium-enrichment facility, is managed by the Department of Energy (DOE). The X-749 landfill, located in the southern portion of PORTS, was operated from the mid 1950s until 1992 when all requirements were met in a Resource Conservation and Recovery Act (RCRA) closure plan. No records exist documenting disposal of contaminated waste oils and solvents in the facility; however, some employees recall the practice. Based upon the anecdotal information, groundwater studies were conducted. These studies determined that over 500 pounds of chlorinated solvents, primarily TCE had been released into the groundwater since the facility began receiving waste in the mid 1950s.

Based upon groundwater studies, a subsurface barrier wall was installed at the X-749 southern boundary to prevent further movement of contaminated groundwater from traveling off the DOE property. This 1,077-foot wall at 25 feet below ground surface was built in a parallel direction to the southern plant boundary line. This barrier was used to contain and divert the groundwater plume for a minimum of three to four years allowing other remedial technology to be implemented at the site.

In the spring of 2004, Reductive Dechlorination was implemented in the X-749 South Barrier Wall area to reduce the TCE concentrations. Reductive Dechlorination is used as a mechanism by which chlorinated hydrocarbons are biologically degraded under anaerobic conditions. Reductive Dechlorination is a slow and unstable natural process where anaerobic microbes substitute hydrogen (H) for chlorine (Cl) on chlorinated contaminant molecules, thus dechlorinating the compound. Therefore, to increase the rate of dechlorination, a Hydrogen Release Compound (HRC) liquid is directly injected into contaminated groundwater and saturated soils. This injection dechlorinates the contaminant and results in the production of non-toxic compounds such as ethane and ethane. Reductive Dechlorination was used because the groundwater recharge in this area will not support a pump and treat approach.

The groundwater of the X-749 South Barrier Wall area will be monitored to demonstrate the effectiveness of the HRC implementation. The groundwater inside the treatment area will be sampled and analyzed for comparison of geochemical changes induced by HRC. Sampling of the groundwater monitoring wells located at the southern edge of the TCE plume occurs every

other month for six months. Once this period of six months of groundwater collection is completed, the sampling is decreased to semi-annual. The data will be presented on a time trend analysis to show the effects of the HRC implementation on the TCE plume at the X-749 area of PORTS.

INTRODUCTION

The Portsmouth Gaseous Diffusion Plant (PORTS), a uranium-enrichment facility, is managed by the Department of Energy (DOE). Since enriching uranium in the early 1950s, PORTS used solvents and degreasers to clean machines and machine tools. Unfortunately, these cleaning practices did not have a defined disposal process. Several investigations have identified various VOCs (volatile organic compounds) from the solvents and degreasers at detectable levels in the groundwater. The most notable VOC is TCE (trichloroethylene). Two sources of groundwater contamination formerly existed in the area, the X-749 Landfill and the X-120 Goodyear Atomic Corporation Training Facility. The X-120 Facility housed both machine shops and training rooms that were used during plant construction. The X-749 Landfill was closed in accordance with Ohio Hazardous and Solid Waste Regulations in 1993.

Once the groundwater plume migrated from the contaminated soils of the X-749 and X-120 areas, a subsurface barrier wall was installed in 1994 at the X-749 southern boundary of the DOE property as a temporary preventative method. This wall was to prevent off-site migration of the TCE-contaminated groundwater plume. Since the plume is moving from north to south at a relatively slow velocity the barrier wall was built in an east-west parallel direction to the DOE property causing the plume to increase velocity to flow around the ends of the barrier wall.

Once the barrier wall was completed, groundwater-monitoring wells located at strategic points along the barrier wall were closely monitored. Monitoring results indicated that higher TCE concentrations, above the Maximum Contaminant Level (MCL), were present in many of the monitoring wells. These monitoring results indicated that the groundwater plume was close to moving off-site through the barrier wall.

DESIGN

To counteract the groundwater plume flow at the X-749 area, the Reductive Dechlorination Compound (RDC) was applied via Direct Push Technology (DPT) at the southern edge of the X-749 portion of the site. Boreholes were drilled to the Gallia sandy silt water-bearing unit above the Sunbury Shale. Although the boreholes are not long-term, this technology was chosen due to the rapid response option for implementation. This application was accomplished by injecting 180 points in three zones, creating a reactive barrier that will intercept and treat the groundwater as it moves through the barrier. The three zones within the X-749 South Barrier Wall area are the Upgradient, Downgradient, and Inside Zones. In these zones, a definitive grid pattern for injection of RDC was chosen according to groundwater flow. The grid pattern was chosen over a barrier array approach, because other projects have demonstrated that grid-based injection reduces TCE more efficiently. Because a barrier array is limited to a single line of injection points, it creates a smaller reactive area than does a grid pattern. See Figure 1 for an overview of the three separate definitive grid zones with borehole locations.

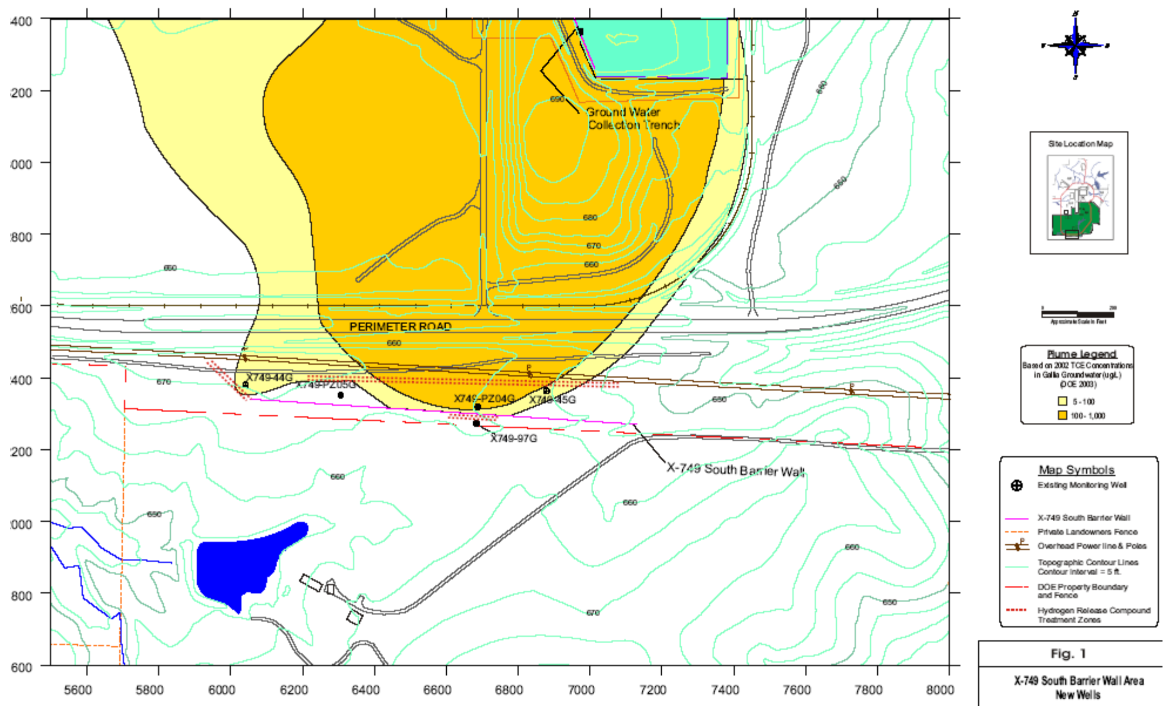

Fig. 1. An overview of X-749 Area where 180 boreholes were placed into three definitive grid patterns for the injection of RDC.

A sampling program was developed to monitor the progress of the HRC. This program calls for baseline samples for the area collected before RDC application, samples every other month for a period of six months from selected groundwater wells within the area, and semi-annual sampling in the same selected wells after the initial six months. At PORTS, data collected as part of the Integrated Groundwater Monitoring Plan (IGWMP) provided the baseline contaminant concentrations and groundwater chemistry. During the initial sampling period, Volatiles Method 8260B analysis was performed, yielding data that included the levels of TCE. See Table I for the listing of parameters collected under IGWMP for the X-749 groundwater wells at PORTS.

Table I. Parameters and Analysis Method Collected Under IGWMP at the X-749 Area of PORTS.

Parameters Collected	**Analysis Method**
Volatiles	SW846-8260B
Alkalinity	EPA 310.1
Chloride, Sulfate	EPA 300.0
Metals	SW846-6010B

PROCESS

HRC is used to enhance in situ biodegradation raters for chlorinated hydrocarbons (CHs) by supporting anaerobic reductive dechlorination processes. Reductive dechlorination is now recognized as one of the primary attenuation mechanisms by which chlorinated solvent groundwater plumes can be contained and/or remediated.

HRC is a proprietary polylactate ester that, upon being deposited into the subsurface, slowly releases lactate. Lactate is metabolized by naturally occurring microorganisms, resulting in the creation of anaerobic aquifer conditions and the production of hydrogen. Naturally occurring microorganisms capable of reductive dechlorination then use the hydrogen to progressively remove chlorine atoms from chlorinated hydrocarbon contaminants (converts tetrachloroethene [PCE] to trichloroethene [TCE] to dichloroethene [DCE] to vinyl chloride [VC] to ethane).

HRC is manufactured as a viscous gel that can be injected into the saturated zone in a grid or barrier configurations for either localized area or cutoff-based treatment approaches. The use of HRC for groundwater remediation offers a comparatively simple and cost-effective remediation alternative for sites that would otherwise require unacceptably long periods of time for natural attenuation or the high levels of capital investment and operating expense associated with active remediation technologies.

Extended release of HRC, known as HRC-X which is a special formulation of HRC, will release lactic acid for more than 3 years. Residual Dense Non-Aqueous Phase Liquids (DNAPLs) are often difficult to find and very costly to treat. Residual DNAPL causes a lingering and unwanted source of groundwater contamination that can represent enormous and unexpected cleanup costs. HRC-X is one solution to this challenging problem. Once injected into the general vicinity of the residual DNAPL, HRC-X goes to work, releasing lactic acid and producing the desired hydrogen throughout the area. This hydrogen, in turn, drives the rapid desorption, dissolution, and degradation of the bound residual DNAPL.

RESULTS OF MONITORING

The HRC injection project was completed in April of 2004, followed by sampling within five separate groundwater-monitoring wells inside the X-749 area. With baseline results of TCE concentrations differing between the three zones, each zone is being sampled and analyzed individually at the same proposed integrals. Each zone within the X-749 area was represented with two wells, except for the Upgradient Zone, which was represented by one well. Results have shown three wells, each within different zones, to have overall decreased levels of TCE. In addition, another well within the Downgradient Zone has a decelerate rise of TCE. Since the injection project's completion, however, monitoring well X-749-45G, located within the Inside Zone, has shown more than double the initial concentrations of TCE. This discrepancy has prompted continued monitoring and sampling. See Figure 2 for TCE monitoring results performed under IGWMP and other sampling.

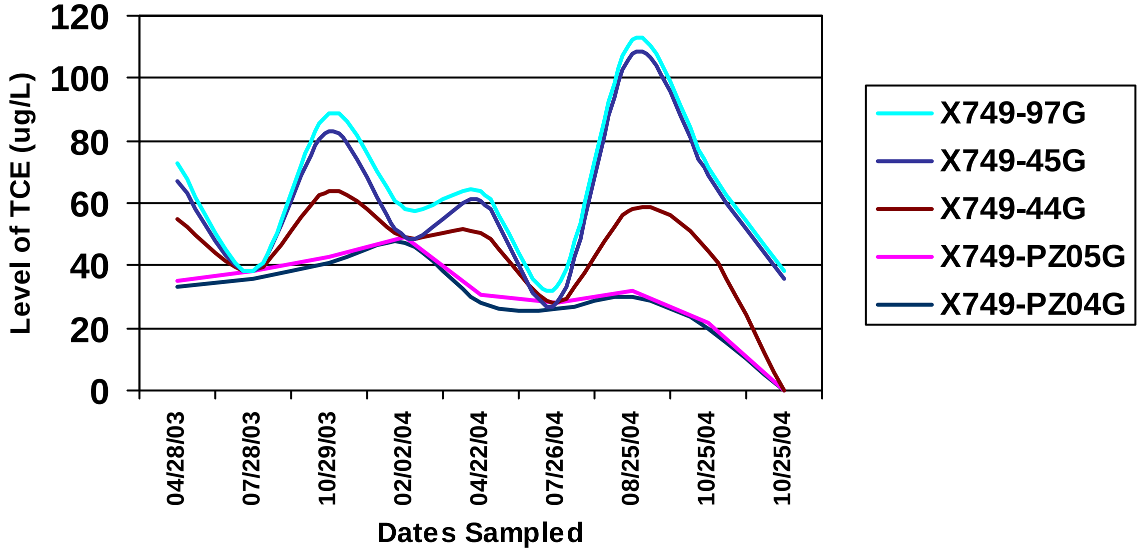

Fig. 2. Variances in TCE measurements from samples collected at the X-749 area of PORTS.

CONCLUSION

HRC-X is a widely accepted solution that has been applied to hundreds of project sites worldwide. In addition to degrading contaminants such as TCE, this cost-effective treatment for groundwater contamination exhibits many benefits for the PORTS site. Some of these benefits are the clean and low-cost application methods, the need for no continuous operations and maintenance, more rapid remediation than the natural attenuation option, and capability to be deployed even when surface structures are present. The need for reapplication of HRC will depend upon more sample analysis, achievable biodegradation rates, and remedial goals for the site. All of these factors influenced the HRC doses and the size of the grid area for PORTS.

REFERENCES

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