

RegenOx[®] Treats Benzene in Low Permeability Soils

Introduction

Service station operations created a benzene contaminant plume in tight subsurface soils. A dual-phase extraction system (DPE) was installed and removed a total of 9,965 pounds of petroleum hydrocarbons over two 90-day operational periods. However, contaminant removal reached asymptotic levels and a more effective remedial strategy was needed to address the remaining benzene concentrations. The DPE system was shut down in December 2004 and RegenOx[®] was selected to evaluate the effectiveness of reducing benzene and MTBE concentrations in tight soil lithology.

Description of Activities

RegenOx was pilot tested around well DPRW-6 to evaluate its effectiveness in tight soil. A total of 1,439 pounds of RegenOx was applied near well DPRW-6 as a pilot test in August 2005 (510 lbs) and July 2006 (929 lbs). Benzene concentrations declined within 15 weeks by 76% and successfully reached the Site Specific Target Level (SSTL) (Graph 1), prompting a design for full scale implementation.

The objective of full-scale treatment was to provide rapid mass reduction of benzene concentrations and reach the SSTL of 20.1ppm across the 9,100 ft² source area. Benzene rebound at DPRW-6 (the original pilot test well) six months post-injection suggested that a previously unidentified plume had re-contaminated that area. After additional site characterization was completed, 7,110 pounds of RegenOx were applied during six injection events over five treatment areas (Figure 1). The RegenOx injections were performed over a 6 month period due to weather delays. Monitoring was conducted to observe potential contaminant rebound from areas requiring additional injections. The applications targeted a treatment thickness of 14-20 feet bgs into silty clay with intermittent sand “stringers”. RegenOx was injected using a top-down direct-push injection technique with 5-15 lbs of RegenOx injected per vertical foot.

Table 1. Pilot Test Results in DPRW-6 (ppm)			
Contaminant	Baseline Pilot	15 wks Post Inj.	Reduction
Benzene	36.3	8.7	76%

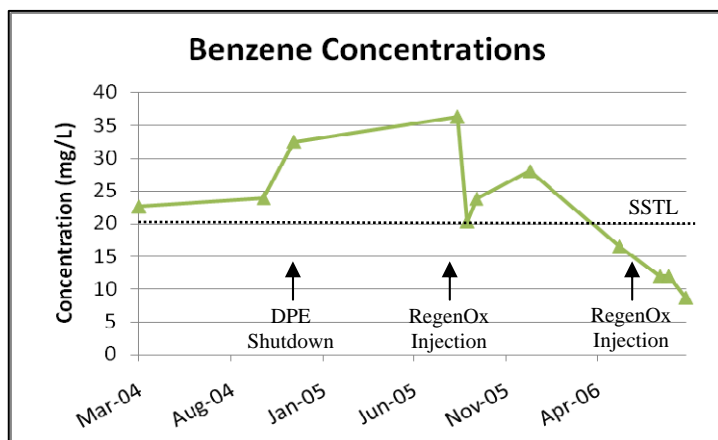
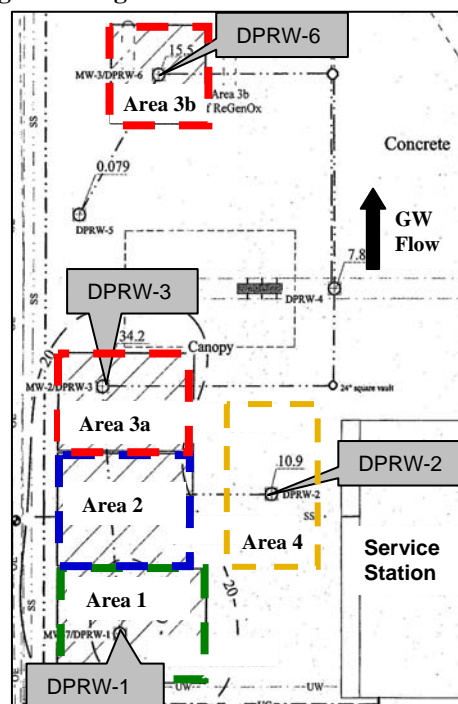


Figure 1. RegenOx Full-Scale Treatment Areas



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- **Soil Type:** Silty clay with sand stringers
- **Depth to Groundwater:** 13 ft
- **Groundwater Velocity:** 0.20 ft/day
- **RegenOx Applied:** 7,110 lbs
- **Injection Spacing:** 5-8 ft on-center
- **Injection Events:** 6 total

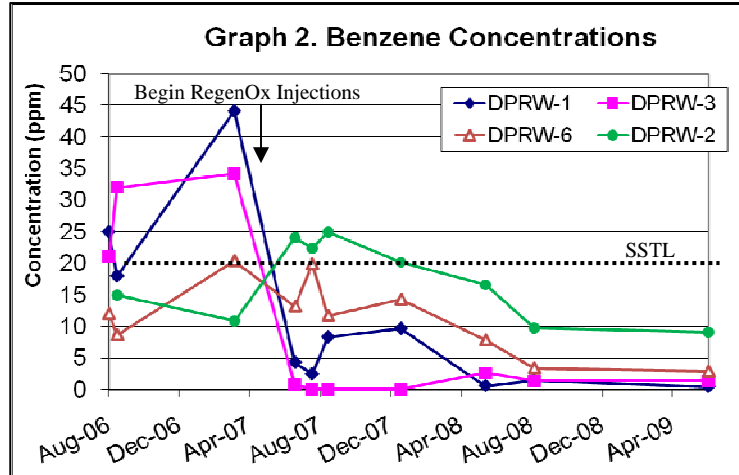
Results

Prior to the full-scale application, benzene concentrations exceeded the SSTL of 20.1ppm in all wells. Monitoring over a 7 month period prior to remedial treatment indicated an increase in concentrations from 12 - 32ppm to 20.4 - 44.1ppm.

RegenOx was applied over six injection events as indicated in Table 2. Sampling conducted after the final application event in December 2007 indicated a benzene reduction to at or below the SSTL in all wells (Graphs 2) including the original pilot test well DPRW-6. As monitoring continued, a decline in benzene concentrations persisted via natural attenuation and all wells sampled below 10ppm in August 2009. Based on the reducing trend observed over the past 12 months, the site was recommended for closure.

Table 2. Full Scale Application Details

	Date of Inj.	Treatment Area (ft ²)	RegenOx Applied (lbs)
Area 1	5/2007	600	1,560
Area 2	6/2007	750	1,320
Area 3a	7/2007	600	1,020
Area 3b	7,10,11/2007	400	1,680
Area 4	11,12/2007	750	735



SLA Environmental Services is a specialized contracting company dedicated to providing professional direct push soil and groundwater sampling, in-situ chemical application and mobile dual phase extraction services to the engineering and environmental consulting industries. Established in 1996, SLA has specialized in the development of successful site-specific approaches to the in-situ application of chemical oxidation products to tight formations and shallow bedrock environments. Michael S. Sewell, P.G. is responsible for the management and development of the company and has more than 20 years experience in the mineral exploration and environmental industries.