

### Shively's Auto Service - Case History

In 1992, remedial activities began at the Shively Service Center located in Radcliff, Kentucky. After the leaking underground storage tanks were removed from the site approximately 1,500 cubic yards of BTEX impacted soil was excavated and disposed off-site from the tank pits. Based on the review of historical sampling activities it was believed that the majority of the impacted soils were removed at that time. The soils at the site consist of highly impermeable clays with interbedded chert lenses.

The initial approach for remediation of the impacted groundwater at the site was the installation of a groundwater pump and treat system. The pump and treat system included a 300 foot long extraction trench, two collection sumps, and groundwater recovery pumps. This extraction system operated until the late 1990's. Based on the results from the June 2001 groundwater sampling, it can be concluded that the pump and treat system had minimal effect on cleanup of the groundwater at the site. A total of approximately \$730,000 had been spent on remedial efforts through the end of 2000.

In 2001, the Owner entered into a Pay for Performance (PFP) contract with the State of Kentucky Office of Petroleum Storage Tank Environmental Assurance Fund to complete the remedial efforts at the Shively site for approximately \$270,000. The first activity conducted under the PFP was 8-quarterly mobile multiphase extraction events. The multiphase extraction events provided minimal reductions in BTEX concentrations in the groundwater at the site. Two pilot test injections using hydrogen peroxide and ORC® separately at different locations were also implemented with similar results (minimal reductions in BTEX concentrations).

In 2005, a dual phase extraction system was installed at the site. The system operated for approximately one year until it was determined that the cost for operation was significantly greater than the rate of hydrocarbons removal. The July 2006 sample results indicate that the dual phase unit provided reductions in Benzene concentrations in four of the nine impacted wells of concern at the site.

In July 2007, the consultant for the owner approached AST Environmental, Inc. (AST) to provide an approach to rapidly remediate the remaining groundwater impacts at the site. AST provided a preliminary design and cost estimate of \$180,000 to perform a BOS 200® injection at the site to achieve action levels. The first step outlined in the AST approach was to perform a remedial design characterization event to refine the conceptual model for the site by determining the vertical distribution of groundwater and soil impacts.

In March 2008, AST performed a rapid remedial design characterization. This rapid remedial design characterization was performed in 2 days and included the installation of 8 continuous soil borings to approximately 20 feet and 8 groundwater implant clusters. Also, a round of samples were also collected from the existing monitoring wells and the results identified four wells that remained above the action level of 0.4 ppm for Benzene (MW-1, MW-2, MW-4, and P3). The results from this design characterization along with the results from the existing wells were used to complete the injection design by refining the vertical intervals targeted for BOS 200® injection as well as the amount of material to be injected. This final injection design resulted in a reduction in the total pounds of BOS 200® required to treat the impacted groundwater and a lower revised price of \$120,000. It should be noted that the cost of the remedial design characterization was \$10,000 and resulted in \$50,000 of cost savings.

After reviewing the overall approach and cost estimate the Owner and his consultant decided to move forward. Due to financial constraints, it was determined that the injection effort be separated into two distinct phases. The first phase was to complete the injection around MW-1 (2500 sf area aka the MW-1 Pilot Test) and the second phase would include the balance of the site. Additionally, the implementation of the second phase was dependent on the success of the first phase as well as funding availability.

In June 2008, the BOS 200® pilot test injection was completed around MW-1 (initial concentration 4.5 mg/l). The pilot test consisted of the injection of 4,375 lbs of BOS 200®, 1,620 lbs of gypsum, 10 gallons of Trap & Treat Bacteria Concentrate, and 6,500 gallons of water in a 50'x50' area around MW-1. The

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aqueous BOS 200® slurry was injected in 25 injection points from 8 to 20 feet below ground surface. The post injection analytical results from the July 24, 2008 sampling demonstrated that the concentration of Benzene in the well was less than 0.0010 mg/l (ND). The well was sampled again on February 25, 2009, eight months after the injection event, and remains less than 0.0010 mg/l (ND) for Benzene indicating no rebound. The sample results are provided in the attached table.

After obtaining results from the pilot test and availability of funding, injections were completed during the first week of February 2009 around the compliance wells (MW-2, MW-4, and P-3) that remained above site action levels. A total of 5,300 square feet from 8 to 20 feet below ground surface was treated during the second phase. The results from the February 25, 2009 sampling, three weeks after this second injection event, demonstrate that the Benzene concentrations in these three wells were reduced well below the site cleanup level of 0.4 mg/l (See the Table below). The analytical results from the groundwater samples collected from the on-site monitoring wells conducted since 2001 are provided on the table below.

The owner and his consultant are now seeking closure based on meeting the action level for benzene in all of the wells.

**ARITHMETIC TOTAL OF BENZENE CONCENTRATIONS**

Shively's Service Center  
Dixie Highway, Radcliff, Kentucky

Date	MW-1	MW-2	MW-3	MW-4	MW-5/5A	MW-23	MW-25	P-3	P-5	Arithmetic Total
2/25/09	< 0.0010	0.049	0.045	< 0.0010	< 0.0010	< 0.0010	0.068	0.0026	0.046	0.21
7/24/08	< 0.0010	1.7	0.054	0.59	0.034	0.058	0.069	5.5	0.18	8.19
1/29/08	6.7	1.1	0.15	0.63	0.12	0.14	0.14	7.1	0.20	16.28
11/1/07	6.0	1.1	0.15	0.63	0.12	0.14	0.14	3.9	0.20	12.38
7/13/06	4.9	2.4	0.11	0.56	0.45	0.56	0.046	5.9	0.14	15.07
2/4/05	7.7	NS	0.70	1.40	0.99	0.38	0.067	7.0	0.60	18.84
12/30/02	6.6	7.8	0.44	1.90	1.10	1.20	0.31	5.0	0.49	24.84
6/19/02	10.0	6.1	0.27	2.20	0.52	2.20	2.1	5.8	0.27	29.46
9/24/01	9.6	5.3	0.18	0.64	1.00	0.64	1.9	8.5	0.69	28.45
6/28/01	8.6	5.0	0.13	0.80	0.82	1.70	1.6	7.5	0.69	26.84

**MILESTONES - BENZENE CONCENTRATION (ppm)**

#2 15.24 ppm  
#3 8.29 ppm  
#4 Action Levels = 0.4 ppm in all wells