

ITRC CASE STUDY

Site: Pierce Service Station, Los Angeles, CA

Contaminant: BTEX

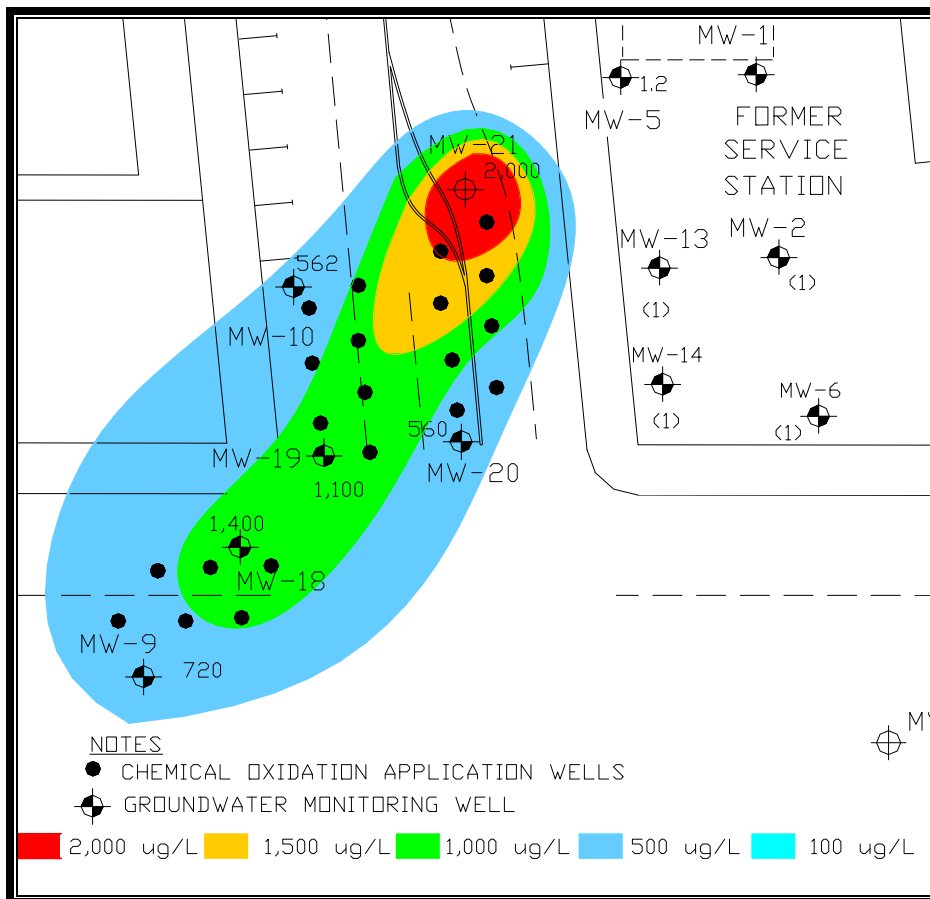
Oxidant: Fenton's Reagent

Regulatory Agency Contact: Ms. Mercedes Hsu (213) 576-6600
Los Angeles Regional Water Quality Control Board

Consultant: Mr. Gary Cronk

Site Setting

An offsite gasoline plume extended approximately 150 feet to the southwest of the former Pierce Service Station site, across two high traffic streets. Groundwater flows towards the southwest at a mild gradient of 0.008 feet per feet. The groundwater velocity is estimated to be 0.04 feet per day. The Los Angeles Regional Water Quality Control Board (LARWQCB) considers the shallow aquifer a potential drinking water source. A High School campus (a sensitive receptor) is located directly down gradient of the site. Baseline iron levels in the groundwater ranged from 6 to 338 mg/l and total organic carbon from 17 to 35 mg/l. The aquifer sediments are comprised of silty sands in the uppermost portion of the aquifer and low permeability clayey silts in the lowermost.



**Figure 1. Benzene Iso-Concentration Map from May 2003
(Baseline Conditions)**

Description of Target Treatment Volume

The contaminants of concern at this site included BTEX as well as TPH as gasoline (TPHg). No MTBE was identified. The plume was confined to a shallow alluvial aquifer at a depth of 30 to 45 feet below grade. The approximate areal extent of the targeted contamination was 7,065 square feet, and the aquifer volume was estimated at 5,200 cubic yards. The highest pre-treatment level of benzene (risk driver) was 2,000 ug/l and the highest TPHg was 65,000 ug/l.

Remedial Design

Design of the field injection parameters were evaluated from a proprietary model that incorporates geochemical and hydrogeologic parameters for the site and determines the appropriate quantities of oxidant required. Specific values of NOD, SOD, or NOM are not evaluated by this model, but are indirectly accounted for in the model output. Twenty-one injection wells (screened from 31 to 46 feet bgs) were installed and used during a full-scale treatment of the site, using the Fenton's oxidation remediation technology. Based on prior experience with low permeability soils, the injection wells were estimated to have a radius of influence (ROI) of about 15 feet. The ROI estimate was confirmed in the field by measuring changes in water quality parameters. The wells were spaced approximately 25-feet apart and staggered to provide overlapping treatment radii and cover the offsite plume. The groundwater was initially "conditioned" by injection of a small quantity (50 gallons per well) of a catalyst solution consisting of ferrous sulfate and hydrochloric acid. Hydrogen peroxide (17.5 percent solution) was then gravity-fed into the subsurface (not pumped or pressurized). Down-hole temperatures were monitored during the injections and the rate of injection of peroxide was controlled to ensure the groundwater temperatures did not exceed 180 degrees Fahrenheit. Over the course of four-weeks, a total of 8,600 gallons of hydrogen peroxide was injected in the groundwater. The average injection quantity was 430 gallons per well.

Results

Overall, the Fenton's oxidation remediation technology was highly successful at this site. Following treatment, the benzene level in the most contaminated well was reduced from 2,000 ug/l to 240 ug/l (88% reduction) and TPHg was reduced from 62,000 ug/l to 4,300 ug/l (93% reduction). Overall, the six monitoring wells showed an average 96% reduction in benzene and 93% reduction in TPHg. The following table summarizes the reductions in TPHg and benzene levels at the six monitoring wells at the site.

Sample Date	TPH Gas (ug/l)	Percent Reduction	Benzene (ug/l)	Percent Reduction
MW-9				
5/21/2003	2,600		720	
8/1/2003	990	62	150	79
1/9/2004	520	80	250	65
6/25/2004	180	93	3.3	100
MW-10				
5/21/2003	17,000		562	
8/1/2003	2,800	84	77	86
1/9/2004	3,100	82	110	80
6/25/2004	1,600	91	21	96

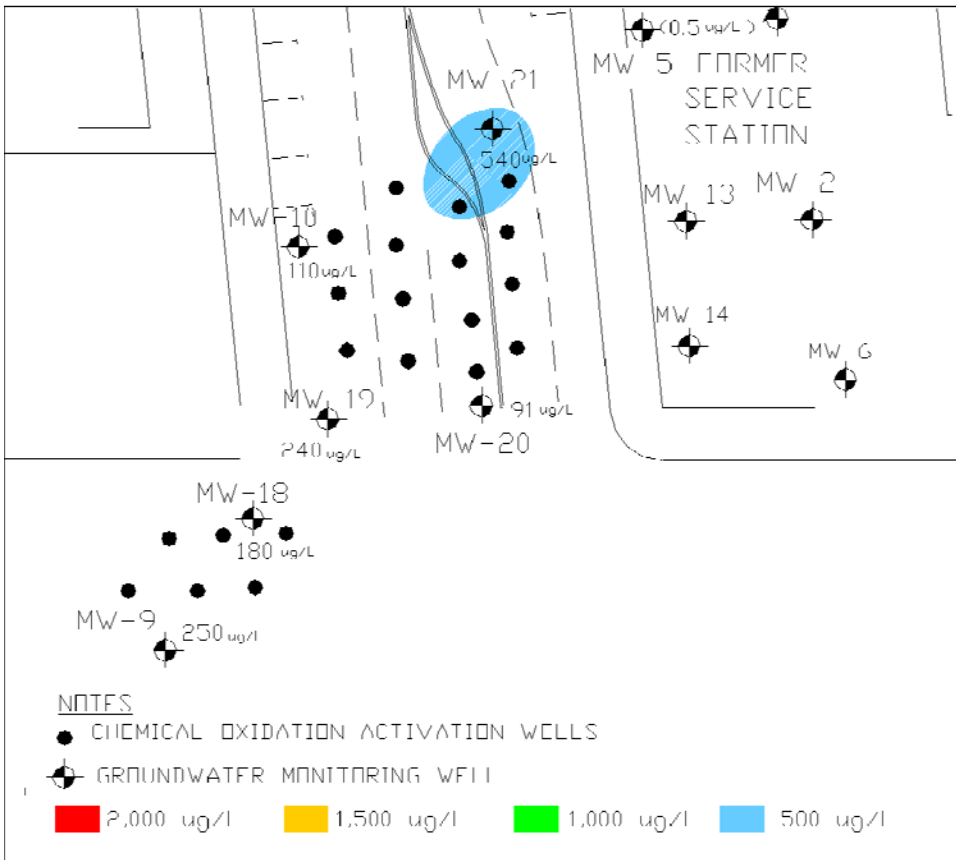
MW-18				
5/21/2003	55,000		1,400	
8/1/2003	61,000	-11	1,300	7
1/9/2004	16,000	71	180	87
6/25/2004	4,000	93	25	98
MW-19				
5/21/2003	66,000		1,100	
8/1/2003	15,000	77	660	40
1/9/2004	7,800	88	240	78
6/25/2004	4,100	94	17	98
MW-20				
5/21/2003	38,000		560	
8/1/2003	7,700	80	490	13
1/9/2004	7,200	81	91	84
6/25/2004	2,100	94	37	93
MW-21				
5/21/2003	62,000		2,000	
8/1/2003	29,000	53	1,700	15
1/9/2004	10,000	84	540	73
6/25/2004	4,300	93	240	88

Several wells nearest the source area indicated no reductions or slight increases in contaminant levels following the first three months of monitoring (August 2003). However, after 4-6 months of groundwater monitoring (January 2004), the benzene concentrations in all the wells were reduced significantly (average 78% reduction). After one year following treatment, the benzene levels were reduced an average of 96%. The delayed treatment effect is believed to be due to the slow re-equilibration of sorbed and dissolved phases in the subsurface following to the vigorous Fenton's reaction. It is also probable that a bio-stimulation effect occurred from increased levels of dissolved oxygen released by the hydrogen peroxide. The bio-stimulation effect may continue to occur at this site for several more months and benzene levels will likely continue to drop. Indoor air quality was not evaluated at this site.

No site specific cleanup goals have been established for this site. Considering the elimination of the contaminant source area and the long-term effects of bio-stimulation and natural attenuation on the remaining low levels of benzene, this site qualifies for closure. Final closure of the site is currently being sought from the LARWQCB.

Cost

The total cost to complete the Fenton's treatment was approximately \$360,000 or \$69 per cubic yard (by volume). The total estimated quantity of hydrocarbons destroyed by the Fenton's treatment was 10,600 pounds at a cost of \$34 per pound removed. This calculation was based on a measured 93% reduction in TPHg applied to a baseline measured adsorbed mass of 11,400 pounds. This project is considered successful because of the mass reduction and the decrease in risk to human health and the environment.



**Figure 2. Benzene Iso-Concentration Map from January 2004.
(Six Months After Fenton's Treatment)**