ORC Injection BTEX & MTBE Remediation in New York

Contaminants	Application Method	Soil Type	Groundwater Velocity
BTEX/MTBE	ORC Injection	Fine Sand	-

Introduction

BTEX and MTBE contamination was detected at a former gasoline service station in New York, New York. Aquifer material consists of fine grained sediments mixed with building debris and groundwater at 22 feet below grade. Following removal of the underground storage tanks (USTs) a soil-vapor extraction (SVE) system was installed in the former UST excavation which was backfilled, paved and used as a parking lot. Data collected from subsurface investigations suggested that the SVE had reached the point of diminishing return and therefore was removed from the site.

Application

After analysis of several additional remedial technologies, bioremediation was selected for this site because it presented the potential for significant reduction of hydrocarbon concentrations while causing minimal site disturbance. Two types of bioremediation treatments were used at the site: injection of microorganisms and injection of ORC. The first application of microorganisms and ORC at the site was conducted in April 1997. Eight test borings drilled by Geoprobe were used and a liquid containing microorganisms was injected in four borings above the groundwater level into four of the borings while an ORC slurry was injected below the groundwater level using the other four borings. Data was collected five months and seven months after the first bioremediation treatment was applied.

Results

Field Results: Bioremediation results are presented in Table 1 and Figure 1. With respect to Table 1, a comparison between the application of microorganisms versus ORC was made in order to determine which application has the potential to accelerate the bioremediation process. The data indicates that following microbe application at Injection Point TB-1 the benzene concentration in ground water decreased in five months by 54% and at seven months to 84%. Values for total BTEX were 44% after five months with a small increase to 40% by Month 7. Similarly, for injection point, TB-6, there was a benzene reduction of 14% after five months and a total of 21% after seven months. The total BTEX was reduced 41% after five months and a small increase to 41% after two more months. The data suggested that the microbe application have been successful in accelerating the bioremediation process during the first five months.

The ORC application shows a similar pattern for benzene (TB-3 and TB-5 injection points) and a higher reduction of total BTEX. For example, at Injection Point TB-3, the total BTEX reduction after five months of ORC application was 80% and increased to 95% after two more months. The data from a second ORC application point (TB-5) showed a smaller reduction of total BTEX (34%) after 5 months but continued to indicate that the bioremediation process was still active after 7 months (51% reduction) following the ORC application.

The data suggest that the ORC application was more efficient then the microbe application. Because the results are completely based on groundwater samples and the ORC application was conducted below the groundwater level while the microorganisms were injected in the vadose zone the effect of ORC application is higher to the

ground water. The injection of microorganisms and ORC in two adjacent geoprobe borings at the site stimulated biodegradation and finally resulted in a reduction of the hydrocarbon concentrations in ground water. In addition, the bioremediation treatment reduced the distance where the plume migrates at concentrations that pose a risk to the environment.

A contour map illustrating the overall impact of the treatments on total BTEX at baseline, Month 5 and Month 7 is presented in Figure 1. The highest BTEX concentration prior to the first application was in the TB-3 area. The extent of the plume showing BTEX concentrations between 30,000 and 200,000 ug/l was approximately 40 feet long. After five months following the bioremediation treatment in eight injection points, the 30,000 ug/l BTEX concentration plume was reduced to 30 feet. The concentration of dissolved BTEX was reduced substantially in most of the injection points and the plume started to show that the application process was very efficient in the core of the contamination plume.

By November 1997, after seven months of the accelerated bioremediation treatment, the configuration of the dissolved plume indicates that while the concentration of the plume remained in the same location a significant reduction of dissolved BTEX was obtained. The results of groundwater analysis showed that the bioremediation treatment was efficient and a significant reduction of hydrocarbon plume was obtained beneath the site.

Sample ID	Date	Benzene (ug/l)	Toluene (ug/l)	E-benzene (ug/l)	Xylenes (ug/l)	BTEX (ug/l)	MTBE (ug/l)
TB-1	4/2/97	7,000	23,000	4,000	20,100	54,100	1,300
TB-1	8/27/97	3,200	14,000	2,000	11,000	30,200	<500
TB-1	11/17/97	1,100	11,000	3,200	17,000	32,300	180
TB-3	4/2/97	6,200	52,000	26,000	122,000	206,200	10,000
TB-3	8/27/97	3,200	5,100	6,000	25,000	39,300	6,900
TB-3	11/17/97	3,100	1,600	2,300	2,900	9,900	4,800
TB-5	4/2/97	20,000	43,000	5,600	24,500	93,100	33,000
TB-5	8/27/97	14,000	21,000	5,100	21,000	61,100	4,900
TB-5	11/17/97	13,000	17,000	3,400	12,000	45,400	5,600
TB-6	4/2/97	14,000	47,000	6,400	31,600	99,000	22,000
TB-6	8/27/97	22,000	22,000	3,300	15,000	52,300	3,800
TB-6	11/17/97	22,000	22,000	4,300	21,000	58,300	2,400
TB-7	4/2/97	670	6,600	2,400	10,900	20,570	540
TB-7	8/27/97	230	490	150	490	1,360	76
TB-7	11/17/97	1,200	14,000	3,200	16,000	34,400	300
TB-8	4/2/97	<1	270	1,200	3,800	5,270	1,000
TB-8	8/27/97	6	25	330	850	1,211	590
TB-8	11/17/97	<1	8	2	11	21	3,300
TB-11	4/2/97	<1	2	<1	5	7	<1
TB-11	8/27/97	1	21	15	120	157	1
TB-11	11/17/97	42	240	72	380	734	4
TB-13	4/2/97	<1	<1	<1	<1	<1	7,100
TB-13	8/27/97	2	4	2	12	20	4,900
TB-13	11/17/97	50	910	3,100	13,000	17,060	580

Table 1

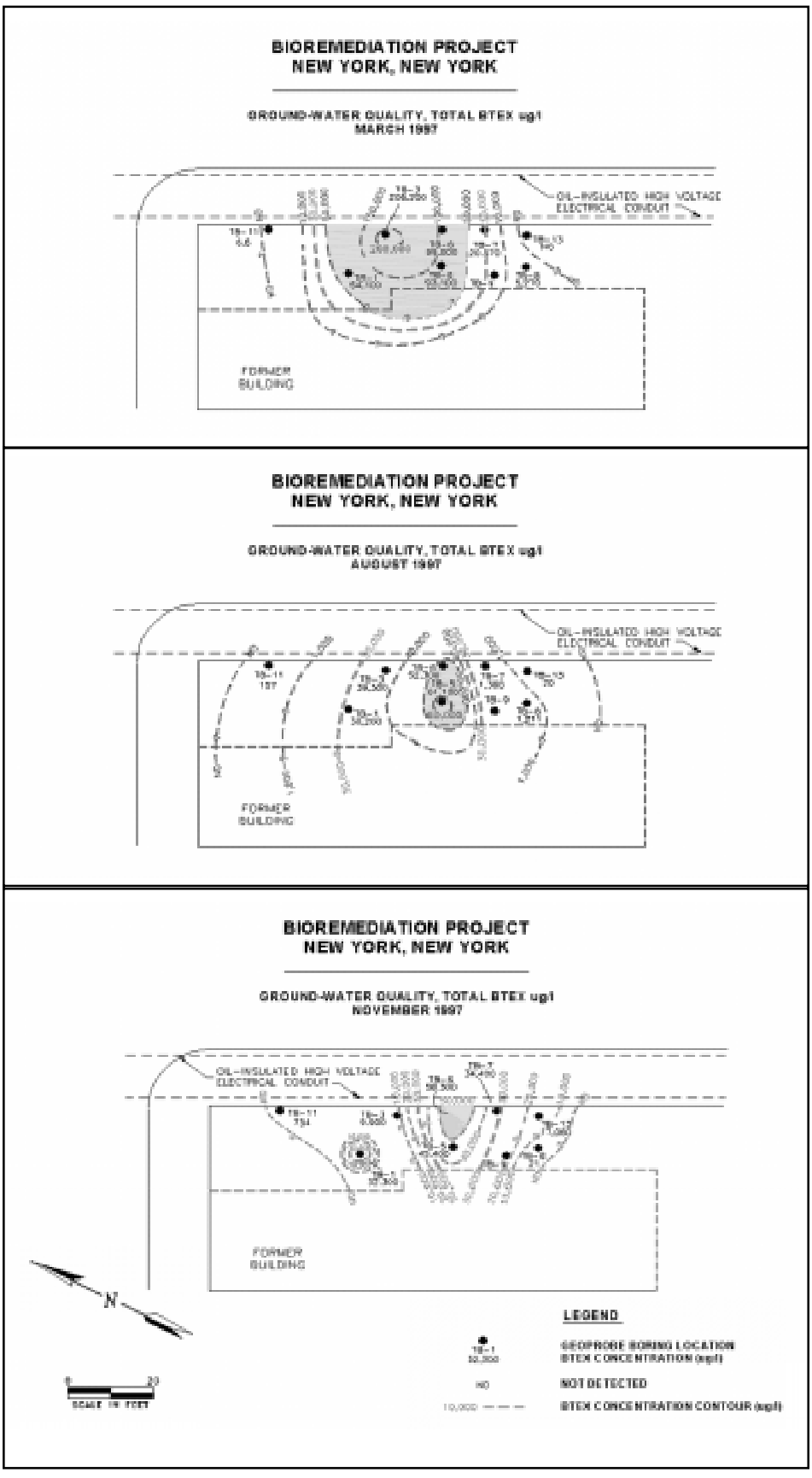
BIOREMEDIATION PROJECT
NEW YORK, NEW YORK
GROUND-WATER QUALITY, TOTAL BTEX ug/l
MARCH 1997
OIL-INSULATED HIGH VOLTAGE ELECTRICAL CONDUIT
FORMER BUILDING
BIOREMEDIATION PROJECT
NEW YORK, NEW YORK
GROUND-WATER QUALITY, TOTAL BTEX ug/l
AUGUST 1997
OIL-INSULATED HIGH VOLTAGE ELECTRICAL CONDUIT
FORMER BUILDING
BIOREMEDIATION PROJECT
NEW YORK, NEW YORK
GROUND-WATER QUALITY, TOTAL BTEX ug/l
NOVEMBER 1997
OIL-INSULATED HIGH VOLTAGE ELECTRICAL CONDUIT
FORMER BUILDING
N
LEGEND
GEOPROBE BORING LOCATION
BTEX CONCENTRATION (ug/l)
ND
NOT DETECTED
BTEX CONCENTRATION CONTOUR (ug/l)

Figure 1

Cost Comparison: The cost of the bioremediation treatment was compared with the cost for other remediation technologies which were determined to be feasible for these site conditions. Remediation techniques like soil excavation and disposal, groundwater pumping and treat, and on-site thermal treatment are not feasible because of site conditions (i.e., access, low aquifer yield, low groundwater levels, high cost) and were eliminated. The costs for implementation of remedial technologies as soil-vapor extraction, air sparging/soil-vapor extraction (AS/SVE) and high vacuum extraction were evaluated in comparison with the bioremediation treatment.

Table 2 lists the capital and operations and maintenance costs for each of these remediation technologies. Capital cost for bioremediation treatment includes drilling of Geoprobe borings and application of microbe and ORC treatment for six times during a three-year period. However, based on results obtained at the Manhattan site, it is expected that the bioremediation treatment will take less than three years.

The operation and maintenance cost for the other remediation technologies include monthly visits and sampling of remediation system and quarterly groundwater sampling for a five-year period. The operation and maintenance cost for bioremediation treatment is related to quarterly groundwater sampling and analysis for five years.

Remediation Technology	Capital Cost			Total Capital Cost
	Wells, Trenching and Piping	Equipment, Material, Permits and Air Treatment	Bioremediation Treatment	
Soil-Vapor Extraction (SVE)	$27,000	$19,000	--	$46,000
Air Sparging/ SVE	$31,000	$25,000	--	$53,000
High Vacuum Extraction (HVE)	$27,000	$51,500	--	$78,500
Bioremediation Treatment[1/]	--	--	$48,000	$48,000

Remediation Technology	Operation and Maintenance			Total O&M
	Monthly O&M	Quarterly Ground-Water Monitoring	Years	
Soil-Vapor Extraction (SVE)	$ 1,000	$ 2,000	5	$100,000
Air Sparging/SVE	$ 1,500	$ 2,000	5	$130,000
High Vacuum Extraction (HVE)	$ 2,000	$ 2,000	5	$160,000
Bioremediation Treatment	$ 0	$ 2,000	3	$ 24,000[2/]

1/ 6 applications in 3 years 2/ Based on only 3 years O&M

TOTAL COST - CAPITAL AND O&M

Soil-Vapor Extraction (SVE):	$146,000
Air Sparging/SVE:	$183,000
High Vacuum Extraction (HVE):	$238,500
Bioremediation Treatment:	$ 72,000

Table 2

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