Case Study Abstract

Recovery of Free Petroleum Product
Fort Drum, Fuel Dispensing Area 1595, Watertown, New York

Site Name: Fort Drum Fuel Dispensing Area 1595	**Contaminants:** Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) - Gasoline and #2 fuel oil - Free product measured in two wells in 1990 and 1994 - Full extent of contamination not yet defined	**Period of Operation:** Status: Ongoing Report covers - 2/92 to 4/94
Location: Watertown, New York		**Cleanup Type:** Full-scale cleanup (interim results)
Vendor: Not Available	**Technology:** Groundwater Extraction followed by Air Stripping and Granular Activated Carbon - 2 recovery wells - approximately 25 ft. below ground surface; average rate of 5-6 gpm - Oil/water separator - 575 gallon capacity - Air stripper - 750 cfm - GAC - 4 55-gallon steel drums; 200 lb GAC per drum; operated 2 in series	**Cleanup Authority:** DoD
SIC Code: 9711 (National Security)		**Point of Contact:** Remedial Project Manager Fort Drum Environmental Division Watertown, NY
Waste Source: Underground Storage Tank	**Type/Quantity of Media Treated:** Groundwater and Free Product - Hydraulic conductivity of aquifer 0.11 to 0.0012 cm/sec - Transmissivity 11,787 to 32,518 using Jacob method	
Purpose/Significance of Application: Full-scale remediation to recover free-phase petroleum product using groundwater extraction and air stripping and granular activated carbon (GAC).		

Regulatory Requirements/Cleanup Goals:
- Final cleanup criteria have not been established at this time; the project is being conducted as a Rapid Response Interim Remediation
- Treated water discharged to the POTW must meet the following criteria - benzene (3 µg/L), toluene (35 µg/L), xylenes (190 µg/L), ethylbenzene (8 µg/L)

Results:
- Information on the total quantity of free product recovered is not available at this time
- The effluent from the treatment system met all discharge criteria

Cost Factors:
- Total Capital Costs - $958,780 (including system design and construction including site work, equipment, and mobilization/demobilization)
- Total Annual Operating Costs - $129,440 (including carbon changeout/regeneration, maintenance, laboratory analysis, and project management)
- An estimated cost for completion of the cleanup is not available at this time

Case Study Abstract

Recovery of Free Petroleum Product, Fort Drum, Fuel Dispensing Area 1595, Watertown, New York (Continued)

Description:
Fort Drum in Watertown, New York, established in 1906, serves as a combat skills training area and operations headquarters for light infantry troops. Motor vehicle and aircraft refueling activities are conducted in Area 1595 of the facility. Area 1595 includes an underground storage tank (UST) and 10 dispensing units for gasoline, diesel fuel, and jet fuel. In 1982, free petroleum product was observed in a spring near this area. Suspected contaminant sources include leaking USTs and wastewaters from vehicle washing operations located adjacent to Area 1595. The primary contaminants of concern are BTEX (benzene, toluene, ethylbenzene, and xylenes) and free petroleum product. The full extent of the contamination had not been defined at the time of this report. The site remediation is being performed as a Rapid Response Interim Remediation and final cleanup criteria have not been established at this time.

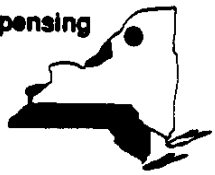
A pump and treat recovery, consisting of two recovery wells, an oil/water separator, an air stripper, and granular activated carbon vessels, was operated from March 1992 to mid-1993. The system was restarted in February 1994 and was operational at the time of this report. The first year of operation focused on troubleshooting and little data were collected during that time. As such, no information is available at this time on the total quantity of free product recovered or the rate of recovery. Data from the air stripper/GAC system indicated that the concentrations of contaminants in the effluent meet the POTW discharge criteria for BTEX. An air emissions certificate was issued by the State in October 1992; however, information on specific emission limits was not available at the time of this report.

The total capital costs for this remediation are $958,780 and the estimated total annual operating costs are $129,440. Based on operations to date, it has been observed that free product recovery pumps require frequent maintenance and that activated carbon efficiency was limited because of fouling by iron and biomass.

TECHNOLOGY APPLICATION ANALYSIS

SITE

Fort Drum, Fuel Dispensing Area 1595
Watertown, NY



TECHNOLOGY APPLICATION

This analysis covers an effort to recover **free phase petroleum product** using an interim groundwater **pump and treat system. Air stripping** and **granular activated carbon (GAC)** have been used in series to treat recovered groundwater. Interim remediation was first initiated in February 1992. This analysis covers performance through April 1994.

SITE CHARACTERISTICS

Site History/Release Characteristics

- Fort Drum, a U.S. Armed Forces Command installation, was originally established in 1906 as a National Guard training area and has served as a combat skills training area and operations headquarters for light infantry troops.
- Motor vehicles and aircraft refueling at Fort Drum took place at nine dispensing facilities located along a 2-mile strip of land known as "Gasoline Alley." Fuel Dispensing Area 1595 (Area 1595), the subject of this report, is located along a portion of Gasoline Alley.
- Area 1595 consists of an underground storage tank (UST) area approximately 150 feet in length, and a dispensing area with 10 dispensing units spread over a distance of approximately 400 feet.
- In 1982, free petroleum product was observed discharging from a natural spring located 550 feet northwest of the underground storage tanks (USTs) which supplied gasoline, diesel fuel and jet fuel to the Area 1595 dispensers.
- The precise source of the free product could not be found. A 1" diameter hole was discovered in an UST removed in 1975. All of the USTs were reported to have been replaced by 1985. The tanks on site passed a leak test in March 1991, but the system piping was determined to have a leak rate of 0.05 gallons/hour. The current status of the USTs is unknown.
- Several former washracks located next to Area 1595 may also have been a source of oil and other materials discharged to the subsurface. The washracks were used to clean wheeled and track vehicles.
- An earthen dike was constructed immediately downstream of the spring to facilitate the surface collection and skimming of free petroleum product. The interim groundwater pump and treat system addressed in this report was constructed in 1991 to recover free product from the subsurface.

Contaminants of Concern

Contaminants of concern focused on during the groundwater remediation are:

Benzene
Toluene
Ethylbenzene
Xylene-m (1,3)
Xylene-o (1,2)
} BTEX

Free petroleum product, a source of the contaminants identified above, was also of concern.

Contaminant Properties

Property at STP*	Units	B	T	E	X***
Empirical Formula	-	C_6H_6	$C_6H_5CH_3$	$C_6H_5CH_3$	$C_6H_4(CH_3)_{2m}$
Density	g/cm^3	0.87	0.87	0.87	~0.87
Vapor Pressure	mmHg	75	29	7	10
Henry's Law Constant	$atm\cdot m^3/mole$	5.6E-3	6.5E-3	8.4E-3	2.5E-1
Water Solubility	mg/L	1,780	534	161	178
Octanol-Water Partition Coefficient; K_{ow}	-	132	490	1,413	1,830
Organic Carbon Partition Coefficient; K_{oc}	-	50	339	565	255

*STP = Standard Temperature and Pressure; 1 atm, 25 °C
** Properties at 20°C ***Mixture of m,o and p-xylenes

Nature & Extent of Contamination

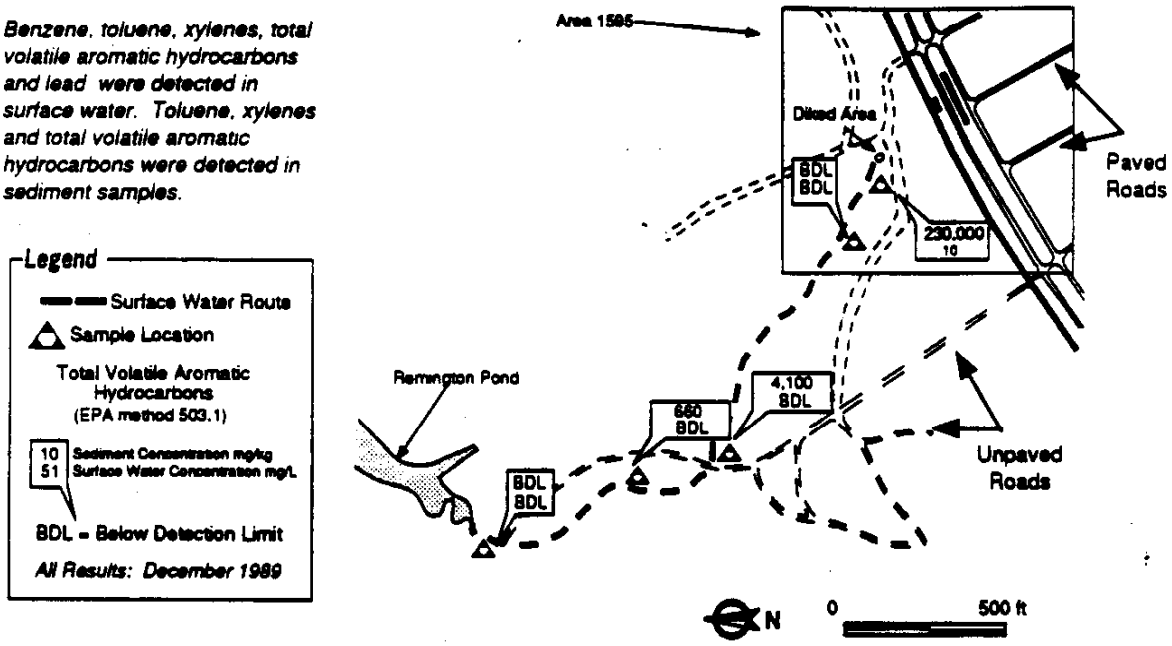
- Laboratory analytical results have indicated that the detected petroleum contamination is gasoline and #2 fuel oil. The free product and the petroleum-contaminated soil and groundwater in Area 1595 appears to be located in a narrow zone hydraulically downgradient and downstream from the fuel dispensing area.
- Petroleum hydrocarbons and lead have been detected in surface water and sediment samples collected from the stream at locations downstream from the dike.
- The full extent of contamination has not yet been defined.
- A preliminary human health risk assessment indicated that petroleum contamination poses an increased lifetime cancer risk of > 1×10^{-4}.

Contaminant Locations and Geologic Profiles

Remedial investigation field activities at the site have included a shallow soil vapor survey; the excavation of shallow test pits, soil borings and groundwater monitoring wells; free product gauging; water level elevation measurements; and the collection and laboratory analysis of surface water, sediment, soil, and groundwater samples. Some of the data is summarized in this report to provide a conceptual understanding of site conditions.

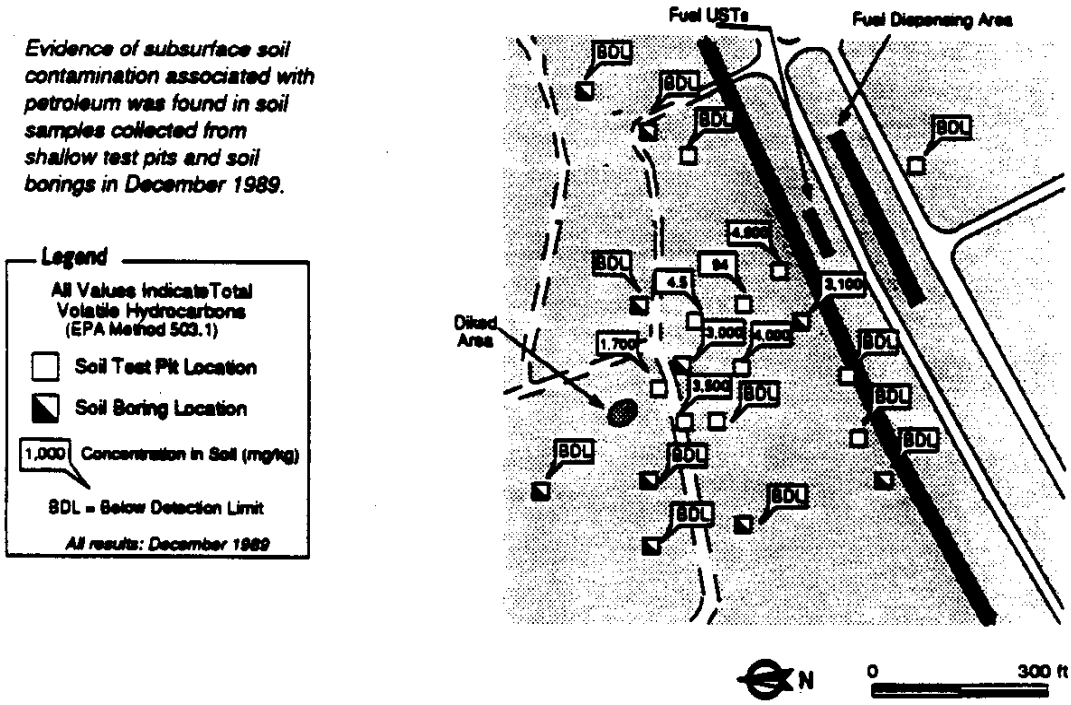
Site Layout and Surface Water/Sediment Contamination (Plan View)

Benzene, toluene, xylenes, total volatile aromatic hydrocarbons and lead were detected in surface water. Toluene, xylenes and total volatile aromatic hydrocarbons were detected in sediment samples.



Soil Contamination (Plan View)

Evidence of subsurface soil contamination associated with petroleum was found in soil samples collected from shallow test pits and soil borings in December 1989.



Contaminant Locations and Geologic Profiles (Continued)

Free Floating Product and Groundwater Contamination (Plan View)

Free product was measured in two of the Area 1595 monitoring wells in 1990. Benzene, toluene, ethylbenzene, xylenes, total volatile hydrocarbons and lead were detected in groundwater samples during late 1989/early 1990.

All of the monitoring wells were again gauged for free product on April 4, 1994; two of the wells within 150 ft. of the former fuel USTs contained free product– one with 7.25 inches, and the other with 3.5 feet.

Legend

All Values Indicate Total Volatile Aromatic Hydrocarbons

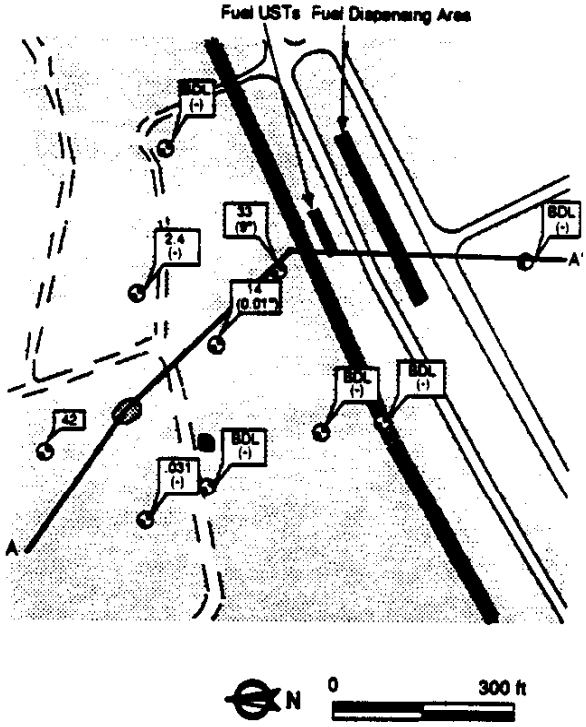
Groundwater Sample Location

A —— A' Cross Section Location

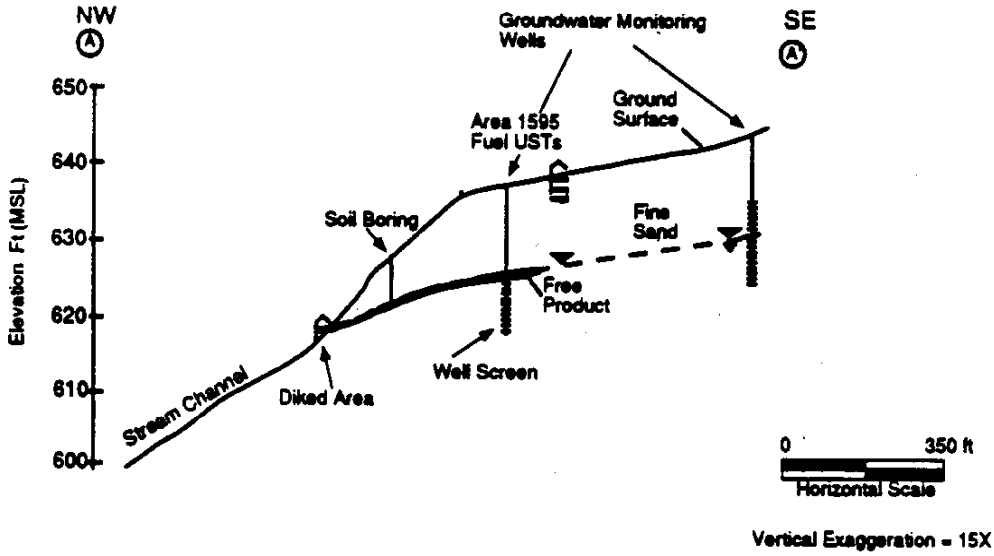
51 (1") Groundwater Concentration Free Product Thickness, 2/90

BDL = Below Detection Limit

(-) indicates no free product measured



Profile A-A'

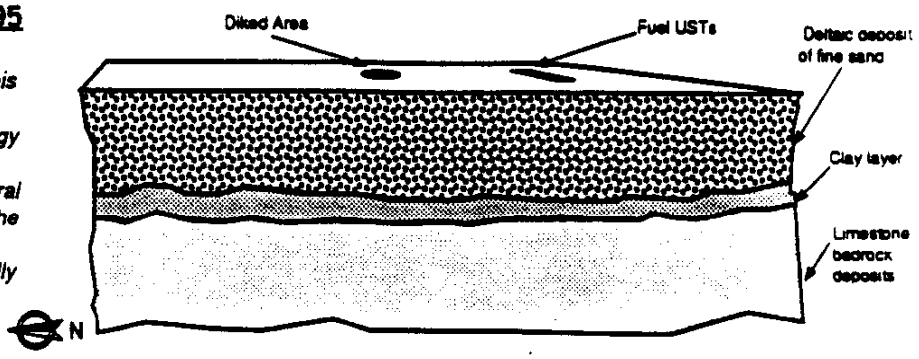


Note: Extent of free product and soil and groundwater contamination not fully defined.

Contaminant Locations and Geologic Profiles (Continued)

Lithology of Area 1595

Conceptual Site Model: This model was constructed based on limited site geology information. The model is intended to provide a general pictorial representation of the site based on available information, but may not fully represent actual site conditions.



- The unconsolidated material observed in the study area is primarily fine-grained, well-sorted sand.
- The unsaturated zone ranges from approximately 6 to 15 feet below ground surface (BGS). It is thickest upgradient of the diked area (south). Groundwater is closest to the ground surface near the stream channel located downgradient of the diked area.
- Bedrock surface elevations at Area 1595 are unknown.

Site Conditions

- The regional average annual temperature is 45.1 °F. The regional monthly average rainfall is 3.28 inches. The monthly average snowfall is 9.51 inches.
- Ground surface elevations within Fort Drum range from approximately 450 to 900 feet above mean sea-level (MSL). The immediate vicinity of Area 1595 is relatively flat and is between 640 and 650 feet (MSL). The ground surface slopes toward the spring and diked area where it decreases to 610 to 620 feet (MSL). The surface elevation decreases from the diked area to approximately 510 feet (MSL) at the pond (approximately 3,000 feet away).
- Surface drainage from Area 1595 flows to the north, and into the unnamed stream, which leads to into Remington Pond.
- Groundwater flow direction within the unconsolidated deposits is primarily to the northwest, from the Area 1595 fuel dispensing area towards the spring and stream.
- The site is unpaved; infiltrating precipitation affects contaminants mobilization and migration.

Key Soil and Aquifer Characteristics

Groundwater Parameters

1993 pump test data, using 8 wells, unless noted:

Property	Range	Comment
Transmissivity	11,787 - 32,518	Jacob method
Storage coefficient	2.01 E -3 to 2.25 E -2	Jacob method
Groundwater velocity (ft/day)*	3.7	At location approximately 150 ft. northwest of fuel dispensing area
Hydraulic conductivity (cm/s)*	1.1 E -1 to 1.2 E -3	
Groundwater gradient (ft/foot)*	0.027	At location approximately 150 ft. northwest of fuel dispensing area
Percolation rate (in/yr)	15	Based on water balance

* Data is from a 1990 study of Area 1595.

Soil Parameters

Gasoline Alley data, not specific to Area 1595:

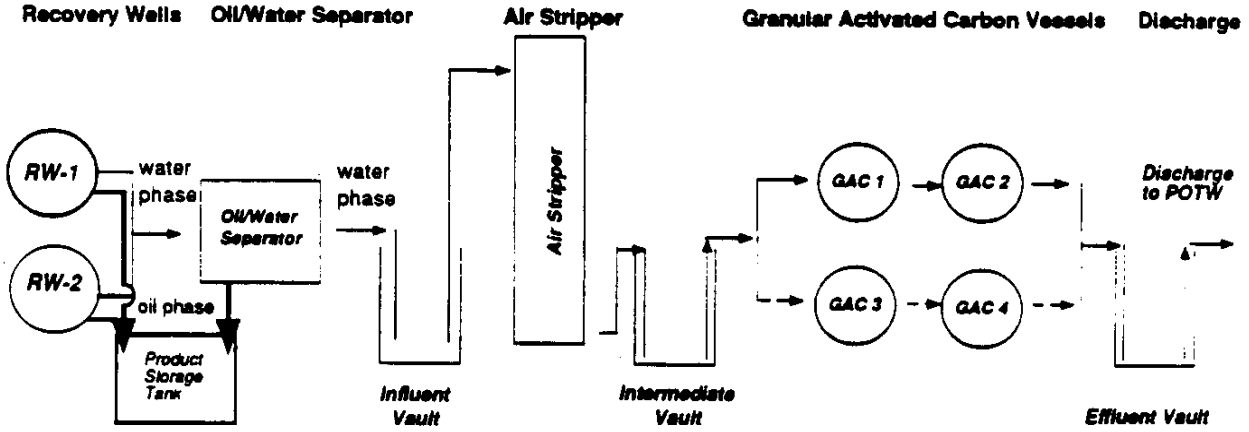
Property	Range
Sand Layer (19 borings)	
Moisture content	2.5 - 26.0
Plasticity index	characteristic not exhibited
Clay Layer (2 borings)	
Liquid limit(%)	22.2, 26.0
Plastic limit(%)	18.2, 19.1
Plasticity index	6.9, 8.3

- Twelve Fort Drum water supply wells and five residential supply wells are located within a one to four mile radius upgradient of Area 1595. Nine of the twelve wells, are completed in bedrock, and three are screened within the unconsolidated deposits.
- The primary source of groundwater for Fort Drum is a confined bedrock aquifer; the secondary source is a water table aquifer located within the unconsolidated deposits.

TREATMENT SYSTEM

The pump and treat recovery system operated from March 1992 to early/mid 1993, and was restarted in February 1994. During the first year of operation, efforts were focused on troubleshooting. Very little data was collected during this time period. Analytical data presented in this report was recorded during the most recent period (1994) of operation.

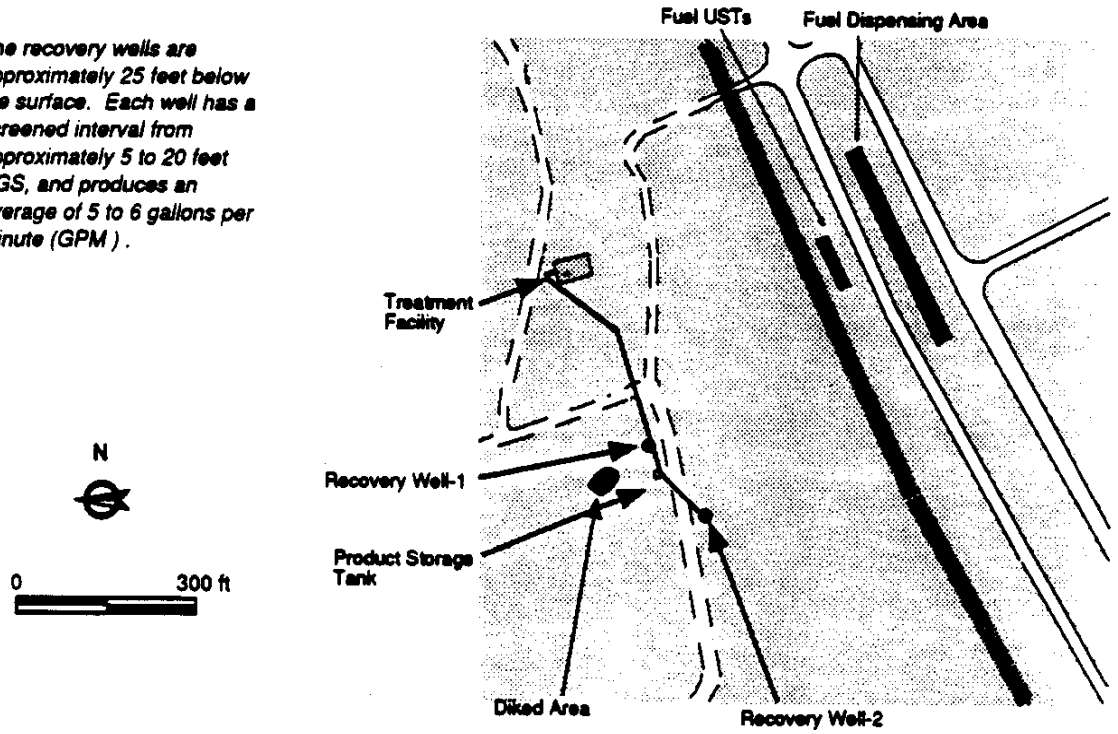
Overall Process Schematic



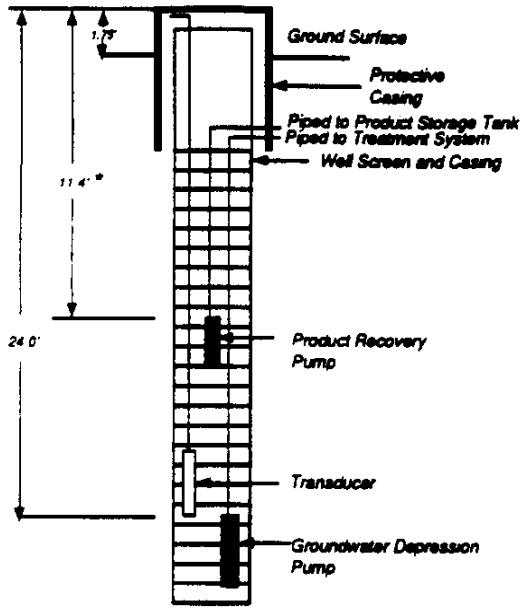
Free petroleum product accumulating in the recovery wells is pumped into a product storage tank. Water from the wells is pumped into the oil/water separator to remove residual free product and is treated by air stripping and granular activated carbon (GAC) to remove dissolved hydrocarbons. Treated water is then discharged to a publicly-owned treatment works (POTW).

Recovery Well Network

The recovery wells are approximately 25 feet below the surface. Each well has a screened interval from approximately 5 to 20 feet BGS, and produces an average of 5 to 6 gallons per minute (GPM).



Extraction Well Detail

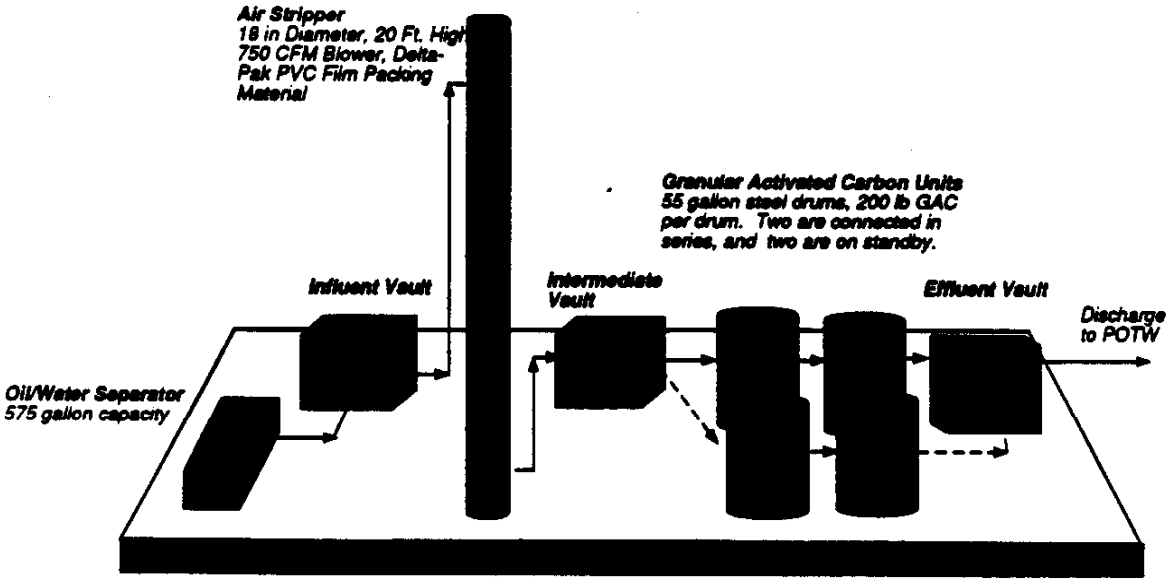


* Operator can manually adjust the elevation of the product recovery pump intake based on the observed floating product thickness and water level in the wells.

Key Monitored Operating Parameters

- Fluid levels in recovery wells
- Product storage tank volumes
- Influent flow rates
- Air stripper: inlet flow rate and pressure, and blower pressure
- Granular activated carbon units: inlet flow rates and pressure
- Total effluent flow
- Contaminant concentrations in air stripper influent, air stripper effluent, and the GAC effluent

Air Stripping/Carbon Adsorption System Schematic



PERFORMANCE

Performance Objectives

- Recover free petroleum product from the water table as an interim measure.

Operational History

Initiated operations in March 1992. Operational difficulties prevented continuous operations.

↓

System shut down in early/mid 1993.

↓

Contractor retained to provide O&M and troubleshooting support. Reinitiated operations in February 1994.

Treatment Approach

Completed Activities

Preliminary assessment of the nature and extent of contamination through Initial Site Investigations

↓

Implementation of diked area skimming

↓

Design, construction, and operation of interim free product recovery (pump and treat) system

↓

Future Activities

Continue operating interim system to recover free floating petroleum product

↓

Conduct Phase II Remedial Investigation to fully define the extent of subsurface contamination associated with Gasoline Alley

↓

Develop and implement a comprehensive remediation program for Gasoline Alley (including Area 1585)

Operational/Treatment Performance

Free Product Recovery

Information on the total quantity of free product recovered and the rate of free product recovery over time was not available.

System Throughput

Information on the volumes of water treated was not available.

Influent Characteristics

Parameter	Concentration
Total hardness	120 mg/L
Total Alkalinity	121 mg/L
Iron	17.3 mg/L
Manganese	1.6 mg/L

System Downtime

The system did not operate continously during its periods of operation. The actual percentage of downtime is not known due to lack of operating records. The causes for the downtime are described below:

- The oil/water separator and the GAC units, fouled with inorganics and/or biomass.
- Seals in fuel recovery pumps deteriorated.
- Recovery well #2 was not recovering free product and was significantly contributing to the iron precipitation problem. This well was shutdown sometime in 1993.
- The system was not operated and maintained by trained personnel, and the monitoring conducted was infrequent.

Skimming from Diked Area

Complete quantitative performance data on the effectiveness of efforts to skim free product from water collected in the diked area was not available.

Air Stripper and Activated Carbon Influent and Effluent

Insufficient data is available to determine if VOCs and target contaminants have been consistently treated below discharge levels. The data presented below represent analytical results for grab samples collected on February 11, 1994. This data represents the second treatment period.

Compound	Air Stripper Influent	Air Stripper Effluent /GAC Influent	GAC Effluent
Benzene	86	2.5	<0.20
Toluene	130	4.3	<0.20
Ethylbenzene	120	2.9	<0.20
m-Xylene	320	9.7	<0.20
o-Xylene	86	3.8	<0.20
p-Xylene	<0.20	<0.20	<0.20

All concentrations in mg/L

Hydrodynamic Performance

The capture zone for the interim system has not been defined.

COST

Detailed cost data for the interim product recovery system construction and operation are not available. The cost breakdown below provides an estimate of costs for some components of the treatment system. Information was derived from projected costs, not actual cost data.

Capital Costs

System Design [a]	
Labor	$349,810
Direct Costs	12,420
Laboratory	3,490
Construction Costs [b]	
Site Work	102,350
Equipment	137,750
Mechanical	48,560
Structural and Architectural	121,770
Electrical	167,630
Mobilization/Demobilization	15,000
Total Capital Costs	$ 958,780

Operating Costs

Carbon Changeout, Transport, and Regeneration	$_____
Electrical Power (@ $.___/kwh)	_____
Equipment, Repair, and Replacement	_____
Laboratory Analysis	_____
O&M Labor (@ $____/hr)	_____
Engineering Support	_____
Project Management	_____
Total Annual Operating Costs [c]	$129,440

[a] These costs were taken from a contractor's 95 percent design estimate prepared in 1991. They are included to provide a representation of the probable breakdown of actual total costs among the various cost elements.

[b] These figures are based on a contractors' cost proposal dated March 1991.

[c] Final operating costs are based on a contractor's scope of work for operation and maintenance of the interim pump and treat system, dated September 1993.

REGULATORY/INSTITUTIONAL ISSUES

• The Fort Drum Area 1595 site remediation is being performed as a Rapid Response Interim Remediation. Final cleanup criteria will be established for the site in the future.

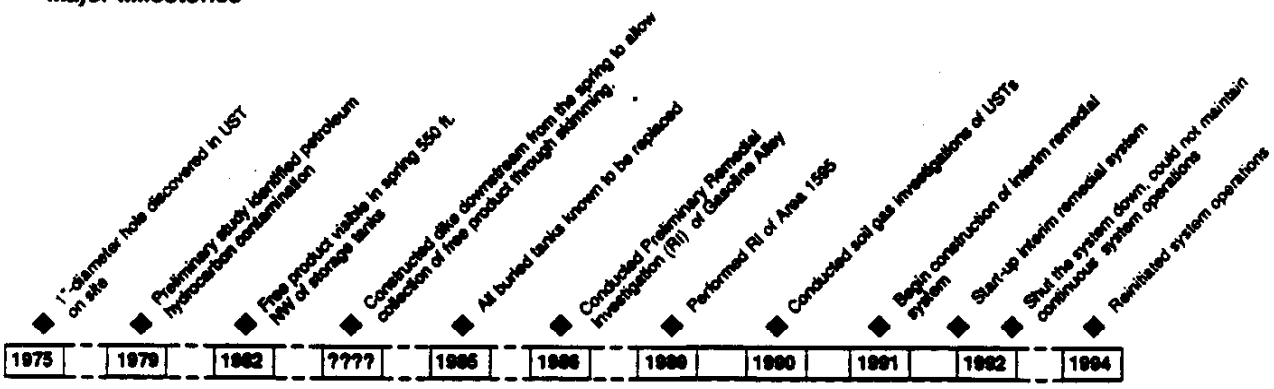
• Treated water is discharged under the authority of a POTW dishcharge interim permit. The permit was issued in December 1992. As an interim, the design effluent discharge limits for the air stripper are used. Discharge limits are summarized below:

Compound	Maximum Air Stripper Effluent Concentration (ug/l)
Benzene	3
Toluene	35
Xylenes	190
Ethylbenzene	8

• An air emission certificate was issued by the New York Department of Environmental Conservation in October 1992. Information on specific emission limits was not available.

SCHEDULE

Major Milestones



LESSONS LEARNED

Implementation Considerations

• Initiating an interim remedial action provided for recovery of free-phase petroleum product and petroleum constituents in groundwater while the full extent of contamination and supplemental remedial actions were planned. Earlier action could have further limited contaminant migration.

• The effectiveness of damming the dike to contain contamination was not addressed. During the winter of 1989, the surface of the diked area froze over. The skimming device froze below the ice, and free product migrated on top of the ice and past the dike. Free product was observed migrating below the absorbent pads.

• High iron concentrations (> 17 mg/L) were present in the Area 1595 groundwater. The presence of iron concentrations and potential precipitation problems should have been addressed in designing the interim system.

• The capture zone was not defined for the interim system. Consequently, the success or failure of the interim recovery system in capturing and limiting further migration of free product at this site is unknown. Defining the capture zone is an important part of evaluating the system's performance in capturing contaminants and stopping plume migration.

Technology Limitations

• The free product recovery pumps required frequent maintenance. Information was not available on whether alternative equipment would have been more appropriate.

• Activated carbon efficiency was limited in this instance by fouling caused by iron and/or biomass.

• No additional information was available on the full range of design and implementation experience gained from this technology application.

Future Technology Selection Considerations

• Application of the interim pump and treat system with above ground air stripping at Area 1595 of Fort Drum has not provided sufficient data to date to allow generalized conclusions to be made concerning the suitability of the technology at Fort Drum. Experience has been obtained, however, on design and implementation issues involved in assuring continuous system operation. Operational difficulties have only recently been overcome at Fort Drum and future performance data should provide a better understanding of the effectiveness of the interim product recovery system.

ANALYSIS PREPARATION

This analysis was prepared by:

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CERTIFICATION

The Fort Drum Environmental Division has indicated that, due to staffing limitations, they are unable to provide additional information necessary to complete this analysis or to review its contents.

SOURCES

Major Sources For Each Section

Site Characteristics:	Source #s (from list below) 1, 2, 3, 5, and personal communications with Brian Roberts of the U.S. Corps of Engineers (COE), Kansas City District.
Treatment System:	Source #s 4,5, and personal communications with Dan Gelb of Radian Corporation
Performance:	Source # 6, and personal communications with Dan Gelb and James Baxter of Radian Corporation
Cost:	Source # 6
Regulatory/Institutional Issues:	Source # 4
Schedule:	Source #s 1,2,3,6
Lessons Learned:	Source # 6, and personal communications with Dan Gelb and James Baxter of Radian Corporation

Chronological List of Sources and Additional References

1. Remedial Investigation Fuel Dispensing Area 1595 Fort Drum, New York; prepared for U.S. Army Corps of Engineers, Kansas City, Missouri (COE, Kansas City); prepared by O'Brien & Gere Engineers, Inc., February 1990.

2. Report of Findings - Corrective Measure Study Gasoline Alley, prepared for COE, Kansas City; prepared by CDM Federal Programs Corporation, September 1991.

3. Remdial Investigation of Fort Drum, New York, AMXTH-AS-CR-85054, prepared for U.S. Army Toxic and Hazardous Materials Agency (USATHAMA); prepared by Dames & Moore, August 1992..

4. Data Package provided by Dan Gelb of Radian Corporation, February 1994.

5. Area 1595 Map provided by James Baxter of Radian Corporation, April 1994.

6. Data Package provided by Brian Roberts of the US COE Kansas City District, April 1994.