Cost and Performance Summary Report
Biotreatment Funnel and Gate at the Moss-American Site, Milwaukee, Wisconsin

Background [1, 2, 3, 6]

The 88-acre Moss-American site, in Milwaukee, Wisconsin, consists of a former wood preserving facility, portions of the Little Menomonee River, and adjacent flood plain soils. Approximately 65 acres of the site are undeveloped Milwaukee County parkland, and the remaining 23 acres are owned by the Union Pacific Railroad and used as a transport, loading/unloading, and storage area for automobiles and light trucks. From 1921 to 1976, the site was used to preserve railroad ties, poles, and fence posts with creosote. Wastes from wood preserving operations were discharged to settling ponds that ultimately discharged to the Little Menomonee River. In addition, releases from storage, application, and drying processes were suspected. The site is contaminated with polycyclic aromatic hydrocarbons (PAHs), from the creosote, as well as fuel oil no. 6, and benzene, toluene, ethylbenzene, and xylenes (BTEX), in the groundwater, soil, and sediment in the river. A mixture of creosote and fuel oil is present as free product in the subsurface at the site. In 1984, the site was added to the National Priorities List.

A Record of Decision (ROD), signed in 1990, addressed (1) free-product recovery, (2) contaminated groundwater collection and treatment, (3) treatment of more highly-contaminated soils, (4) containment of lesser-contaminated soils and treated soil residuals, and (5) sediment management.

Free-product recovery was performed from 1996 to 1999. The free product was concentrated at a depth of 6-12 feet below ground surface (bgs). The recovery system included six extraction wells, conductivity probes to distinguish between creosote and groundwater, and supplementary storage tanks. A total of 12,580 gallons of liquids were extracted over the four year operating period, with the PRP estimating that an average of 10% of the extracted liquids being creosote, and the remainder contaminated groundwater. Extracted liquids were disposed of off site. In 1999, the free product recovery system was dismantled.

In 1998, EPA issued an amended ROD to change the remedy for soil from bioslurry treatment to thermal desorption. Thermal desorption was performed from mid-2001 to February 16, 2002. For sediment in the Little Menomonee River, the ROD required construction of a new river channel, and treatment of excavated material with the excavated soil. As of early 2002, EPA was in the process of reviewing the design plan for sediment management. In 1997, EPA issued an Explanation of Significant Differences (ESD) that modified the remedy for contaminated groundwater from groundwater collection and treatment (using a series of drains and above-ground treatment) to funnel and gate using biotreatment. EPA noted that the ROD had not sufficiently considered the challenges to groundwater management due to the presence of "significant, extractable deposits of free-product creosote". The biotreatment funnel and gate system is the focus of this report.

CERCLIS ID Number	WID039052626
Cleanup Type	Superfund Remedial
Lead/Oversight	PRP Lead/Federal Oversight

Timeline [1, 2, 3, 4, 5]

Date(s)	Activity
September 1990	ROD signed
April 1997	ESD signed
1999 – July 2000	Funnel and gate treatment system constructed
October 2000 - present	Funnel and gate treatment system operating; air injection in all six gates
June 2001	Nutrient injection at Treatment Gate 1

Matrix Characteristics Affecting Treatment Cost or Performance [5]

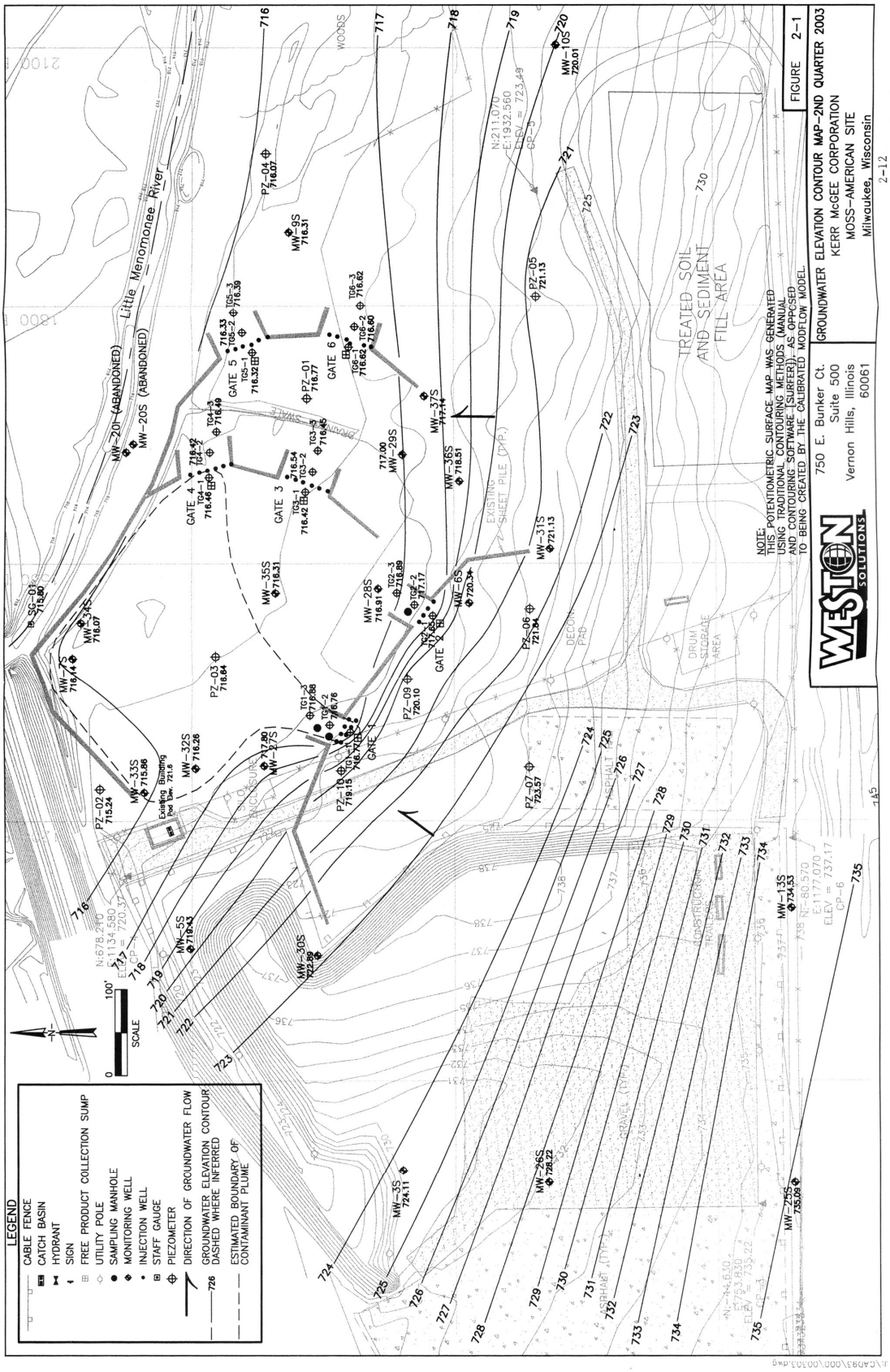
The depth to groundwater at the site is 3.6 to 7.3 ft bgs and groundwater generally flows to the northeast, toward the Little Menomonee River. Hydraulic gradients vary across the site; within the treatment gate area, the hydraulic gradient was measured as approximately 0.0009 ft/ft in an easterly direction. Groundwater flow velocities within the treatment gates were estimated to range from 0.0076 to 0.14 ft/day. Matrix characteristics potentially affecting treatment cost or performance are provided below.

Matrix Characteristic	Value
Soil Classification	Dense silty-clay (glacial till-silt, silty-clay, sandy-silt, sand, and silty-sand)
Depth to Groundwater	3.6 – 7.3 ft bgs
pH	5.37 – 6.78
Redox Potential	21.5 – 230.1 millivolts
Specific Conductance	0.672 – 1.534 millimhos per cm
Temperature	8.34 – 12.7 ^{o}C

Technology Design and Operation [5, 6]

The biotreatment funnel and gate system, shown in Figure 1, includes six treatment gates, constructed in three rows of two gates each, with Waterloo sheet piling located on both sides of the gates, to direct the flow of groundwater through the gates. The sheet piling is keyed into a silty clay till confining layer beneath the aquifer. The system also includes collection sumps installed slightly up-gradient from each of the treatment gates to collect any free-product prior to its entering the treatment gates. Specific information about the dimensions of each gate was not provided.

Figure 1. Location of Biotreatment Funnel and Gate System [5]



Groundwater augmentation began in October 2000, with the injection of air into the six gates. In late June 2001, nutrients (a solution that contained potassium nitrate and potassium phosphate) were added in Treatment Gate 1. Nutrient injection was discontinued at this gate at the end of October 2002, as part of site modifications recommended in the Quarter 2 2002 Monitoring Report, and approved by EPA. The site will continue to be monitored for nutrient and contaminant levels.

The groundwater monitoring network includes 7 shallow groundwater monitoring wells, 8 containment performance monitoring wells, 9 piezometer wells, and 1 staff gauge. The groundwater monitoring wells were initially sampled on a quarterly basis, with a subsequent reduction in performance monitoring well sampling frequency from monthly to quarterly, and a reduction in the number of wells monitored based on the number of non-detects in these wells.

In June 2000, because of concerns about low levels of dissolved oxygen (DO) in the treatment gates, well packers were installed in Treatment Gate 5 injection. However, no discernable changes in DO levels were noted. In addition, an attempt was made to install inflatable bladder packers in Treatment Gates 1 and 2 in August 2001; however these packers could not be installed because of the injection well configuration. The contractor is continuing to evaluate alternatives for introducing air into the treatment gates.

As of June 2003, the flow of groundwater was directly though treatment gates 1 and 2, but at an obtuse angle to gates 3 to 6. EPA indicated that the system is expected to be in place for approximately 20 years. A five-year review was performed in September 2000, and the next five-year review is expected to be performed by September 2005.

Operating Parameters Affecting Treatment Cost or Performance

Operating Parameters	Value
Air Injection	Not available
Nutrient Injection	Solution containing potassium nitrate and potassium phosphate
Dissolved Oxygen	<1 mg/L (for most wells)

Treatment Performance [1, 5]

The specified cleanup goals for groundwater are based on the Wisconsin Department of Natural Resources (WDNR) Preventative Action Limits (PALs) for BTEX constituents and for 8 PAHs. The BTEX levels are: benzene – 0.5 µg/L; ethylbenzene – 140 µg/L; toluene – 68.6 µg/L; and total xylenes – 124 µg/L. The PAHs levels are: anthracene – 600 µg/L; benzo(a)pyrene – 0.2 µg/L; benzo(b)fluoranthene – 0.2 µg/L; chrysene – 0.2 µg/L; fluorine – 80 µg/L; fluoranthene – 80 µg/L; naphthalene – 8 µg/L; and pyrene – 50 µg/L. Groundwater is monitored for 8 additional PAHs with no associated PAL - acenaphthylene, acenaphthene, benzo(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and phenanthrene. Additional groundwater parameters monitored include: oxidation-reduction potential (ORP), DO, microbial enumeration, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl nitrogen (TKN), ammonia-nitrogen, total phosphate-phosphorus, orthophosphate, biochemical

oxygen demand (BOD), chemical oxygen demand (COD), groundwater elevation, pH, temperature, turbidity, and specific conductance.

Performance data are available through June 2003. During the 3 years of operation, contaminant concentrations have been reduced to below cleanup goals in a number of wells. Table 1 summarizes data from the June 2003 sampling event, showing only those contaminants and wells where constituents were detected above the PAL. As shown in Table 1, only five contaminants, benzene; benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and naphthalene, were detected above the PAL in one or more of the monitoring wells. The detected concentrations of contaminants other than naphthalene ranged from about 1.4 to 7.9 µg/L; naphthalene concentrations ranged from 41 to 6,100 µg/L.

Figure 1 shows the estimated boundary of the groundwater contaminant plume as of June 2003. The boundary shows that the plume is located near Treatment Gate 1 (TG-1) and covers an area several hundred feet north-northeast of TG-1.

Table 1. Summary of Groundwater Monitoring Results for Contaminants Detected Above the PAL in June 2003 (µg/L) [5]

Constituent	WDNR PAL	MA3-MW7S-062603-04	MA3-MW33S-062603-02	MA3-MW34S-062603-05	MA3-TG1-1-062303-01	MA3-TG1-2-062303-02
Benzene	0.5	2.4 J	2 U	15 J	1.4 J	0.2 U
Benzo(a)pyrene	0.02	0.02 U	0.02 U	0.18	7.9 J	0.02 U
Benzo(b)fluoranthene	0.02	0.04 U	0.04 U	0.18 J	6.8 J	0.04 U
Chrysene	0.02	0.08 U	0.08 U	0.5	15 J	0.08 U
Naphthalene	8	3,400	2,500	6,100	1,300 J	41

Notes:
U – constituent not detected; detection limit indicated
J – estimated concentration

Additional data were provided in the June 2003 quarterly monitoring report showing concentrations of naphthalene from September 2000 to June 2003 in well MW-34S, located in the contaminated area. As shown in Table 2, naphthalene concentrations have remained relatively constant over the three-year period, ranging from 5,000 to 7,000 µg/L, with a concentration of 6,100 µg/L detected in June 2003. The PRP contractor suggested that the relatively fine-grained soil and low groundwater flow rates have lead to low oxygen conditions and inhibited the ability to introduce nutrients and other additives due to poor dispersion from the injection points, resulting in the elevated contaminant concentrations.

Table 2. Naphthalene Concentrations in Well MW-34S (September 2000 to June 2003) [5]

Date	Concentration (µg/L)
September 2000	5,720
December 2000	5,050
March 2001	5,900
June 2001	5,700
September 2001	6,200
December 2001	6,700
March 2002	5,400
June 2002	6,100
September 2002	7,000
December 2002	5,300
March 2003	6,100
June 2003	6,100

Groundwater quality data indicated that the plume is anoxic, with DO levels of less than 1 mg/L. In addition, the carbon:nitrogen:phosphorus (C:N:P) ratio indicates that the levels of both nitrogen and phosphorus in the groundwater are insufficient, which further limits biodegradation potential. The minimum ratio for C:N:P to support biodegradation is 100:14:1, and the measured value on a site-wide basis is 100:10.3:0.4.

Figure 2 shows the concentration of microbial degraders measured from February 2001 to June 2003 in selected monitoring wells located within Treatment Gates 1 and 2. As shown in this figure, the degrader population has shown a decreasing trend during this 2 1/3 year period. The contractor indicated that the cause of the decrease in the bacterial concentrations at the site is not known. Since air injection began in Treatment Gate 1 in October 2000, the population of degraders has generally been higher in this well compared to Treatment Gate 2, though the contactor noted that it was not known if this trend was due to air/nutrient injection, the presence of higher levels of substrate, or other factors.

Treatment Cost [6]

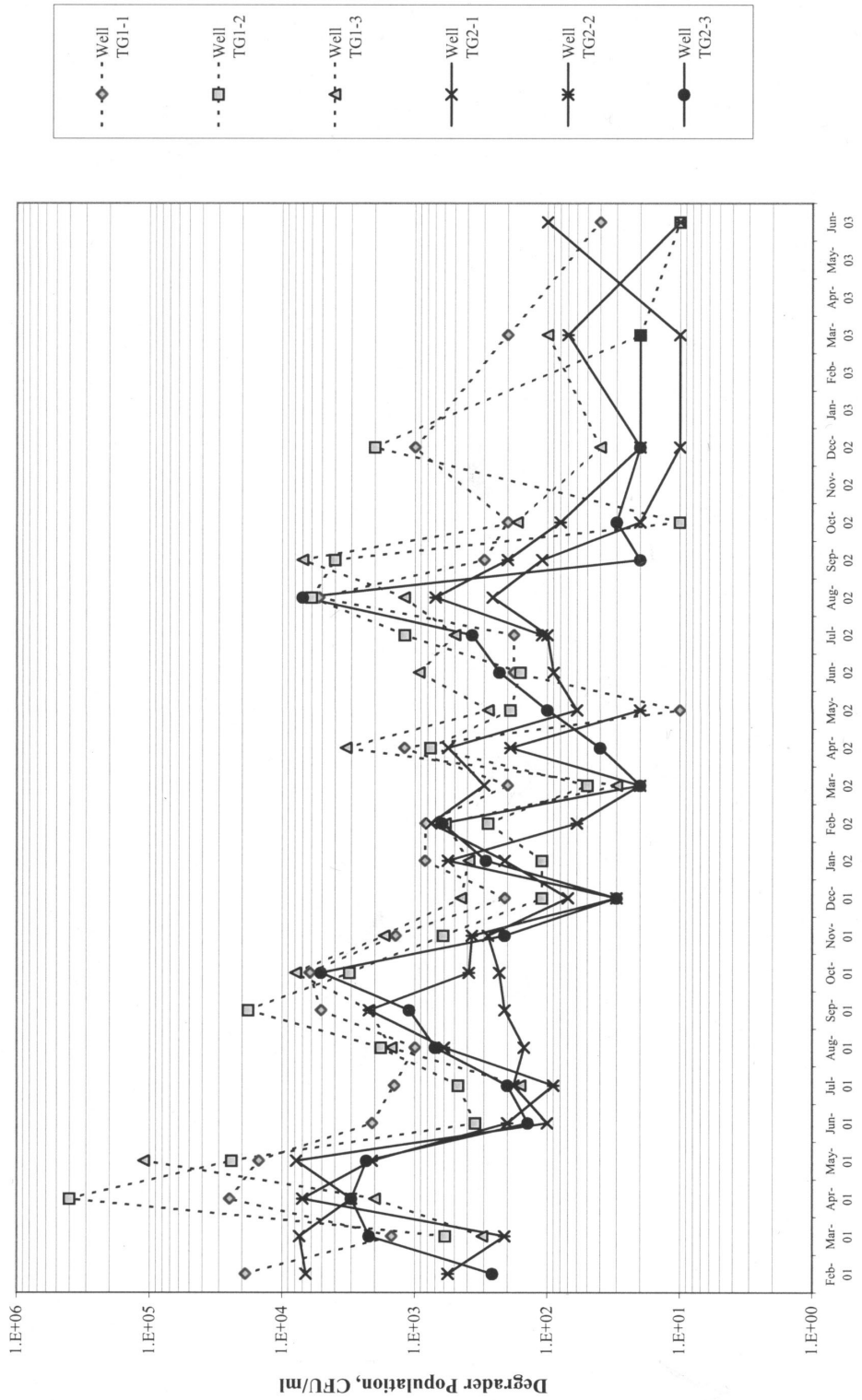
No cost data were provided for the biotreatment funnel and gate system.

Observations and Lessons Learned

Over a period of three years, the biotreatment funnel and gate system reduced contaminant concentrations in the groundwater at the site to below cleanup goals in many of the monitoring wells. While nutrient injection ceased in October 2002, monitoring of nutrient and contaminant levels will continue.

While no costs were provided for the biotreatment funnel and gate system, the capital cost for the free product recovery system which operated from 1996 to 1999 was estimated at $250,000. Operation and maintenance (O&M) costs for that system, including disposal fees, averaged approximately $20,000 per year over the four-year system lifetime.

Figure 2. Microbial Degrader Population in Treatment Gates 1 and 2 [5]



The following observations were noted by the contractor in the June 2003 quarterly monitoring report:

- None of the treatment performance wells exhibited the recommended C:N:P ratio for bioremediation of groundwater contaminants at a site. Nitrogen and phosphorous are the limiting nutrients at the site.
- In response to low DO levels, several modifications to the system were attempted, including installation of well packers and inflatable bladder packers in the injection wells. These were not effective or could not be properly installed. The contractor will continue to evaluate alternatives for air injection into the treatment gates.

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2. EPA Superfund Explanation of Significant Differences: Moss-American Co., Inc. (Kerr-McGee Oil Co.), EPA ID: WID039052626, OU 1, Milwaukee, WI. EPA ESD-R05-97-171. April 29, 1997.
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4. EPA Annual Status Report 11th Edition. Moss-American Groundwater. April 9, 2003.
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