Cost and Performance Summary Report
Thermal Desorption at the Arlington Blending and Packaging Superfund Site
Arlington, Tennessee

Summary Information [1,2,3,8]

The Arlington Blending and Packaging Superfund site, located in Arlington, Tennessee, is a 2.3 acre site that was used for the formulation and packaging of pesticides and herbicides from 1971 to 1978. Chemicals handled at the facility included the pesticides endrin, aldrin, dieldrin, chlordane, heptachlor, lindane, methyl parathion, and thimet, and solvents and emulsifiers used in the formulation operations. Leaks and spills of chemicals occurred during these operations and process wastewater was discharged to drainage ditches at the site. In addition, leaking drums (between 1,000 and 1,200) and bags of pesticides were stored at the site.

During investigations performed in 1983, the U.S. Environmental Protection Agency (EPA) identified elevated concentrations of pesticides in soil and groundwater at the site and in a housing development adjacent to the site. In October 1983, EPA conducted a removal action that included excavating 1,920 cubic yards of surface soil from on- and off-site areas that was contaminated with chlordane at levels above 50 milligrams per kilogram (mg/kg). In addition, 12 drums of chemical waste were removed. The site was placed on the National Priorities Lis in July 1987.

A remedial investigation (RI), begun in 1988, determined that the main areas of soil contamination at the site were located around and beneath the process buildings. The soil, contaminated at depths of up to 12 feet, was determined to be a likely source of groundwater contamination. During the RI, concentrations of contaminants were measured in the surface soil ($\leq$1 foot below ground surface or bgs) and subsurface soils (> 1 foot bgs). The reported maximum concentrations of contaminants were: chlordane - 390 mg/kg surface and 120 mg/kg subsurface; endrin - 70 mg/kg surface and 20 mg/kg subsurface; and pentachlorophenol 130 mg/kg surface and 9.5 mg/kg subsurface. Arsenic was found in surface soil at concentrations as high as 370 mg/kg; arsenic was not found in the subsurface soil.

A Record of Decision (ROD) was signed on June 28, 1991, addressing both soil and groundwater contamination at the site. This report focuses on the soil remediation at the site. For soil, the contaminants of concern were arsenic, chlordane, heptachlor, heptachlor epoxide, endrin, and pentachlorophenol. The ROD specified excavation of contaminated soil, treatment on site using thermal desorption, and backfilling of treated soils. For excavated soil with an arsenic concentration greater than 25 mg/kg, the ROD specified solidification/stabilization and off-site disposal.

In January 1992, EPA issued a Unilateral Administrative Order (UAO) for remedial design/remedial action for the site. The potentially responsible parties (PRPs) for the site formed the Arlington Blending Site Group (ABSG) to conduct the remediation. The ABSG was responsible for site remediation with oversight from EPA in coordination with the state, county, and city. ABSG's contractors included Memphis Environmental Center (general project management), Focus Environmental (remedial design and oversight for the remediation), and Smith Environmental Technologies Corporation (Smith), formerly Canonie Environmental Services Corporation, (on-site low temperature thermal desorption). Full-scale operation of the system was conducted between January 13 and June 4, 1996 and a total of 41,431 tons of soil were treated.

The ROD established excavation standards for the contaminated soils at the site. Surface and subsurface standards were established for chlordane (10 mg/kg surface; 3.3 mg/kg subsurface), endrin (2.7 mg/kg surface, 0.61 mg/kg subsurface), and pentachlorophenol (0.64 mg/kg surface, 0.64 mg/kg subsurface). Surface standards were established for heptachlor epoxide (2.0 mg/kg) and heptachlor (3.0 mg/kg). Soils were sampled to define the boundaries ("cutlines") for the excavation and the contaminated soil was excavated and stockpiled on site.

In addition, the ROD specified an excavation standard for arsenic (surface soil only) of 25 mg/kg. However, EPA subsequently determined that excavation was not required and allowed one foot of clean soil to be placed over all areas exceeding 25 mg/kg arsenic in lieu of excavating the soil. According to EPA, the change was allowable because the excavation standard was established for the protection of dermal contact only and arsenic was not a contaminant of concern for groundwater at the site.

During excavation, small patches of tar were discovered in the surface soil. A total of 5 tons of tar-contaminated soil were excavated and processed through the LTTD unit. According to the PRP's contractor, the soils contained only "traces" of tar.

CERCLIS ID Number:	TND980468557
Type of Action:	Remedial
Lead:	PRP
Oversight:	EPA

Timeline [1]

June 28, 1991	ROD signed
December 5-6, 1995	LTTD pre-test conducted
December 19-20, 1995	LTTD performance test conducted
January 13 to June 4, 1996	Full-scale operation of LTTD
July 1996	Demobilization completed
April 1997	Final Remedial Action report submitted to EPA

Factors That Affected Cost or Performance of Treatment [1,2,7]

The surface of the site is primarily Pleistocene loess except for the portions that are located within the flood plain where alluvial deposits are present. Shallow groundwater occurs at about 5 feet bgs.

Listed below are the key matrix characteristics for this technology and the values measured for each during site investigations.

Matrix Characteristics [1,7]

Parameter	Value
Soil Classification:	Silty clay
Clay Content and/or Particle Size Distribution:	98.6% of particles < 2.0 mm in diameter (wt%)
Moisture content:	10-26 wt% (average 17 wt%)
Total Organic Carbon:	1,700 mg/kg
pH:	6.8

Treatment Technology Description [1]

Smith's low temperature thermal aeration (LTTA) process was used to treat the contaminated soil at the site. The unit included a direct-fired rotating dryer that heated the soil to between 580 and 750 °F using a hot air stream. Propane gas was used to heat the air stream, and the organic constituents in the soil were desorbed in the dryer through contact with the heated air. The heated soil was discharged from the rotary dryer to an enclosed pugmill where it was quenched with water to cool and rehumidify the soil. The treated soil was then sampled, and based on the results, backfilled on site or stabilized and shipped off-site for disposal.

Off-gases from dryer were vented to a cyclone/baghouse system to remove particulates, then to a low pressure drop Venturi air scrubber to remove acid vapor and condensable constituents. The off-gases were then sent through vapor-phase carbon adsorption units (two units operated in parallel) to remove remaining organic constituents prior to discharge to the atmosphere. A slight vacuum of 0.10 to 0.18 inches of water was maintained throughout the process train using three induction fans located downstream of the baghouse, downstream of the Venturi scrubber, and in the carbon bed emission stacks. The dust collected in the cyclone/baghouse was sent to the pugmill where it was mixed with the treated soil.

In addition, the LTTA system included equipment to monitor and control process operations and emissions, including temperature, air pressure, and flow rates of the process and concentrations of oxygen, carbon monoxide, and total hydrocarbons in the emissions. The system was equipped with an interlock system that automatically shut down the process unit when key components malfunctioned or were operating outside normal ranges.

Prior to beginning full-scale operations, Smith performed a pre-test and a performance test of the LTTA unit. The pre-test consisted of stack emissions monitoring for pesticides, arsenic, particulates, hydrogen chloride, and chlorine. The results were used to verify that the system could meet the required performance standards and to help establish ranges for operating parameters. A performance test was used to demonstrate compliance with the performance standards for the treated soil and the treated flue gas. The results of these tests were then used to define the parameters for full-scale operation.

Listed below are the key operating parameters that affected cost or performance and the values measured for each.

Operating Parameters [1,8]

Parameter	Value
Residence Time:	10 to 20 minutes (estimated)
System Throughput:	10-30 tons/hr (average 15 tons/hr)
Exit Soil Temperature:	580-750°F (average 680°F)
Moisture Content:	10-26 wt% (average 17 wt%)
Vacuum in Rotary Dryer Drum	0.10-0.18 inches of water (average 0.15 inches of water)

Performance Information [1,2,8]

The ROD established the following cleanup goals for thermal treatment of contaminated soil at the site:

- chlordane - 3.3 mg/kg
- heptachlor - 0.3 mg/kg
- pentachlorophenol - 0.635 mg/kg
- endrin - 0.608 mg/kg
- heptachlor expoxide - 0.2 mg/kg
- arsenic - 25 mg/kg

EPA subsequently issued an Explanation of Significant Differences (ESD) changing the cleanup level for arsenic from the ROD level of 25 mg/kg to 100 mg/kg. The ESD required that all treated soil be analyzed for total arsenic and that any treated soil with a total arsenic concentration in excess of 100 mg/kg was to be disposed of off-site. In addition, any soil with arsenic above 100 mg/kg would also be analyzed for leachable arsenic using the toxicity characteristic leaching procedure (TCLP). Treated soils with TCLP arsenic concentrations above 5 mg/L were to be identified as hazardous waste and stabilized prior to disposal off-site.

The emission standards for the unit were:

- Total hydrocarbons (THC) - 500 ppmv
- Particulates - 0.08 gr/dscf
- System removal efficiency - > 95%

Emissions standards were based on modeling results and pre-testing and were established to meet applicable or relevant and appropriate regulations (ARARs). The emissions standards were consistent with a 10^{-4} cancer risk.

Compliance with the emissions standards was verified during the performance test. The unit met all emissions standards during the three test runs, achieving a system removal efficiency greater than 99.999%.

Full-scale operations were conducted from January 13 to June 4, 1996. Soil was treated in batches. Each batch of treated soil was placed in a pile and a composite sample was collected and analyzed for the contaminants of concern (total chlordane, heptachlor, endrin, heptachlor expoxide, pentatchlorophenol, and arsenic).

A total of 84 batches of soil (41,431 tons) were treated using the Smith LTTA process. All but six batches of soil met the cleanup goals for organics (total chlordane, heptachlor, endrin, heptachlor expoxide, and pentatchlorophenol) on the first pass through the system. Three batches exceeded the cleanup levels and were retreated. Batch # 42 exceeded the cleanup levels for total chlordane with a concentration of 7.760 mg/kg and pentachlorophenol with a concentration of 0.678 mg/kg. The batch was retreated (as Batch # 48) and met the cleanup levels. Batches #58 and #59, which exceeded the cleanup levels for pentachlorophenol (0.961 mg/kg and 0.889 mg/kg, respectively) were retreated as Batches #80 and #81 and met the cleanup level.

An additional three batches (#44, #45, and #46) were slightly above the 3.3 mg/kg cleanup level for total chlordane, with concentrations of 3.6 mg/kg, 4.65 mg/kg, and 4.6 mg/kg, respectively. However, EPA determined that the batches did not require re-treatment on the basis that the cleanup levels had been established assuming that the entire mass of the treated soil to be backfilled at the site would contain levels of contaminants at the established treatment standard. Since the average concentration of total chlordane in the treated soil was 0.517 mg/kg compared to the treatment standard of 3.3 mg/kg, EPA determined that the impact of not retreating the three batches would have been negligible.

Following confirmation that the cleanup goals had been met, treated soil was backfilled at the site. Only one batch of treated soil (Batch #10) did not meet the 100 mg/kg limit for arsenic. The soil from this batch was shipped offsite for disposal in a Subtitle C landfill. However, because the TCLP level for arsenic was below the 5 mg/L limit, solidification/stabilization prior to off-site disposal was not required.

Performance Data Quality [1]

Samples were collected and analyzed in accordance with QA/QC procedures described in the Remedial Action Report. Data were provided for all treated soil samples and air emissions samples from pre-test and performance tests. No deviations in QA/QC procedures were noted in the Remedial Action Report.

Cost Information [4,5,6]

Memphis Environmental Center served as the prime contractor to the ABSG for this project, and provided general project management support. The design for the project was performed by Focus Environmental, in conjunction with BCM Engineers. Smith served as the treatment vendor.

Cost data were provided by Memphis Environmental Center and are the actual costs invoiced for the project. Table 1 presents the costs for this application, including capital costs, O&M costs, other technology-specific costs, and other project costs. The total project cost was $5,586,376 including $4,356,244 in costs directly associated with the thermal treatment of the contaminated soil at the Arlington Blending and Packaging site. The treatment costs included $4,293,893 in capital costs and $62,351in O&M costs. The calculated unit cost for this application is $105 per ton, based on 41,431 tons of soil treated.

Observations and Lessons Learned [1]

The Smith LTTA system treated a total of 41,431 tons of pesticide-contaminated soil to the required cleanup goals within a five month period. Only three batches of soil had to be retreated because they did not meet the cleanup goals on the first pass; the batches of soil met the cleanup goals after being retreated. One batch of treated soil exceeded the 100 mg/kg cleanup goal for arsenic and was shipped off-site for disposal. All other treated soil was backfilled at the site.

The total cost for the project was $5,586,376 including $4,356,244 in costs directly associated with the thermal treatment of the contaminated soil. The treatment costs included $4,293,893 in capital costs and $62,351 in O&M costs. The calculated unit cost for this application is $105 per ton, based on 41,431 tons of soil treated.

The original schedule for the project called for the project to start in July 1995, with completion of soil treatment by November 9, 1995. According to Focus Environmental, there were several factors that resulted in extending the completion date for soil treatment to June 1996:

- Delays in initial site mobilization after EPA's conditional approval of the Remedial Action Work Plan
- Delays in turnaround times for laboratory analyses, resulting in delays in confirming results of excavation activities
- Identification of an additional 30,000 tons of contaminated soil requiring treatment above the original estimate of 10,000 tons.

The original estimate for the soil excavation was based on the results from field-based screening using the Drexil method, which measured for total chlorine. Subsequent verification analyses, performed in an off-site laboratory using EPA method 8080, indicated that the results from the Drexil analyses were not accurate. The field method had identified only about a fourth of the soil that required excavation. Followup sampling and analyses identified an additional 30,000 tons of soil requiring excavation.

Focus Environmental used immunoassay sampling to recharacterize the site for excavation. The site was sampled in grids (20 by 20 feet and 40 by 40 feet). According to Focus Environmental, the use of immunoassay sampling saved time by providing real time results (versus 5 to 6 day turnaround time for an off-site laboratory). The results of the immunoassay sampling were confirmed by an off-site laboratory and were determined to be accurate. A detailed study performed by Focus Environmental on the correlation of immunoassay testing to off-site laboratory analyses is presented in Reference 1.

Table 1 - Summary of Actual Project Costs [5,6,8]

Cost Category/Element	Cost (1996 $ Basis)	Cost for Calculating Unit Cost ($)
1. Capital Cost for Technology		
Technology mobilization, setup, and demobilization		
- mobilization/erection	359,641	
- placement of borrow material	36,062	
- site restoration	8,800	
- sound barrier fencing	8,000	
Planning and preparation		
- RA work plan preparation	97,020	
- treatability testing	138,000	
- procurement phase	58,000	
- RA work plan oversight	26,000	
- RA report preparation	34,000	
- oversight of RA contractor (by Focus)	297,000	
Site work		
- site preparation and construction	265,693	
Equipment and appurtenances		
- thermal treatment	2,839,015	
Startup and testing		
- startup	67,582	
Other		
- performance bond	59,080	
TOTAL CAPITAL COSTS		4,293,893
2. O&M for Technology		
Labor	Included in capital costs	
Materials	Included in capital costs	
Utilities and fuel	Included in capital costs	
Equipment ownership, rental, or lease	Included in capital costs	
Performance testing and analysis		
- LTTD system performance test	62,351	
Other (Includes nonprocess equipment overhead and health and safety)	0	
TOTAL OPERATION AND MAINTENANCE COSTS		62,351
3. Other Technology-Specific Costs		
Compliance testing and analysis	0	
Soil, sludge, and debris excavation, collection, and control		
- excavation of soil	407,133	
Disposal of residues		
- backfilling of treated soil	226,395	
- disposal of soils shipped off site		
Subtotal for category 3	633,528	
4. Other Project Costs		
- contaminated concrete remediation	79,364	
- uncontaminated concrete remediation	12,152	
- demolition of Building H	58,254	
- decontamination/disposal of debris	15,947	
- analytical services (for excavation activities)	253,431	
- remedial design report	167,000	
- community relations	10,456	
Subtotal for category 4	596,604	
Total cost	5,586,376	
Total cost for calculating unit cost		4,356,244
Quantity treated		41,431 tons
Calculated unit cost		105/ton
Basis for quantity treated		quantity of soil treated in thermal desorber

Contact Information [1]

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References

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2. EPA Region 4. *Record of Decision, Arlington Blending and Packaging Site.* June 28, 1991.

3. EPA Region 4. Arlington Blending and Packaging - NPL Site Narrative at Listing. Internet document summarizing the regulatory history of the Arlington Blending and Packaging site. February, 1999. <http://www.epa.gov/superfund/sites/npl/nar498.htm>

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