

**PHASE IV REMEDIATION
PILOT TEST PROGRAM REPORT
FORMER C-E CAST FACILITY
MUSE, PENNSYLVANIA**

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Submitted to:

Prospect Hill Management Corporation

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Project No. 5832-31

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ABB Environmental Services, Inc.

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MUSE, PENNSYLVANIA

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EXECUTIVE SUMMARY

Based on field and analytical results from the pilot test program conducted by ABB Environmental Services at the former C-E CAST facility, the Thermally Enhanced Vapor Extraction (TEVE) technology successfully treated the site soil contaminants of concern (COCs) to concentrations below the Pennsylvania Department of Environmental Protection ACT 2 Statewide Health Standards (Statewide Health Standards) for Soils.

Fifty-five out of 56 soil samples collected from the pilot test stack on the fourth and seventh days of treatment were below Statewide Health Standards for the COCs. Field measurements of volatile organic compounds (VOCs) volatilizing from the soil into the stack air stream (contaminated air stream) during treatment indicated that the concentration of VOCs decreased sharply after the fourth day of treatment. During the remaining days of treatment (total of seven) the concentration of VOCs in the contaminated air stream appeared to be minimal.

ABB-ES recommends that the remaining estimated 6,500 cubic yards of contaminated soil be treated using the TEVE technology. Based on Round 2 data (collected following four days of treatment) with COC concentrations below Statewide Health Standards, and the decrease in the concentration of VOCs in the contaminated air stream following four days of treatment, and including a factor for safety, ABB-ES proposes that each soil stack be treated for five days.

1.0 INTRODUCTION

This report presents the results of the Thermally Enhanced Vapor Extraction (TEVE) technology pilot test conducted in August 1995 at the former C-E Cast facility (facility). These results are the basis for the strategy for proceeding with full-site treatment of the contaminated soil at the facility. This report documents the activities conducted during the pilot test program and presents field and analytical sampling results. On-site activities included excavation of soils contaminated with chlorinated volatile organic compounds (cVOCs), and benzene, toluene, ethylbenzene and xylenes (BTEX), construction of the pilot test stack, TEVE treatment, sampling, backfilling.

TABLE 1

ACT 2 STATEWIDE HEALTH STANDARDS
 PILOT TEST PROGRAM
 CE CAST MUSE, PENNSYLVANIA

CONTAMINANTS OF CONCERN	ACT 2 STATEWIDE HEALTH STANDARDS (µG/KG)
1,1,1-TCA	20,000
TCE	2,000
PCE	2,000
Vinyl Chloride	10,000
Benzene	800
Ethylbenzene	70,000
Toluene	100,000
Total Xylenes	5,000
Chlorobenzene	10,000
1,2-Dichlorobenzene	7,000
1,3-Dichlorobenzene	7,000
1,4-Dichlorobenzene ¹	No Criteria

1. Act 2 Statewide Health Standards for soils designates 1,4-Dichlorobenzene as P-Dichlorobenzene

3.0 EXCAVATION

As discussed in the work plan (ABB-ES, 1995), ABB-ES excavated the more highly contaminated soils for treatment during the pilot test. On August 1, 1995, soil was excavated from Area 3 and along the railroad (RR) bed at Area 1. Figure 1 shows the approximate excavation locations at Areas 1 & 3.

Approximately 70 to 100 cubic yards (cy) of soil were excavated from Area 3. This excavation was larger than anticipated due to elevated Photo Ionization Detector (PID) readings (9 to 150 parts per million (ppm)). Upon completion of the Area 3 excavation, PID readings ranged from 15 to 25 ppm. Concrete piers, previously used to support aboveground storage tanks at Area 3, were encountered during excavation. Soil was scraped from the concrete piers for treatment. The piers were left in the excavation.

Approximately 570 to 600 cy of soil were excavated from Area 1. The excavation continued until clay or shale was observed along the western slope and the bottom of the excavation. Elevated PID readings (90 to 250 ppm) were recorded in the southwestern portion of the excavation. Based on these elevated readings and the presence of vinyl chloride in this area during Phase III investigations, two air samples were collected with vinyl chloride Draeger tubes. No vinyl chloride was detected.

The upgradient erosion control ditch that had previously been constructed provided adequate protection from stormwater run-on to excavation locations at Areas 1 and 3. Additionally, Area 1 was excavated to maintain positive drainage and a line of haybales was staked at the downgradient (northern) end of the excavation for erosion and siltation control.

A perimeter safety fence was installed around the excavation at Area 3 during the pilot test.

4.0 PILOT TEST PROGRAM

The pilot test stack was constructed on August 1, 1995, with base dimensions of 35 feet (ft) x 93 ft, top dimensions of 13 ft x 72 ft, and a height of approximately 9 ft. Subtracting approximately 910 linear ft of 12-inch diameter perforated aluminum heating pipe, the total volume of soil treated was approximately 670 cy (1000 tons). The nine-foot high stack was constructed in three layers (lifts), with thicknesses of approximately 2 ft, 5 ft, and 2 ft measured from the base of the stack.

Startup of the TEVE system was at 3:00 pm on August 2, and the propane burner was finally shutdown at 8:00 am on August 9, 1995. The propane burner temperature ranged from 545 to 620 degrees Fahrenheit. The burner was shut down twice during the seven day pilot test. The first shutdown occurred at approximately 5:00 pm on August 4, to allow the system to cool down prior to making repairs on the seal between the reinforced nylon cover tarp and the heating pipes. The system was restarted at approximately 5:00 pm on August 5 following completion of repairs. A second burner shutdown occurred at approximately 7:30 pm on August 6 to allow the system to cool prior to placing a new cover tarp. On the morning of August 7, a new tarp was placed over the old tarp, due to deterioration of the original tarp. The TEVE system was restarted at 8:00 am the same day. The TEVE system operated for a total of 161 hours. Although the propane burner was shutdown for approximately 38 hours, residual heat in the stack continued to cause volatilization, and the blowers and vacuum systems continued to move the contaminated air stream through the catalytic reactor, removing VOCs.

5.0 SAMPLING LOCATIONS AND COLLECTION METHODS

During the pilot test, ABB-ES or its subcontractors monitored the contaminated air stream, stack emissions and ambient air and collected three rounds of soil samples.

The purpose of each type of sampling is provided in Table 2.

The Subcontractor measured the concentration of VOCs in the air stream as it moved from the soil stack to the burn chamber (contaminated air stream). The Subcontractor also measured the concentration of VOCs in the exhaust air following VOC destruction in the burn chamber and the catalytic reactor. These measurements were collected on an hourly basis, using a Photo Ionization Analyzer (HNU). Measurements of the contaminated air stream were used to determine the concentrations of VOCs volatilizing from the soil. Measurements of the exhaust air were used to determine the concentrations of VOCs being exhausted into the atmosphere.

As proposed in the sampling plan attached to the work plan (ABB-ES, 1995), three rounds of soil samples were collected from the pilot test stack. Each of the three lifts was divided into a grid and soil samples were collected randomly within each grid space. Approximately 25 soil samples were collected during each round. Samples were collected using a bucket auger at heights of 1 to 2 ft, 5 ft and 8 ft (measured vertically from the base of the stack) corresponding to the first, second, and third lifts.

An attempt was made to maintain the same sample locations during the first and second rounds to characterize treatment efficiency. Sample locations were different for the third sampling round. Ten soil samples were collected from locations where higher concentrations of COCs had been detected during Round 2. The remainder of the Round 3 soil samples were collected based on visual observations of the treated soils. Sampling locations are illustrated on Figure 2.

Round 1 untreated soil samples were collected prior to startup of the TEVE system. Round 2 partially treated soil samples were collected between 94 and 101 hours, or after approximately four days of treatment. Half of the Round 3 treated soil samples were collected the day after final shutdown of the TEVE system

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TABLE 2

PILOT TEST SAMPLING
 PILOT TEST PROGRAM
 CE CAST MUSE, PENNSYLVANIA

TYPE OF SAMPLING	LOCATION	PURPOSE
Air	Excavations at Areas 1 and 3	PID readings of soil to determine when to collect confirmation samples at Area 3. PID readings of breathing zone in excavations and around perimeter of treatment stack for health and safety purposes.
	Contaminated air stream	HNU readings to determine the concentration of VOCs volatilizing from the soil into the stack airstream during treatment.
	Exhaust air	HNU readings to observe VOC emissions to the atmosphere.
Soil	Excavation at Area 3	Samples collected for off-site analysis to confirm removal of soils exceeding Statewide Health Standards
	Pilot Test Stack	Samples collected for off-site analysis: Round 1: to establish a baseline of soil contaminant concentrations; Round 2: to determine treatment efficiency and to determine if Statewide Health Standards have been achieved; and Round 3: to confirm soil treatment has achieved Statewide Health Standards.

(August 10), and the remainder were collected a week later (August 18) during the removal of aluminum piping from the pilot test stack.

First round samples were collected prior to placement of the nylon cover tarp. For the second and third sampling rounds, a small hole was cut in the tarp at each sample location. Following sample collection, each hole was patched with black nylon tape. Soil temperatures were measured during the second and third sampling rounds and ranged from 111 to 356 degrees Fahrenheit.

Eight confirmation soil samples were collected from the excavation at Area 3 to confirm the removal of contaminated soils exceeding Statewide Health Standards. These grab soil samples were collected randomly in accordance with Tables 1 and 2 of Act 2 Chapter 2 - Section 3, Interim Soil Monitoring and Statistical Methodology, Paragraph A (PADEP, 1995). Samples were collected with stainless steel spatulas at depths ranging from 6-inches to 1 foot.

6.0 CHEMICAL ANALYSIS

A total of 91 soil samples, collected from the pilot test stack and the Area 3 excavation, were analyzed for VOCs as part of the pilot test program. Eighty-five of these samples were analyzed by Quanterra Incorporated, and six samples were analyzed by Blue Marsh Lab for the Subcontractor. Chemical analysis was performed in accordance with USEPA Method 8240A in "Test Methods for Evaluating Solid Waste", SW-846, Third Edition, September 1986 and subsequent revisions. Details of laboratory quality assurance and quality control procedures and protocols are included in the QA/QC Plan attached to the work plan (ABB-ES, July 1995).

A preliminary quality control review (method blank contamination, laboratory adherence to quality control criteria) was performed to assess the quality of the data. No severe non-conformances were observed that could affect the useability of the data. Analytical reports are on file at ABB-ES and are available upon request.

7.0 FIELD AND ANALYTICAL RESULTS

This section summarizes the results of field measurements of the contaminated air stream and the exhaust air, and laboratory analytical results of soil samples collected from the pilot test stack.

Hourly measurements of the contaminated air stream show that the concentration of VOCs in the air stream decreased from a maximum of 47 parts per million (ppm) to 10 ppm during the 161 hour treatment time (Figure 3). The maximum concentrations occurred following 37 hours of treatment and decreased most sharply during the third and fourth days of treatment (61 to 93 hours).

Exhaust air was measured hourly to observe VOC emissions to the atmosphere. HNU readings were consistently at background concentrations during the pilot test.

Analytical results of the three rounds of soil samples are presented on Tables 3, 4 and 5, respectively.

Round 1 results indicate the presence of all 12 COCs in the soil prior to treatment. A total of 27 samples of untreated soil were collected and analyzed. Total COC concentrations were calculated for each sample location using the summation of the detected results. The total COC concentration for Round 1, ranged from 32.7 parts per billion (ppb) to 50,030 ppb with an average concentration of 19,332 ppb. Eleven samples exceeded the Statewide Health Standards for 1,2-dichlorobenzene (1,2-DCB) and/or total xylenes. These exceedances are highlighted in Table 3.

A library search of tentatively identified compounds (TICs) identified naphthalene with estimated concentrations exceeding the Statewide Health Standard in six samples collected during Round 1. The Statewide Health Standard is 8000 ppb, and exceedances ranged from an estimated 9900 to 20,000 ppb.

A total of 28 samples of partially treated soil were collected and analyzed during Round 2. The total concentration of COCs for Round 2 ranged from 1 ppb to 5300 ppb with an average concentration of 529 ppb. Analytical results indicate that all COC concentrations in partially treated soil samples were below the

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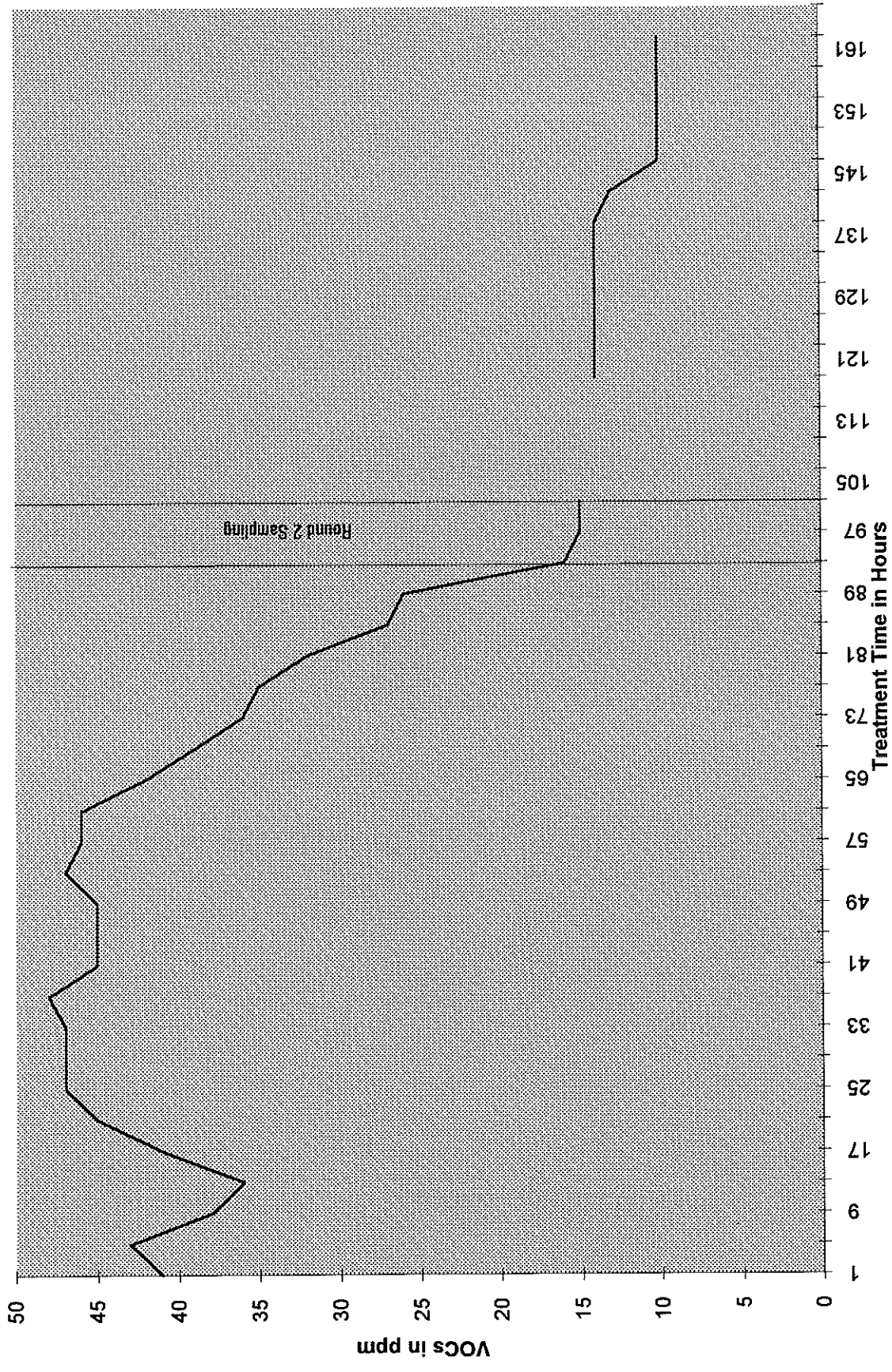


FIGURE 3
CONTAMINATED AIRSTREAM CONCENTRATIONS
PILOT TEST PROGRAM
CE CAST MUSE, PENNSYLVANIA

Statewide Health Standards (Table 4). Naphthalene was identified during the library search in Round 2 analyses at estimated concentrations below the Statewide Health Standard.

A total of 28 samples of treated soil were collected and analyzed during Round 3. The total concentration of COCs for Round 3 ranged from 7 ppb to 13,920 ppb with an average concentration of 1152 ppb. Analytical results from 27 of 28 treated soil samples indicated that all COC concentrations were below the Statewide Health Standards. Statewide Health Standards were exceeded at only one sample location, where total xylenes were detected at 8900 ppb (3900 ppb above the Statewide Health Standard). Round 3 analytical results are shown on Table 5. Naphthalene was identified during the library search in Round 3 analyses at estimated concentrations below the Statewide Health Standard.

Analytical results of the eight confirmation samples collected from the excavation at Area 3 indicated that COC concentrations were below the Statewide Health Standards. Only chlorobenzene, toluene and 1,1,1-TCA were detected, all at concentrations below the Statewide Health Standard. Based on the analytical results from the excavation at Area 3, approximately 100 cy of treated soil from the pilot test stack was backfilled at Area 3. The results of the confirmation sample analyses from Area 3 are shown in Table 6.

8.0 CONCLUSIONS

As stated in Section 7.0, COC concentrations were below the Statewide Health Standards for all (28 of 28) of the partially treated soil samples and 27 of 28 treated soil samples. Figure 4 provides a comparison of the average concentrations of COCs for the three rounds of analytical results. This figure illustrates the decrease in the concentration of COCs following for four and seven days of treatment.

ABB-ES has concluded from these results that the TEVE technology is successful in treating soils contaminated with cVOCs and BTEXs. One of 56 soil samples analyzed for 11 COCs exceeded the Statewide Health Standard. This one exceedance out of 616 analyses (11 analytes times 56 samples) represents an effectiveness of more than 99 percent. This one sample may be indicative of soils within a small area of the stack; however, the activities of stack deconstruction and excavation backfilling are expected to improve the quality of these soils through volatilization and dilution caused by exposure to the atmosphere and soil mixing.

Based on the success of the Pilot Test Program, ABB-ES has determined an optimal treatment time. Figure 3 illustrates the decrease in VOC concentrations in the contaminated air stream over time. As previously stated, the concentration of VOCs decreases sharply after the fourth day of treatment. During the remaining days of treatment (total of seven) the concentration of VOCs in the contaminated air stream appears to be minimal. Round 2 soil samples were collected following four days of treatment. Based on the success of the Round 2 samples achieving Statewide Health Standards within four days and the decrease in the concentration of VOCs in the contaminated air stream after four days, the optimum treatment time appears to be four days.

Figure 5 shows removal efficiencies of COCs based on analytical results from Round 2 and Round 3 data. Nine out of 11 COCs had removal efficiencies greater than 90 percent. Removal efficiencies of benzene and toluene were lower, but still exceeded 68 percent. Analytical results for benzene showed that it was detected at sample locations during Rounds 2 and 3 in areas where it had not been detected during Round 1. It is possible that some of the detected benzene could be a product of thermal decomposition of other VOCs or a release from

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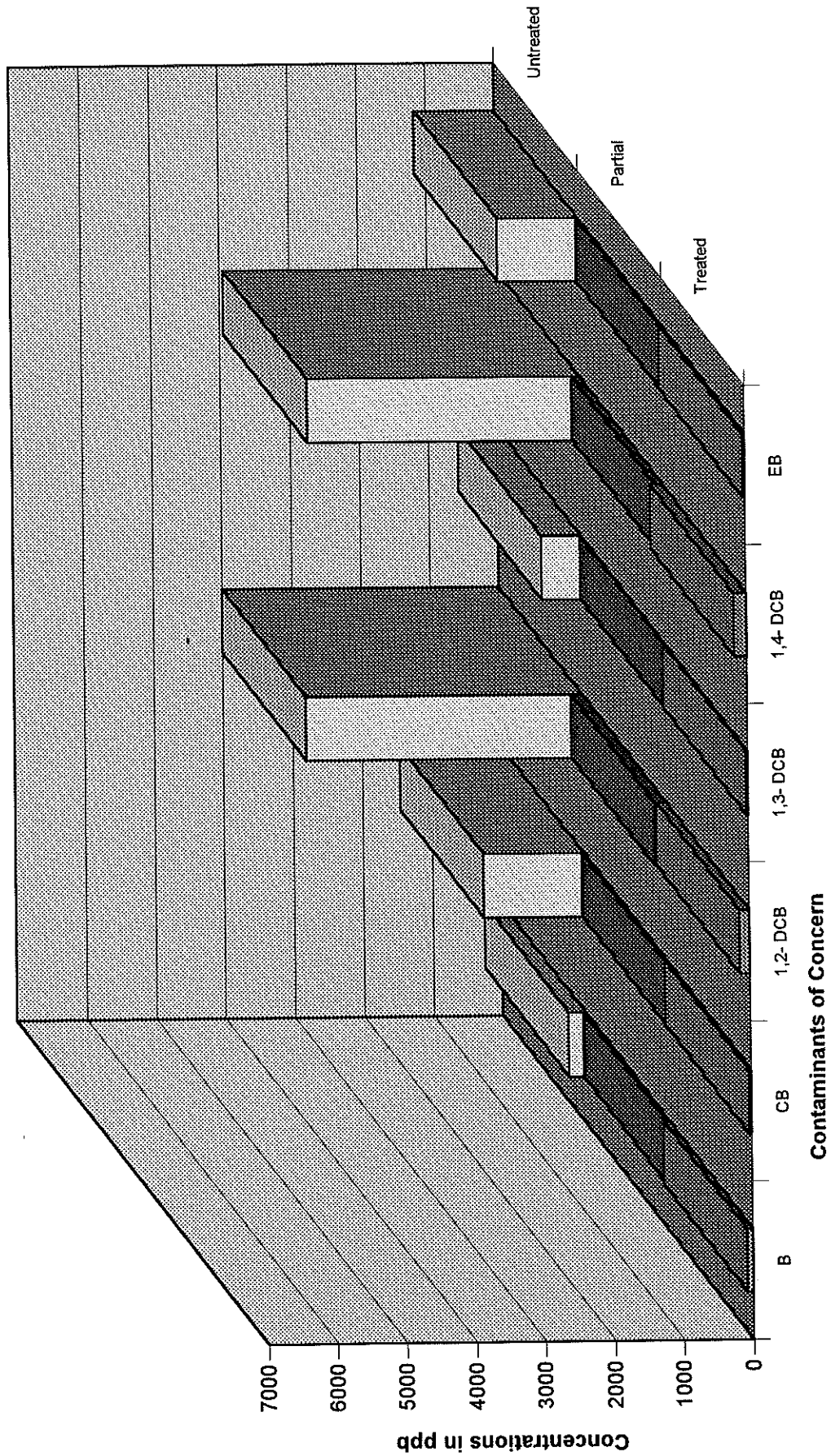


FIGURE 4
AVERAGE DETECTIONS
PILOT TEST PROGRAM
CE CAST MUSE, PENNSYLVANIA

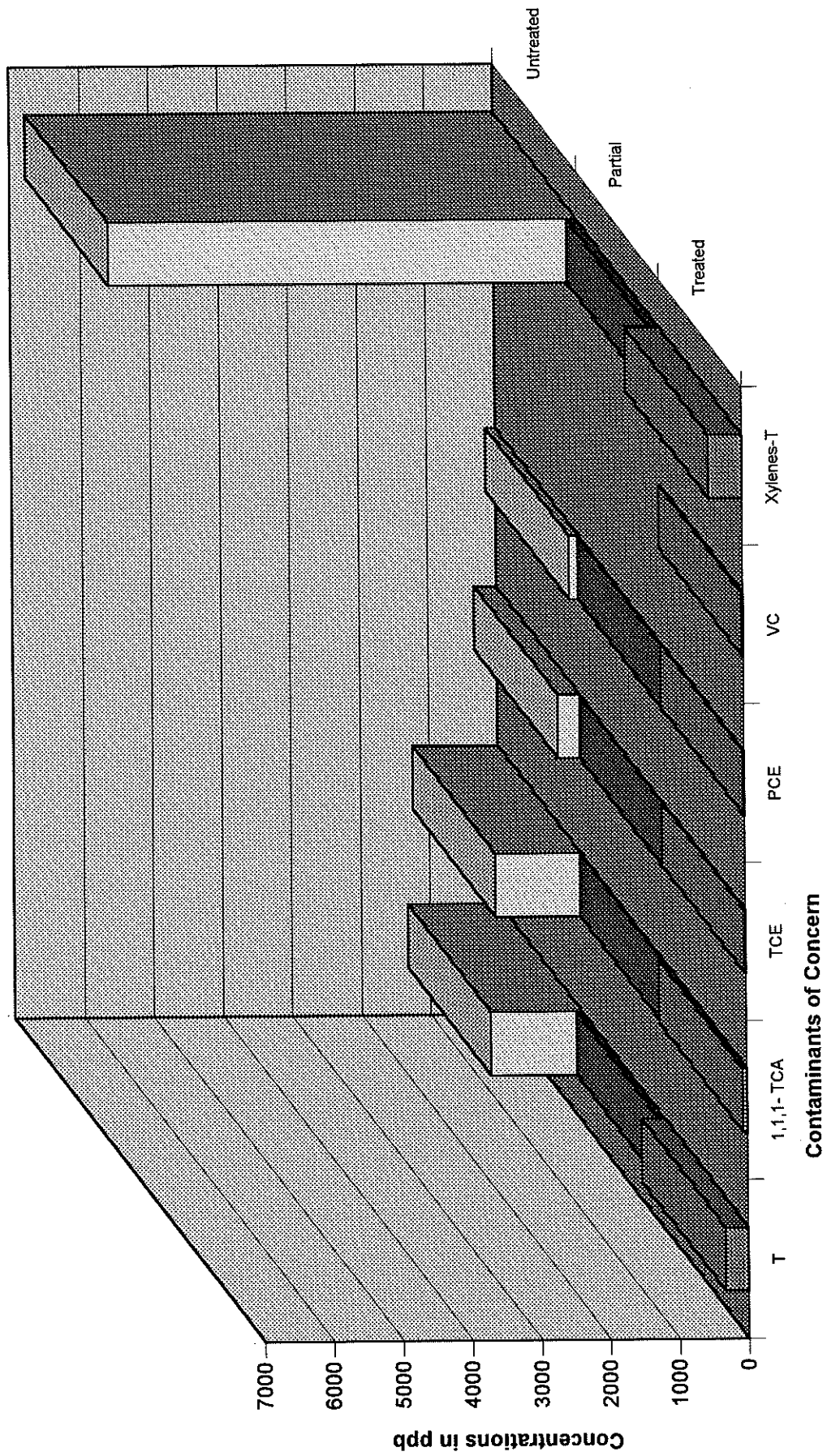
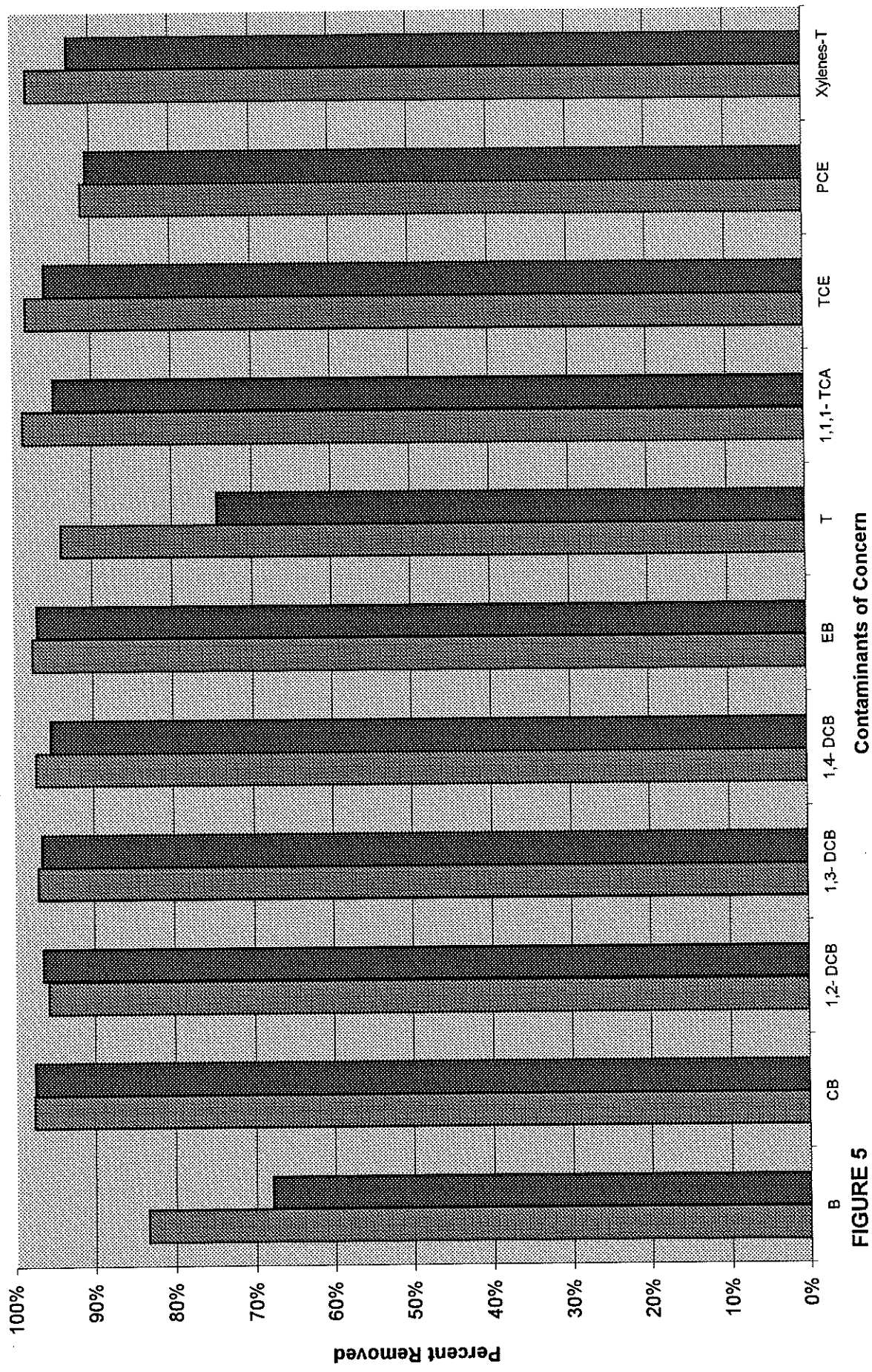


FIGURE 4 (cont'd)
AVERAGE DETECTIONS
PILOT TEST PROGRAM
CE CAST MUSE, PENNSYLVANIA



Partial
Treated

Contaminants of Concern

FIGURE 5
REMOVAL EFFICIENCIES
PILOT TEST PROGRAM
CE CAST MUSE, PENNSYLVANIA

coal and shale in the soil during TEVE treatment. This phenomena, detection of benzene where it had not been previously been detected, has been observed at other sites using thermal treatment for soils.

9.0 RECOMMENDATIONS

Based on the success of the TEVE technology at treating 670 cubic yards (cy) of contaminated soils at the facility during the pilot test program, ABB-ES proposes to treat the remaining estimated 6500 cy of contaminated soil using the TEVE technology.

Including a factor for safety to the optimum treatment time of four days, it is recommended that each soil stack be treated for five days or 120 hours.

During the pilot test a two-foot section of perforated aluminum heating pipe located at one end of the stack appears to have deteriorated. ABB-ES proposes that the remaining soil stacks be constructed using steel heating pipe.

Because the pilot test analytical results have shown that the TEVE technology successfully treated the COCs to concentrations below the Health Standards, ABB-ES proposes collection of fewer samples from the stacks during full-site remediation. The Subcontractor will collect one sample per 200 cy. For 670 cy soil treatment stacks, the Subcontractor will collect approximately 4 samples per stack. ABB-ES will collect additional samples, if necessary, to meet the requirements of Act 2 (PADEP, 1995).

REFERENCES

ABB Environmental Services, Inc. (ABB-ES), 1995. Work Plan - Former C-E Cast Facility, Phase IV Remediation Pilot Test Program. Portland, Maine: July.

Pennsylvania Department of Environmental Protection, (PADEP), 1995. The Land Recycling and Environmental Remediation Standards Act (ACT 2). Commonwealth of Pennsylvania: July.

PHASE IV REMEDIAL ACTION PLAN
FORMER CE CAST FACILITY
MUSE, PENNSYLVANIA

ADDENDUM NO. 7, SEPTEMBER 15, 1995

INTRODUCTION

The Commonwealth of Pennsylvania revised the legislation pertaining to site remediations in 1995. Act 2 of 1995 - Land Recycling and Environmental Remediation Standards Act, was signed by the Governor May 19, 1995 and became effective July 18, 1995.

Act 2 soil treatment standards replaced the PADER 2 standards for the CE Cast Facility project. All references to Pennsylvania Department of Environmental Resources shall be changed to The Commonwealth of Pennsylvania Department of Environmental Protection. All references to "PADER" shall be changed to "PADEP", and "PADER 2" to "ACT 2".

This Addendum No. 7 modifies II.A Introduction and II.D.1.B Specifications of the Phase IV Remedial Action Plan, as described below.

II.A INTRODUCTION

Page 1-1, Section 1.0 - Introduction. The first paragraph shall be amended to add the Pennsylvania Department of Environmental Protection (PADEP) Land Recycling and Environmental Remediation Standards Act - Act 2 of 1995 (ACT 2).

A third paragraph is added to say "A thermal soil treatment technology known as Thermally Enhanced Vapor Extraction (TEVE) is being used to treat the contaminated soils at the facility. Based on vendor interviews, ABB-ES project personnel selected the TEVE technology for its ability to treat on-site contaminated soils and achieve the Statewide Health Standards (Act 2 - Appendix B2)."

Page 1-2, Section 1.3 - Conceptual Site Model. References to PADER 2 criteria shall now reference PADEP ACT 2 Statewide Health Standards.

II.D.1.B SPECIFICATIONS

Section 01010 - Summary of Work

- 1.01 A. The third sentence is revised to say "Soil will be treated to PADEP ACT 2 Statewide Health Standards, Appendix B-2 soil to Groundwater Pathway."
- 1.01 B. Sentence is revised to say "All work is being performed under the provisions of ACT 2."

- 1.01 C.5. The second sentence is revised to say "Load and haul soil to treatment area, off-load, construct treatment stack, and treat contaminated soil with the Thermally Enhanced Vapor Extraction (TEVE) technology."

Section 01060 - Regulatory Requirements

- 1.02 A. The second sentence is revised to say "All work is being performed under the provisions of ACT 2."
- 1.03 A. Amend to add line 12 to say "The Land Recycling and Environmental Standards Act - Act 2 of 1995 (ACT 2)."

Section 01091 - Reference Codes and Standards

- 1.01 A. Line 5 is revised to say "6. PADEP - Commonwealth of Pennsylvania Department of Environmental Protection."
- Line 6 shall be revised to be line 7.

Section 01410 - Sampling and Analysis

- 1.02 C. Sentence is revised to say "The Owner's representative will conduct soil sampling and analysis to delineate the actual limits of excavation as specified in Part 3 - Execution."
- 3.01 A.1. Sentence is revised to say "A minimum of one sample per 200 cy of treated soil will be collected based on a statistical sampling strategy described in Act 2 Chapter 2 - Attachment 1."
- 3.01 D. This section shall become 3.01 E.
- A new Section 3.01 D shall be added to say "Soil sampling and analysis shall be conducted to delineate the actual limits of the excavation based on Act 2 Chapter 2 - Section 3 Interim Soil Monitoring and Statistical Methodology."

Section 02212 - Contaminated Materials Excavation and Backfilling

- 1.03 C.1. The summary table is revised to delete C-1,2-DCE, styrene and cyclohexane. Based on Act 2 Statewide Health Standards, these chemicals are no longer contaminants of concern for soils.

Section 11177 - Thermal Treatment Unit

Exhibit B This exhibit is revised to delete the Target Cleanup Level PADER 2 criteria column and substitute Act 2 Appendix B2 - Table B2 Statewide Health Standards, Soil to Groundwater pathway for benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, ethylbenzene, toluene, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, vinyl chloride, and total xylenes.

End of Addendum