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APPENDIX E

Report on the HT-6 Process Thermal Desorption Studies

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

FINAL REPORT
HT-6 PILOT SCALE TREATABILITY STUDY
PENSACOLA SITE
PENSACOLA, FLORIDA
MARCH, 1993

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Prepared by:

Roy F. Weston, Inc.

Richard J. Tobia
Task Leader

3/1/93
(Date)

W. Scott Butterfield
Project Manager

3/1/93
(Date)

Prepared for:

U.S. EPA/ERT

Harry Compton
Work Assignment Manager

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1.0 INTRODUCTION

On November 9-11, 1992, personnel from the U.S. Environmental Protection Agency's Environmental Response Team (U.S. EPA/ERT) and its Response Engineering and Analytical Contract (REAC) conducted a pilot-scale treatability study at the Escambia Wood Treating Company's Pensacola Superfund Site in Pensacola, Florida. This study was conducted to evaluate the technical feasibility of thermal distillation technology on PCP, creosote, and dioxin contaminated waste.

This report covers the pilot-scale thermal distillation study performed using the HT-6 High Temperature Thermal Distillation Unit (formerly the HT-5) which was supplied and operated by Seaview Thermal Systems of Houston, Texas.

The purpose of this study was to obtain enough information about the process to determine its feasibility as a remedial alternative for this site and to make site remediation recommendations.

1.1 Objectives of this Study

The objectives of this study were to:

- Perform thermal distillation treatability studies on contaminated soil washing process water sludge and contaminated site soils from the Pensacola site and on contaminated tank sludge from the Southern Maryland Wood Treating site.
- Determine the costs and steps required to treat the contaminated sludge and/or soil during a full-scale cleanup.
- Determine if pentachlorophenol (PCP) and dioxins are decomposed during the treatment process.
- Calculate a mass balance for the chemical contaminants.

1.2 Background

The Pensacola Facility of the Escambia Wood Treating Company is located at 3910 N. Palafox Street in Pensacola, Florida. The contamination is a result of former wood-treating practices. The soils are contaminated with creosote compounds, PCP, and petroleum hydrocarbons. Currently, approximately 250,000 cubic yards of creosote, dioxin, and PCP contaminated soil have been excavated and stockpiled at the Pensacola site. Many different treatability/feasibility studies have been proposed and tested for the cleanup of the site soil. Previous work has included bench- and pilot-scale washing studies of the contaminated site soil, pilot-scale UV/peroxide treatment of the process water from the soil washing studies, and bench-scale physical and chemical characteristic studies of the soil washing study process water.

The Southern Maryland Wood Treating Site (SMWT) is located in Hollywood, Maryland. The contamination at this site is the result of prior wood-treating practices. Studies to determine the feasibility of bioremediation are currently underway. A sample from the SMWT site was studied with the HT-6 process as a worst case scenario for PCP, dioxin, creosote, and petroleum hydrocarbon contamination. The sample for the study was collected from the bottom of Tank No.9 by Mary Lee and Jacqueline Marrone, both of REAC, and shipped directly to the Pensacola site.

2.0 PROCESS DESCRIPTION

The HT-6 High Temperature Thermal Distillation Unit (HT-6) is a trailer mounted pilot-scale unit capable of running small batches (< 1500 grams) of sample. The unit is constructed entirely of stainless steel and high temperature alloys. The unit consists of a primary distillation chamber, a secondary degradation chamber, three condensers, and a scrubber (Figure 1).

The sample, approximately 1 liter in volume, is loaded into the sample tray and is placed directly into the heated primary distillation chamber under a nitrogen atmosphere. Temperatures in this chamber are around 1950 °F. Any water and contaminants are volatilized and carried by the nitrogen sweep gas [1 cubic foot per minute (cfm)] to the secondary degradation chamber; a proprietary catalyst is used to dechlorinate the contaminants producing byproducts of chloride and hydrochloric acid. The sweep gas is then passed through three condensers in series containing ice water and dry ice which lower the temperature to -10 °F. The cooled nitrogen gas is passed through a water scrubber and finally through a carbon canister. Each test run is conducted for 20 minutes.

The full-scale unit differs from the pilot-scale unit in that the nitrogen sweep gas and the particulates are recycled back to the unit. Additionally the temperature is ramped in three stages and the full-scale unit runs in a continuous fashion.

3.0 METHODOLOGY

3.1 Soil/Water/Sludge Sample Collection

The waste samples, whether solid or liquid, were homogenized and weighed or measured for the planned number of runs to be performed. A pre-treatment sample was collected for analysis. The sample was loaded onto the tray and inserted into the heated primary distillation chamber. Temperatures of the distillation chamber, the degradation chamber, and the condenser exit gas were recorded every five minutes. After the 20 minute run time, the condensate was sampled through a valve at the bottom of each condenser to collect a composite sample. Subsequent runs were performed to yield enough sample for the analyses. The scrubber water was checked for pH, and a sample was collected at the end of each test. Any other waste streams that were produced during the test were sampled at the end before clean-out procedures commenced. These included the condenser dust and the condenser oil that were collected from condenser #1.

Three samples contaminated with dioxins, pentachlorophenol (PCP), creosote compounds, and petroleum hydrocarbons were passed through the unit to test the manufacturer's claim that both PCP and dioxins are decomposed during the process, and that a recyclable oil is recovered as a byproduct. A unit clean-out was performed with clean sand before any tests commenced (Section 3.4).

Table 1 presents a matrix of the samples collected during the study and the corresponding analyses. Pre- and post-treatment samples were collected along with condensate water and oil from the process and scrubber water.

3.1.1 Pensacola Soil

Contaminated site soil from the Pensacola site was utilized for the first test. This soil was the same that was used for runs 19 and 20 of the pilot-scale soil washing study performed by ERT/REAC in July, 1992 (Final Report Pilot-Scale Soil Washing Study, Pensacola, Florida, Roy F. Weston, Inc. REAC, January, 1993). These soils

were stockpiled and covered since the end of July, 1992. Approximate concentrations of PCP and creosote were 140 and 2000 parts per million (ppm), respectively. Approximately three gallons of soil was placed in a 5-gallon plastic pail and mixed thoroughly. Four batch runs were conducted with 1500 grams of the contaminated soil mixed with 200 milliliters (ml) of distilled water. Water was added to the soil so that enough water could be collected from the condensers for the analyses to be performed.

3.1.2 SMWT Tank Sludge

Contaminated sludge from Tank No.9 of the Southern Maryland Wood Treating Site was used for the second test. Previous analyses had shown high levels of PCP and total creosotes in the thousands of ppm. Three batch runs were conducted with 1000 grams of contaminated sludge mixed with 500 mls distilled water.

3.1.3 Pensacola VRU Sludge

Contaminated process water sludge generated during the Superfund Innovative Technology Evaluation (SITE) program's Volume Reduction Unit (VRU) pilot-scale test was used for the third test. Thirty gallons of sludge from the underflow of the clarifier was collected in a 55-gallon drum for use in this test. Sulfuric acid was added to the sludge sample to allow the solids to flocculate and settle. Standing water was decanted and the pH was brought up to seven units for the HT-6 unit study. Four gallons of the concentrated sludge was collected for the study. Two batch runs were conducted with 1000 mls of the contaminated sludge.

3.1.4 Clean Sand

The clean sand for the decontamination runs and the control runs was collected from an on-site pile previously found to be clean. The control test consisted of two batch runs conducted with 1500 grams of clean sand mixed with 500 mls water. This test was performed before the contaminated soil/sludge tests.

3.2 Soil/Water/Wipe Analytical Procedures

3.2.1 Dioxin/Furan

Dioxin/furan analyses were performed by Southwest Research Institute (SWRI), San Antonio, Texas. Dibenzodioxin/dibenzofuran concentrations were determined using U.S. EPA Method 1613, SW-846.

3.2.2 BNAs

BNA analyses were performed by SWRI. BNA concentrations were determined using U.S. EPA Method 8270, SW-846.

3.2.3 Chloride

Chloride analyses were performed by SWRI. Chloride content was determined using U.S. EPA Method 325.3.

Further details on the above procedures can be found in Appendices A, B, and C.

3.3 Air Sample Collection/Analytical Procedures

In-line emission samples collected during the performance evaluation of the HT-6 were analyzed for dioxin, PCP, PAHs and VOCs. Emission samples were drawn from an inlet between the final condenser and the scrubber as illustrated in Figure 2. Dioxin samples were collected during treatment of both contaminated soil from the Pensacola site, and contaminated tank sludge from the SMWT facility. BNA and VOC samples were collected during treatment of clean sand and contaminated soil from the Pensacola site. XAD-2 tubes, Tenax/Carbon Molecular Sieve (CMS) tubes, and polyurethane foam (PUF) plugs were utilized for sample collection. Flow rates for each collection media were monitored and recorded (Appendix D).

Air samples were collected to further confirm the unit's capabilities and to calculate a mass balance for the process.

3.3.1 Dioxin/Furan

Dioxin/furan samples were collected onto 3-inch polyurethane foam (PUF) plugs and analyzed by SWRI according to U.S. EPA Method 1613. Samples were drawn from the inlet through a teflon tube apparatus to the PUF, which was held in place by a modified General Metal Works PS-1 sample head. Samples were collected using a diaphragm vacuum pump calibrated with a rotameter to an approximate flow rate of 17 liters per minute (l/min). Flow rate variation was checked with a rotameter placed at the outlet of the sample train.

3.3.2 PAHs/PCP

PAH/PCP samples were collected and analyzed by REAC, Edison NJ, using a modified NIOSH method 5515 (Appendix A). Samples were drawn from the inlet through the teflon tubing onto 600 milligram XAD-2 resin tubes using a personal air sampling pump. The pump was calibrated using a rotameter to flow rates ranging between 2.3 l/min and 243 milliliters per minute (ml/min). Flow rates were decreased during the sampling of emissions from contaminated soil treatment runs to minimize the risk of breakthrough on the tubes.

3.3.3 VOCs

VOC samples were collected and analyzed according to a modified U.S. EPA methods TO1/TO2: Determination of Volatile Organic Compounds in Ambient Air Using Tenax/Carbon Molecular Sieve Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS). Collocated samples were drawn from the inlet through the teflon tubing onto Tenax/CMS tubes using a low flow air sample pump. The pump was calibrated using a rotameter to flow rates ranging between 60 ml/min and 36 mL/min. Sample rates varied as a result of the appearance of visible contamination on the tubes during initial runs.

3.4 Unit Clean-Out

On November 9, 1992 the unit arrived on site. Brian Horne and Doug Vaughan of Seaview Thermal Systems (STS), and Srinivas Avantsa and Frank Keleman of Xytel-Bechtel, Inc. (XBi), a subcontractor to STS, arrived to set up the unit. Harry Compton, U.S. EPA/ERT, and Richard Tobia and Tina Jones, REAC, arrived that afternoon to prepare for the sampling runs. Clean sand mixed with 500 mls of distilled water was run through the unit to ensure the unit was free of any contamination. The condensate from this first run had a blue tint to it and was contaminated with some black particulates. The following morning clean water was run through the unit to further flush out any residual contamination. The condenser water appeared clean. A clean sand run was performed as a control for the contaminated soil and sludge runs. Two batches of 1500 grams clean sand mixed with 500 mls of distilled water were run. Samples were collected of the pre- and post-treated soil, the condenser water, and the air emissions for analysis.

Before changing the contaminated matrix, all lines were flushed and steam cleaned with the exception of the heated chambers. Clean water runs were performed prior to changing the sample matrix to ensure the cleanliness of the unit.

4.0 RESULTS

4.1 BNA/PCP/Chloride/Percent Solids

Results of the BNA/PCP analyses and percent solids analyses for the Pensacola soil, the Pensacola VRU sludge, the control clean sand, and the SMWT tank sludge are presented in Table 2 (pre-treatment solids), Table 3 (post-treatment solids), and Table 4 (condenser water). Scrubber water results are presented in Table 5 for the Pensacola soil and the SMWT tank sludge. Chloride results of the condenser and scrubber water are presented in Tables 4 and 5, respectively. Condenser oil wipe results for BNA/PCP for the Pensacola soil run and condenser dust results for BNA/PCP for the SMWT tank sludge run are presented in Table 6. Appendix E contains a summary of operating parameters and notes.

4.2 Dioxin/Furan

Dioxin/furan results are presented in Table 7 for the Pensacola soil runs and Table 8 for the SMWT tank sludge runs. Pre-treatment soil sample results, post-treatment soil sample results, condenser water sample results, scrubber water results, and condenser oil wipe or condenser dust results are reported. The 1987 Toxicity Equivalency Factors (TEF) were utilized to calculate equivalencies for each sample. Equivalency results are reported in parts per trillion (ppt) levels.

4.3 Air

4.3.1 PAH/PCP

Table 9 presents results of four samples collected and analyzed for PAHs and PCP. Results are presented in total micrograms (ug) and in ug/liter (ug/l) for each sample. Sample #12422 was taken during the clean sand control run, this sample was collected at approximately 2.0 l/min for 45 minutes for a total volume of 90 liters. Three samples were taken during the treatment of the contaminated Pensacola soil. Sample #12424 was collected during the first run, spanning four minutes at an approximate rate of 1.2 l/min for a total volume of 4.7 liters. Sample #12427 was

collected during the second treatment run, spanning a period of twenty minutes at an approximate flow rate of 226 ml/min for a total volume of 4.5 liters. Sample #12429 was collected during the third and fourth treatment runs, spanning a period of 44 minutes at an approximate flow rate of 186 ml/min for a total volume of 8.2 liters.

Both a field blank and a trip blank accompanied the PAH/PCP samples to the laboratory. These were designated sample numbers 12437 and 12436, respectively.

4.3.2 VOCs

Table 10 presents results of five samples collected and analyzed for VOCs. Results of method, field, and lot blanks are also presented. Three sets of collocated samples were collected and analyzed for VOCs. Sample #12421 was taken during the clean sand control run; this sample was collected at 60 ml/min for 45 minutes for a total volume of 2.7 liters. Two sets of samples were taken during the treatment of the contaminated Pensacola soil. Sample #12425 was collected during the first treatment run, spanning 18 minutes at a rate of 36 ml/min for a total volume of 0.65 liters. Sample #12426 was collected during the second treatment run, spanning 10 minutes at a flow rate of 36 ml/min for a total volume of 0.36 liters.

Both a field blank and a lot blank accompanied the VOC samples to the laboratory. These were designated sample numbers 12435 and 12434, respectively.

4.3.3 Dioxin/Furan

Table 11 presents results of four samples collected and analyzed for dioxins and furans. Two samples were collected during the treatment of the contaminated Pensacola soil. Sample #12423 was collected spanning 18 minutes during the first run. The total volume collected was 306 liters. Sample #12428 was collected spanning 57 minutes during the second thru fourth runs for a total volume of 969 liters. Two samples were collected during the treatment of the SMWT tank sludge. Sample # 12431 was collected spanning 57 minutes during the second and third run of the sludge for a total volume of 969 liters. Sample #12340 was collected and analyzed but because of flow rate variation, no time or volume could be calculated.

Both a field blank and a trip blank accompanied the dioxin samples to the laboratory. These were designated sample numbers 12432 and 12433, respectively.

5.0 DISCUSSION OF RESULTS

5.1 Pensacola Soil

Feed soil contamination concentrations were 955 ppm total creosote, non detect PCP, and 37.3 ppt dioxin toxicity equivalents. Although PCP was not detected in the soil, the sample was known to contain approximately 100 ppm PCP from previous analytical results. The non detect result may have been due to the high detection limit of 270 ppm. Post-treatment soil levels were nondetect for PCP and total creosote, and 5.6 ppt for dioxin equivalents. These numbers correspond to contaminant reductions of greater than 99 percent creosote and 85 percent dioxin toxicity equivalents. PCP was not detected in either of the condenser water, the scrubber water, or the condenser oil wipe. Individual creosote compounds detected in the scrubber water were less than 1 ppm, and in the condenser water were less than 1 ppm

with the exception of naphthalene, 6.6 ppm, and phenol, 1.8 ppm. Chloride levels of the condenser water and the scrubber water are 53 mg/l and 1 mg/l, respectively. The elevated chloride levels are a byproduct of PCP and/or dioxin breakdown. Dioxins were detected at less than 0.1 ppt toxicity equivalents in the scrubber and condenser water. Condenser oil wipe concentrations, based on a wipe sample mass of 1.0 gram, were 35 ppt toxicity equivalents for dioxins and 8960 ppm total creosote compounds.

Total creosote levels up to 1694 ug/l (264 ppmv), VOCs up to 5406 ug/m^3, and dioxins up to 10.1 pg/m^3 were detected in the nitrogen sweep gas from these test runs.

5.2 VRU Sludge

Feed sludge contamination concentrations were 341 ppm total creosote and 46 ppm PCP. Dioxins were not analyzed as part of this test. Post-treatment sludge levels were nondetect for PCP and less than 1 ppm total creosote. These numbers correspond to contaminant reductions of greater than 99 percent. PCP was not detected in the condenser water. Total creosote concentrations of 12.4 ppm were detected in the condenser water. No other samples were collected since there was no visual sign of other contamination. Individual creosote compounds detected in the condenser water were less than 1 ppm with the exception of naphthalene, 9.5 ppm. Chloride levels of the condenser water are 600 mg/l.

5.3 Clean Sand

Feed sand contamination concentrations were less than 1 ppm total creosote and non detect for PCP. Dioxins were not analyzed as part of this test. Post-treatment sand levels were nondetect for PCP and total creosote. PCP was not detected in the condenser water. Individual creosote compounds detected in the condenser water were less than 0.1 ppm. Chloride levels of the condenser water were 26 mg/l. No other samples were collected since there was no visual sign of other contamination.

5.4 SMWT Tank Sludge

Feed sludge contamination concentrations were the highest of the tests performed, 5299 ppm total creosote, 80000 ppm PCP, and 690 ppt dioxin toxicity equivalents. Post-treatment soil levels were nondetect for PCP, less than 1 ppm total creosote, and 3.4 ppt dioxin toxicity equivalents. These numbers correspond to contaminant reductions of greater than 99 percent. PCP was not detected in either of the condenser water, the scrubber water, or the condenser dust. Individual creosote compounds detected in the scrubber water were less than 2 ppm. Individual creosote compounds in the condenser water were detected to levels up to 1800 ppm. Chloride levels of the condenser water and the scrubber water were 61500 mg/l and 78 mg/l, respectively. Dioxin levels of the condenser water were 157 ppt toxicity equivalents. Dioxins were detected at less than 0.5 ppt toxicity equivalents in the scrubber water. Dioxin toxicity equivalents of the condenser dust were 9.9 ppt and total creosote levels were approximately 11000 ppm.

Dioxins were detected in the nitrogen sweep gas at levels of 692 pg/m^3.

A mass balance for the process was calculated for PCP, creosote, and dioxin toxicity equivalents (Table 12). Sweep gas analyses were not included in the calculation. Weights and volumes of various process streams were estimated in order to determine a total mass of contaminants. Percent reductions were calculated from this data.

6.0 CONCLUSIONS

Although PCP feed concentrations were as high as 80000 ppm, no PCP contamination was detected in any of the post-treatment solid, water, or sweep gas samples. Dioxin levels in the pre- and post-treatment solid samples were reduced between 85 to 99.5 percent. Dioxins were detected in the SMWT condenser water, sweep gas samples, and condenser wipe and dust show that not all the dioxins were being decomposed. Post-treatment levels of tetrachlorinated dibenzodioxins (TCDD) increased for the Pensacola soil test as compared to the feed soil. This generation of TCDD may have been the result of too short a residence time of the sample in the degradation chamber resulting in incomplete or partial dechlorination.

Although the pre- and post-treatment solids results show very good reductions in the contaminants of concern, these results may be misleading. Contamination from the feed is being carried over into other process exit streams such as the sweep gas, the condenser and scrubber water, an oily condensate, and the condenser dust, a fine carbon black-like material. PCP was completely degraded in the pilot test; a longer residence time in the degradation chamber may be all that is necessary to completely degrade the dioxins. But there will still be elevated levels of VOCs and BNAs in the process exit streams that will require some type of treatment before disposal.

Mass balance results of the Pensacola soil show that greater than 97 percent of all creosote compounds and 84.4 percent of dioxin equivalents were degraded or unaccounted for. Results of the SMWT tank sludge show that 100 percent of PCP, 15.6 percent of total creosote compounds, and 81.1 percent of dioxin equivalents were degraded or unaccounted for (Table 12). Degradation of the PCP and dioxins is supported by the elevated chloride levels detected in the condenser and scrubber water (Tables 4 & 5). Levels of naphthalene did increase in the waste streams which may account for some losses due to volatilization.

There are several differences between the pilot-scale unit and a full-scale unit which may account for different results. In the full-scale unit, the waste is heated in three separate chambers at increasing temperatures. Gases and vapors are removed at each stage. In this stage there may be a possibility of separating the water and volatile fractions from the heavier semivolatile compounds. Whether or not this will have any effect on the quantity of contaminants in the condenser and scrubber water is unknown at this time. Controls are utilized on the full-scale system to separate the dust produced in the degradation chamber from the condenser water. Gases and any solids retained in the system are recycled in the full-scale system with a portion being sent to a flare.

Preliminary costs to operate a full-scale 10 ton/hour unit were estimated by Seaview Thermal Systems to be approximately $200/ton. The cost to clean up the 250,000 cubic yards of contaminated site soil would be 50 million dollars and the cleanup would take approximately 3.85 years. This assumes 24 hour/day operation with 10 percent down time with 300 working days/year. With two units, this time can be reduced to less than 2 years.

If the unit were only used to clean up the sludge produced from the soil washing system, the cost of washing the 250,000 cubic yards, plus the cost of running the sludge through the system, is estimated to be $16.5 million. These estimates are based on a soil washing estimate of $10.3 million and 2 years (see Final Report Pilot-Scale Soil Washing Study) and a HT-6 estimate of $6.25 million (25,000 tons of sludge at a higher cost of $250/ton). A smaller 5 ton/hr unit could be used to clean up the sludge in less than a year. This cost does not include the water treatment costs for the soil washing, but at the current savings of $33.5 million, water treatment would have to cost more than $134/ton of treated soil or $100/1000 gallons to be more expensive than HT-6 treatment alone. Studies are currently being performed to determine the cost of water treatment.

7.0 RECOMMENDATIONS

It is recommended that before any full-scale work is performed with this process, more studies be performed to determine the fate of the waste streams. These waste streams are the water and oily condensates, the scrubber water, the carbon black material, and the air emissions. The quantity of each waste stream and contamination levels need to be defined so that treatment options can be determined. Additional studies of the mass balance are necessary to determine the fate of the chemical constituents, i.e. chemical degradation or reformation.

TABLE 1
SAMPLE MATRIX
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SAMPLE	TOTAL SOLIDS	BNA	CHLORIDE	DIOXIN	VOC
PRE-TREAT SOLIDS	PS,PWS, CS,TS	PS,PWS, CS,TS	---	PS,TS	---
POST-TREAT SOLIDS	PS,PWS, CS,TS	PS,PWS, CS,TS	---	PS,TS	---
CONDENSER WATER	---	PS,PWS, CS,TS	PS,PWS, CS,TS	PS,TS	---
SCRUBBER WATER	---	PS,TS	PS,TS	PS,TS	---
OIL WIPE	---	PS	---	PS	---
CONDENSER DUST	TS	TS	---	TS	---
CONDENSER EXIT AIR	---	PS,CS	---	PS,TS	PS,CS

PS = Pensacola Soil
PWS = VRU Process Water Sludge
CS = Clean Sand
TS = SMWT Tank Sludge

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TABLE 2
PRE-TREATMENT SOLIDS RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SITE	PENSACOLA	PENSACOLA	SMWT	CONTROL
SAMPLE TYPE	SOIL	VRU SLUDGE	TANK SLUDGE	CLEAN SAND
% SOLIDS	92	18	64	97
DETECTION LIMIT	110	10	390	0.34
SAMPLE #	18628	18639	18631	18624
UNITS	mg/kg	mg/kg	mg/kg	mg/kg
PHENOL	ND	ND	ND	ND
NAPHTHALENE	21 J	2 J	240 J	ND
2-METHYLNAPHTHALENE	61 J	16	1100	ND
ACENAPHTHYLENE	ND	0.97 J	ND	ND
ACENAPHTHENE	89 J	ND	400	ND
DIBENZOFURAN	62 J	26	310 J	ND
FLUORENE	90 J	37	320 J	ND
PHENANTHRENE	330	110	1500	ND
ANTHRACENE	53 J	16	ND	ND
CARBAZOLE	ND	5.4 J	ND	ND
Di-n-BUTYLPHTHALATE	ND	0.59 J	ND	ND
FLUORANTHENE	130	54	670	ND
PYRENE	72 J	40	500	ND
BENZO(a)ANTHRACENE	17 J	8.5 J	90 J	ND
CHRYSENE	20 J	8.7 J	95 J	ND
BIS(2-ETHYLHEXYL)PHTHALATE	ND	ND	ND	ND
Di-n-OCTYLPHTHALATE	ND	5.2 J	ND	0.05 J
BENZO(b)FLUORANTHENE	5.5 J	3.9 J	37 J	ND
BENZO(k)FLUORANTHENE	4.6 J	3.5 J	37 J	ND
BENZO(a)PYRENE	ND	2.7 J	ND	ND
INDENO(1,2,3-cd)PYRENE	ND	0.89 J	ND	ND
BENZO(g,h,i)PERYLENE	ND	ND	ND	ND
TOTAL CREOSOTE	955	341	5299	0.05
PENTACHLOROPHENOL	ND(270)	46	80000	ND(0.82)

( ) = Special Detection Limit
J = Estimated value below the lowest calibration standard.
ND = Compound not detected.

TABLE 3
POST-TREATMENT SOLIDS RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SITE	PENSACOLA	PENSACOLA	SMWT	CONTROL
SAMPLE TYPE	SOIL	VRU SLUDGE	TANK SLUDGE	CLEAN SAND
% SOLIDS	99	98	97	99
DETECTION LIMIT	0.33	10	10	0.33
SAMPLE #	18629	18640	18633	18625
UNITS	mg/kg	mg/kg	mg/kg	mg/kg
PHENOL	ND	ND	ND	ND
NAPHTHALENE	ND	ND	ND	ND
2-METHYLNAPHTHALENE	ND	ND	ND	ND
ACENAPHTHYLENE	ND	ND	ND	ND
ACENAPHTHENE	ND	ND	ND	ND
DIBENZOFURAN	ND	ND	ND	ND
FLUORENE	ND	ND	ND	ND
PHENANTHRENE	ND	ND	ND	ND
ANTHRACENE	ND	ND	ND	ND
CARBAZOLE	ND	ND	ND	ND
Di-n-BUTYLPHTHALATE	ND	0.62	0.81	ND
FLUORANTHENE	ND	ND	ND	ND
PYRENE	ND	ND	ND	ND
BENZO(a)ANTHRACENE	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	ND	ND	ND	ND
CHRYSENE	ND	ND	ND	ND
Di-n-OCTYLPHTHALATE	ND	ND	ND	ND
BENZO(b)FLUORANTHENE	ND	ND	ND	ND
BENZO(k)FLUORANTHENE	ND	ND	ND	ND
BENZO(a)PYRENE	ND	ND	ND	ND
INDENO(1,2,3-cd)PYRENE	ND	ND	ND	ND
BENZO(g,h,i)PERYLENE	ND	ND	ND	ND
TOTAL CREOSOTE	ND	0.62	0.81	ND
PENTACHLOROPHENOL	ND(0.81)	ND(26)	ND(26)	ND(0.81)

( ) = Special Detection Limit
ND = Compound not detected.

TABLE 4
CONDENSER WATER RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SITE	PENSACOLA	PENSACOLA	SMWT	CONTROL
SAMPLE TYPE	SOIL	VRU SLUDGE	TANK SLUDGE	CLEAN SAND
DETECTION LIMIT	0.05	0.05	50	0.05
SAMPLE #	18627	18641	18632	18626
CHLORIDE (mg/l)	53	600	61500	26
UNITS	mg/l	mg/l	mg/l	mg/l
PHENOL	1.8	0.58	10 J	0.02 J
NAPHTHALENE	6.6	9.5	1800	ND
2-METHYLNAPHTHALENE	ND	0.08	26 J	ND
ACENAPHTHYLENE	0.87	0.82	720	ND
ACENAPHTHENE	ND	0.02 J	9 J	ND
DIBENZOFURAN	0.33	0.31	10 J	ND
FLUORENE	0.04 J	0.03 J	54	ND
PHENANTHRENE	0.67	0.34	580	0.03 J
ANTHRACENE	0.06	0.04 J	88	ND
CARBAZOLE	0.02 J	0.01 J		ND
Di-n-BUTYLPHTHALATE	ND	ND	ND	ND
FLUORANTHENE	0.28	0.18	480	0.03 J
PYRENE	0.44	0.26	540	0.05
BENZO(a)ANTHRACENE	0.1	0.03 J	55	0.05
CHRYSENE	0.09	0.03 J	57	0.07
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 J	0.01 J	ND	ND
Di-n-OCTYLPHTHALATE	0.01 J	ND	3.1 J	ND
BENZO(b)FLUORANTHENE	0.07	0.04 J	90	0.02 J
BENZO(k)FLUORANTHENE	0.05	0.03 J	54	0.03 J
BENZO(a)PYRENE	0.09	0.04 J	110	0.03 J
INDENO(1,2,3-cd)PYRENE	0.03 J	0.03 J	89	0.01 J
BENZO(g,h,i)PERYLENE	0.07	0.04 J	130	0.02 J
TOTAL CREOSOTE	11.6	12.4	4905	0.36
PENTACHLOROPHENOL	ND	ND	ND	ND

J = Estimated value below the lowest calibration standard.
ND = Compound not detected.

TABLE 5
SCRUBBER WATER RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SITE	PENSACOLA		SMWT	
SAMPLE TYPE	SOIL		TANK SLUDGE	
DETECTION LIMIT	0.05		0.15	
SAMPLE #	18630		18638	
CHLORIDE (mg/l)	1		78	
UNITS	mg/l		mg/l	
PHENOL	0.01	J	0.37	
NAPHTHALENE	0.54		1.8	
2-METHYLNAPHTHALENE	0.01	J	0.04	J
ACENAPHTHYLENE	ND		ND	
ACENAPHTHENE	ND		0.02	J
DIBENZOFURAN	0.11		0.05	J
FLUORENE	0.01	J	0.14	J
PHENANTHRENE	0.16		1.1	
ANTHRACENE	ND		0.11	J
CARBAZOLE	ND		ND	
Di-n-BUTYLPHTHALATE	ND		ND	
FLUORANTHENE	0.03	J	0.84	
PYRENE	0.02	J	1	
BENZO(a)ANTHRACENE	ND		0.13	J
CHRYSENE	0.01	J	0.15	
BIS(2-ETHYLHEXYL)PHTHALATE	ND		ND	
Di-n-OCTYLPHTHALATE	ND		ND	
BENZO(b)FLUORANTHENE	0.01	J	0.2	
BENZO(k)FLUORANTHENE	ND		0.14	J
BENZO(a)PYRENE	ND		0.21	
INDENO(1,2,3-cd)PYRENE	0.01	J	0.17	
BENZO(g,h,i)PERYLENE	0.01	J	0.25	
TOTAL CREOSOTE	0.93		6.72	
PENTACHLOROPHENOL	ND		ND	

J = Estimated value below the lowest calibration standard.
ND = Compound not detected.

TABLE 6
CONDENSER OIL WIPE/CONDENSER DUST RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SITE	PENSACOLA SOIL	PENSACOLA SOIL	SMWT TANK SLUDGE
SAMPLE TYPE	OIL WIPE	OIL WIPE	DUST
DETECTION LIMIT	0.05	50	390
SAMPLE #	18637	18637	18635
UNITS	mg	mg/kg*	mg/kg
PHENOL	ND	ND	ND
NAPHTHALENE	3.1	3100	2800
2-METHYLNAPHTHALENE	0.04 J	40	60
ACENAPHTHYLENE	0.69	690	2000
ACENAPHTHENE	ND	ND	ND
DIBENZOFURAN	0.32	320	25 J
DIETHYLPHTHALATE	0.03	30	ND
FLUORENE	0.04 J	40	180 J
PHENANTHRENE	1.1	1100	1300
ANTHRACENE	0.17	170	160 J
CARBAZOLE	ND	ND	ND
Di-n-BUTYLPHTHALATE	ND	ND	ND
FLUORANTHENE	0.62	620	1100
PYRENE	1.2	1200	1700
BENZO(a)ANTHRACENE	0.52	520	96 J
CHRYSENE	0.36	360	120 J
BIS(2-ETHYLHEXYL)PHTHALATE	ND	ND	ND
Di-n-OCTYLPHTHALATE	ND	ND	ND
BENZO(b)FLUORANTHENE	0.21	210	100 J
BENZO(k)FLUORANTHENE	0.19	190	120 J
BENZO(a)PYRENE	0.2	200	250 J
INDENO(1,2,3-cd)PYRENE	0.02 J	20	310 J
BENZO(g,h,i)PERYLENE	0.15	150	650
TOTAL CREOSOTE	9	8960	10971
PENTACHLOROPHENOL	ND	ND	ND(980)

* = Numbers based on a wipe of 1 gram.
( ) = Special Detection Limit
J = Estimated value below the lowest calibration standard.
ND = Compound not detected.

TABLE 7
PENSACOLA SOIL DIOXIN RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SAMPLE DESCRIPTION	PRE-TREAT SOIL		POST-TREAT SOIL		CONDENSER WATER		CONDENSER OIL WIPE		SCRUBBER WATER	
	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*
SAMPLE #	18628	18628	18629	18629	18627	18627	18637	18637	18630	18630
UNITS	pg/g	ppt	pg/g	ppt	pg/l	ppq	pg/g**	ppt**	pg/l	ppq
TCDD	ND	0	1	1	57.5	57.5	ND	0	110	110
OTHER TCDD	0	0	0	0	0	0	2.5	0.025	0	0
PeCDD	8	4	5.5	2.75	45	22.5	ND	0	ND	0
OTHER PeCDD	4	0.02	0.75	0.00375	10	0.05	20	0.1	2.5	0.0125
HxCDD	323	12.92	19.25	0.77	140	5.6	142.5	5.7	85	3.4
OTHER HxCDD	777	0.3108	0.55	0.00022	78	0.0312	27.5	0.011	10	0.004
HpCDD	10000	10	15.2	0.0152	770	0.77	160	0.16	ND	0
OTHER HpCDD	18000	0.18	0.8	8.0E-06	690	0.0069	80	0.0008	0	0
OCDD	110000	0	63.3	0	6500	0	690	0	530	0
EQUIV. (ppt)		27.4		4.54		0.09		6		0.11
TCDF	6	0.6	ND	0	210	21	130	13	17.5	1.75
OTHER TCDF	0	0	0.25	0.00025	253	0.253	160	0.16	5	0.005
PeCDF	42	4.2	7.25	0.725	102.5	10.25	120	12	25	2.5
OTHER PeCDF	178	0.178	0.5	0.0005	372.5	0.3725	260	0.26	2.5	0.0025
HxCDF	262.5	2.625	33.05	0.3305	325	3.25	382.5	3.825	177.5	1.775
OTHER HxCDF	2537.5	0.25375	1.45	0.000145	188	0.0188	97.5	0.00975	2.5	0.00025
HpCDF	1970	1.97	15.8	0.0158	297.5	0.2975	212.5	0.2125	80	0.08
OTHER HpCDF	7230	0.0723	1.5	0.000015	512.5	0.005125	47.5	0.000475	2.5	0.000025
OCDF	8800	0	33.5	0	750	0	240	0	ND	0
EQUIV. (ppt)		9.90		1.07		0.04		29		0.01
TOTAL EQUIV. (ppt)		37.3		5.6		0.1		35		0.1

* = Equivalents based on 1987 Toxicity Equivalency Factors.
** = Based on a 1 gram wipe sample.
ND = Not Detected
ppt = parts per trillion
ppq = parts per quadrillion

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TABLE 8
SMWT TANK SLUDGE DIOXIN RESULTS
PENSACOLA PILOT–SCALE STUDIES HT–6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SAMPLE DESCRIPTION	PRE–TREAT SOIL		POST–TREAT SOIL		CONDENSER WATER		CONDENSER DUST		SCRUBBER WATER	
	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*
SAMPLE #	18631	18631	18633	18633	18632	18632	18635	18635	18638	18638
UNITS	pg/g	ppt	pg/g	ppt	pg/l	ppq	pg/g	ppt	pg/l	ppq
TCDD	ND	0	ND	0	13000	13000	ND	0	ND	0
OTHER TCDD	0	0	0	0	167000	1670	83	0.83	110	1.1
PeCDD	56	28	4.12	2.06	39000	19500	ND	0	170	85
OTHER PeCDD	64	0.32	0.52	0.0026	131000	655	77	0.385	540	2.7
HxCDD	8280	331.2	11.34	0.4536	16800	672	19.75	0.79	122.5	4.9
OTHER HxCDD	10720	4.288	5.66	0.002264	36200	14.48	−13.25	−0.0053	77.5	0.031
HpCDD	230000	230	27.6	0.0276	ND	0	ND	0	110	0.11
OTHER HpCDD	140000	1.4	18.3	0.000183	500	0.005	3	0.00003	80	0.0008
OCDD	1700000	0	150	0	84000	0	87.3	0	510	0
EQUIV. (ppt)		595		2.5		36		2.0		0.09
TCDF	100	10	3.35	0.335	990000	99000	ND	0	3100	310
OTHER TCDF	140	0.14	6.95	0.00695	1510000	1510	849	0.849	4300	4.3
PeCDF	390	39	3.09	0.309	200000	20000	62.8	6.28	670	67
OTHER PeCDF	1910	1.91	0.78	0.00078	290000	290	207.2	0.2072	2030	2.03
HxCDF	770	7.7	23.72	0.2372	101000	1010	45.1	0.451	270	2.7
OTHER HxCDF	29230	2.923	9.58	0.000958	19000	1.9	664.9	0.06649	250	0.025
HpCDF	31200	31.2	0	0	14000	14	8.75	0.00875	47.5	0.0475
OTHER HpCDF	168800	1.688	10.3	0.000103	6000	0.06	3.25	0.000033	35	0.00035
OCDF	230000	0	23.7	0	24000	0	32.8	0	140	0
EQUIV. (ppt)		95		0.9		122		7.9		0.39
TOTAL EQUIV. (ppt)		690		3.4		157		9.9		0.48

* = Equivalents based on 1987 Toxicity Equivalency Factors.
ND = Not Detected
ppt = parts per trillion
ppq = parts per quadrillion

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TABLE 9
XAD-2 TUBE RESULTS
PENSACOLA PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

LOCATION	CLEAN SAND		PENSACOLA SOIL		PENSACOLA SOIL		PENSACOLA SOIL	
RUN #	RUN #1&2		RUN #1		RUN #2		RUN #3&4	
SAMPLE #	12422		12424		12427		12429	
UNITS	ug	ug/l	ug	ug/l *	ug	ug/l *	ug	ug/l *
NAPHTHALENE	13	0.14	285	604	123	27.2	333	40.5
2-METHYLNAPHTHALENE	ND	0.00	2.4	5	ND	0.0	3.2	0.4
1-METHYLNAPHTHALENE	ND	0.00	2	4	ND	0.0	3	0.4
BIPHENYL	ND	0.00	7	15	ND	0.0	3.5	0.4
ACENAPHTHYLENE	1.7	0.02	52	110	13	2.9	51	6.2
DIBENZOFURAN	ND	0.00	56	119	8.2	1.8	20	2.4
FLUORENE	ND	0.00	5.4	11	ND	0.0	ND	0.0
PHENANTHRENE	9.8	0.11	220	466	33	7.2	85	10.3
ANTHRACENE	10	0.11	27	57	3.4	0.6	10	1.1
FLUORANTHENE	3.5	0.04	55	116	16	3.5	46	5.6
PYRENE	6.3	0.07	58	123	23	5.0	71	8.6
BENZO(a)ANTHRACENE	6.5	0.07	6.7	14	ND	0.0	5.7	0.6
CHRYSENE	7.4	0.08	3.8	8	ND	0.0	3.6	0.4
BENZO(b)FLUORANTHENE	ND	0.00	6	13	ND	0.0	ND	0.0
BENZO(k)FLUORANTHENE	ND	0.00	4	8	ND	0.0	ND	0.0
BENZO(g,h,i)PERYLENE	ND	0.00	9.8	21	ND	0.0	ND	0.0
TOTAL CREOSOTE	58.2	0.65	800.1	1694	219.6	48.2	635	76.8
PENTACHLOROPHENOL	ND	0	ND	0	ND	0	ND	0

ND = Compound not detected.
* = Clean sand control subtracted out.

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TABLE 10
TENAX/CMS TUBE RESULTS
PENSACOLA PILOT–SCALE STUDIES HT–6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

LOCATION	METHOD BLANK	LOT BLANK	FIELD BLANK	METHOD BLANK	CLEAN SAND	PENSACOLA SOIL RUN #1	PENSACOLA SOIL RUN #1	PENSACOLA SOIL RUN #2	PENSACOLA SOIL RUN #2
RUN #									
SAMPLE #	NI593	12424	12435	N1599	12421	12425	12425	12426	12426
UNITS	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3 *	ug/m3	ug/m3 *
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	0	2.26	2.26
Chloromethane	1.27	0.66	0.94	1.13	1.44	24.27	22.83	48.75	47.31
Vinyl Chloride	ND	ND	ND	ND	0.25	ND	−0.25	1.28	1.03
Trichlorofluoromethane	ND	0.63	50.3	0.36	27.11	42.28	15.17	388	360.89
1,1–Dichloroethene	0.25	4.76	10.05	0.52	0.2	1.6	1.4	15.89	15.69
Trichlorotrifluoroethane	ND	1.47	0.77	ND	1.33	3.56	2.23	5.33	4
Methylene Chloride	ND	0.47	0.71	0.89	0.67	1.09	0.42	4.44	3.77
1,1,1–Trichloroethane	3.93	34.02	31.06	2.47	6.2	7.19	0.99	78.53	72.33
Benzene	0.87	2.14	2.38	0.84	184	1610	1426	2670	2486
Trichloroethene	ND	0.53	0.36	ND	0.16	ND	−0.16	1.33	1.17
Tetrachloroethene	3.15	0.22	0.29	ND	0.4	1.54	1.14	4.72	4.32
Toluene	1.24	1.95	95.27	1.57	19.23	726	706.77	1445	1425.77
Chlorobenzene	ND	ND	ND	ND	1.52	1.28	−0.24	4.56	3.04
Ethylbenzene	0.08	0.11	0.42	0.13	0.29	9.61	9.32	19.67	19.38
p&m–Xylene	0.28	0.51	0.97	0.45	1.26	21.5	20.24	45.69	44.43
Styrene	0.11	0.26	0.64	0.1	3.02	382	378.98	633	629.98
o–xylene	0.09	0.12	0.25	0.17	0.37	13.13	12.76	29.92	29.55
1,3,5–Trimethylbenzene	ND	0.07	ND	0.11	0.23	0.44	0.21	0.98	0.75
1,2,4–Trimethylbenzene	0.12	0.23	0.3	0.39	0.63	1.33	0.7	3.31	2.68
1,4–Dichlorobenzene	0.49	0.27	0.42	1.06	0.24	ND	−0.24	3.25	3.01
Total VOC's	11.88	48.42	195.13	10.19	248.55	2846.82	2598.27	5405.91	5157.36

ND = Compound not detected
* = Clean sand control subtracted out.

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TABLE 11
DIOXIN RESULTS – AIR
PENSACOLA PILOT–SCALE STUDIES HT–6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

SAMPLE DESCRIPTION	PUF BLANK		PUF FIELD BLANK		PENSACOLA SOIL RUN #1		PENSACOLA SOIL RUN #2–4		SMWT TANK SLUDGE RUN #1		SMWT TANK SLUDGE RUN #2&3	
	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*	CONC.	EQUIV.*
SAMPLE #	12433	12433	12432	12432	12423	12423	12428	12428	12430	12430	12431	12431
SAMPLE VOLUME (l)	--		--		306		969		--		969	
UNITS	pg	pg	pg	pg	pg	pg	pg	pg	pg	pg	pg	pg
TCDD	nd	0	nd	0	nd	0	nd	0	nd	0	120	120
OTHER TCDD	0	0	0	0	0	0	0	0	1	0.01	1880	18.8
PeCDD	3	1.5	6.5	3.25	8	4	8.5	4.25	6.5	3.25	160	80
OTHER PeCDD	0	0	0.25	0.00125	5	0.025	4.5	0.0225	0.5	0.0025	780	3.9
HxCDD	10.5	0.42	31.55	1.262	31	1.24	29	1.16	19.5	0.78	104	4.16
OTHER HxCDD	1	0.0004	2.45	0.00098	6.5	0.0026	32	0.0128	5	0.002	146	0.0584
HpCDD	9.75	0.00975	30.8	0.0308	42	0.042	32	0.032	39	0.039	35	0.035
OTHER HpCDD	0	0	8.2	0.000082	23.5	0.000235	23.5	0.000235	29	0.00029	29	0.00029
OCDD	45.3	0	160	0	250	0	170	0	410	0	160	0
TCDF	0.75	0.075	0.5	0.05	15.5	1.55	37.5	3.75	82	8.2	3600	360
OTHER TCDF	0.25	0.00025	0	0	68	0.068	82.5	0.0825	58	0.058	13400	13.4
PeCDF	1.75	0.175	10	1	15.5	1.55	34.5	3.45	6.5	0.65	710	71
OTHER PeCDF	0.25	0.00025	0.5	0.0005	29.5	0.0295	115.5	0.1155	7	0.007	2390	2.39
HxCDF	16.5	0.165	47.75	0.4775	60.5	0.605	113.5	1.135	37	0.37	264.5	2.645
OTHER HxCDF	1	0.0001	3.05	0.000305	11.5	0.00115	46.5	0.00465	4.5	0.00045	335.5	0.03355
HpCDF	6.75	0.00675	21.8	0.0218	58.5	0.0585	33	0.033	28	0.028	43	0.043
OTHER HpCDF	0.25	2.5E–06	8.5	0.000085	10.5	0.000105	2.5	0.000025	5	0.00005	16	0.00016
OCDF	21.5	0	63.3	0	81.5	0	37.5	0	65.5	0	23	0
EQUIV. (pg)*		2.35		6.10		9.17		14.0		13.4		676
EQUIV. (pg/m3)*		**		**		10.1		8.2		**		692

* = Equivalents based on 1987 Toxicity Equivalency Factors.
** = Due to lack of volume data no calculation could be performed.

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TABLE 12
MASS BALANCE
PENSACOLA PILOT–SCALE STUDIES HT–6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER, 1992

LOCATION	PENSACOLA SOIL	PENSACOLA SLUDGE	SMWT TANK SLUDGE	CLEAN SAND
RAW WASTE				
TOTAL SOLIDS (%)	92	18	64	97
TOTAL CREOSOTE IN (mg/kg)	955	341	5299	0.05
PCP IN (mg/kg)	ND	46	80000	ND
DIOXIN EQUIV. IN (ng/kg)	37.3	--	690	--
WET WEIGHT SOLIDS (kg)	5.52	0.36	1.92	2.9
WATER ADDED (l)	1.28	1.64	2.13	1.1
TOTAL WATER (l)	1.72	1.94	2.82	1.19
DRY WEIGHT SOLIDS (kg)	5.08	0.06	1.23	2.81
CREOSOTE IN (mg)	4850	22.1	6511	0.14
PCP IN (mg)	0.0	3.0	98304	0.0
DIOXIN EQUIV. IN (ng)	189	--	848	--
TREATED WASTE				
TOTAL CREOSOTE (mg/kg)	ND	0.6	0.8	ND
PCP (mg/kg)	ND	ND	ND	ND
DIOXIN EQUIV. (ng/kg)	5.6	--	3.4	--
CREOSOTE OUT (mg)	0	--	1.0	--
PCP OUT (mg)	0	--	0	--
DIOXIN EQUIV. OUT (ng)	28.4	--	4.2	--
CONDENSER WATER				
WATER RECOVERED (l)	1.20	1.20	1.00	1.10
TOTAL CREOSOTE (mg/l)	11.6	12.4	4905	0.4
PCP (mg/l)	ND	ND	ND	ND
DIOXIN EQUIV. (ng/l)	0.1	--	157	--
CREOSOTE OUT (mg)	13.9	14.9	4905	0.4
PCP OUT (mg)	0	0	0	0
DIOXIN EQUIV. OUT (ng)	0.12	--	157	--
SCRUBBER WATER *				
TOTAL CREOSOTE (mg/l)	0.93	--	6.7	--
PCP (mg/l)	ND	--	ND	--
DIOXIN EQUIV. (ng/l)	0.1	--	0.5	--
CREOSOTE OUT (mg)	5.3	--	38.2	--
PCP OUT (mg)	0	--	0	--
DIOXIN EQUIV. OUT (ng)	0.57	--	2.85	--
CONDENSER WASTE				
TOTAL CREOSOTE (mg/kg)	8960	--	10971	--
PCP (mg/kg)	ND	--	ND	--
DIOXIN EQUIV. OUT (ng/kg)	35	--	9.9	--
CREOSOTE OUT (mg)**	89.6	--	548.55	--
PCP OUT (mg)	0	--	0	--
DIOXIN EQUIV. OUT (ng)**	0.35	--	0.495	--
WASTE REDUCTION				
CREOSOTE	97.8%	32.7%	15.6%	--
PCP	ND	100.0%	100.0%	ND
DIOXIN	84.4%	--	81.1%	--

* = Approximately 5.7 liters.
** = Based on 10 grams oil waste and 50 grams carbon black dust
ND = Not detected

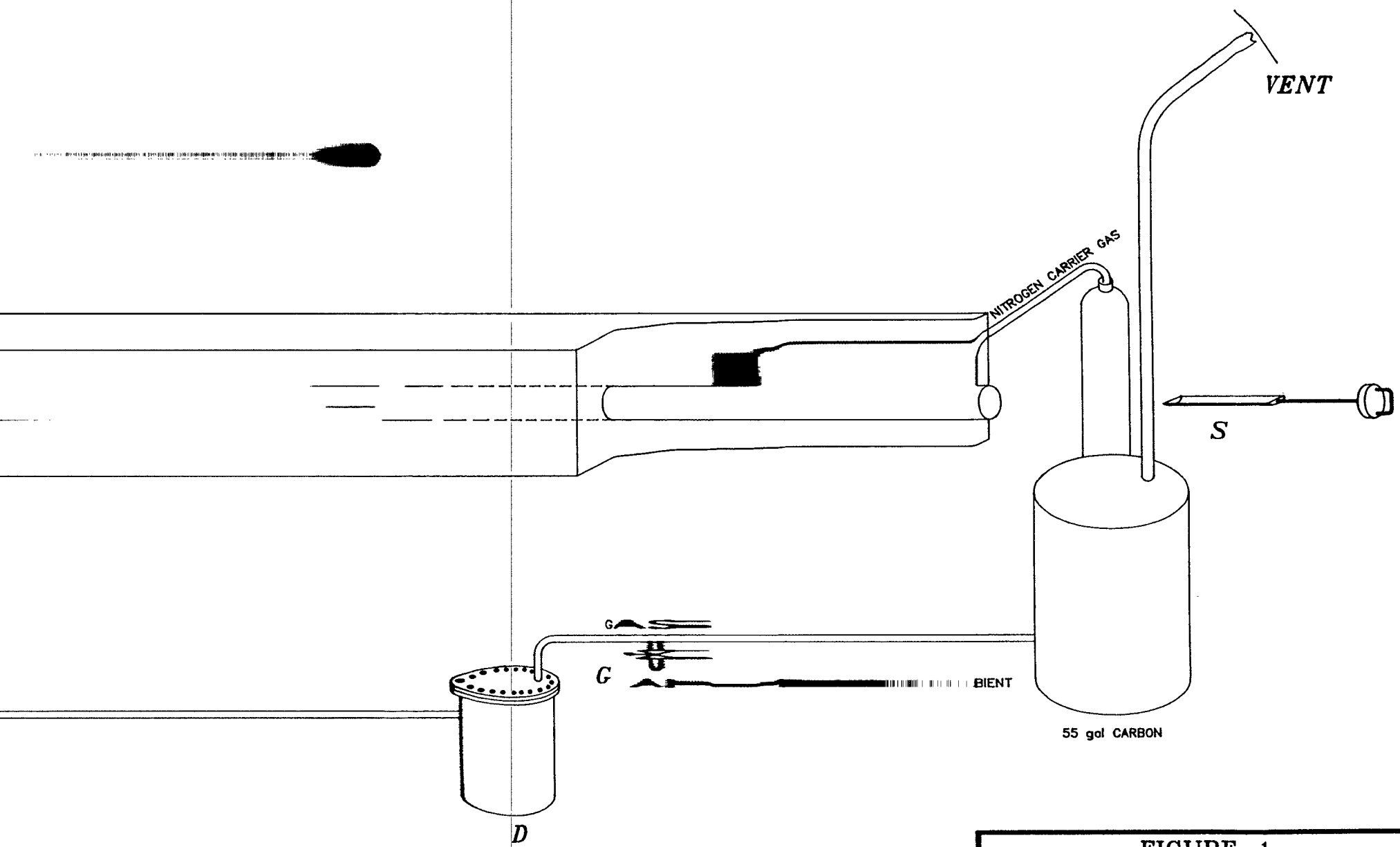
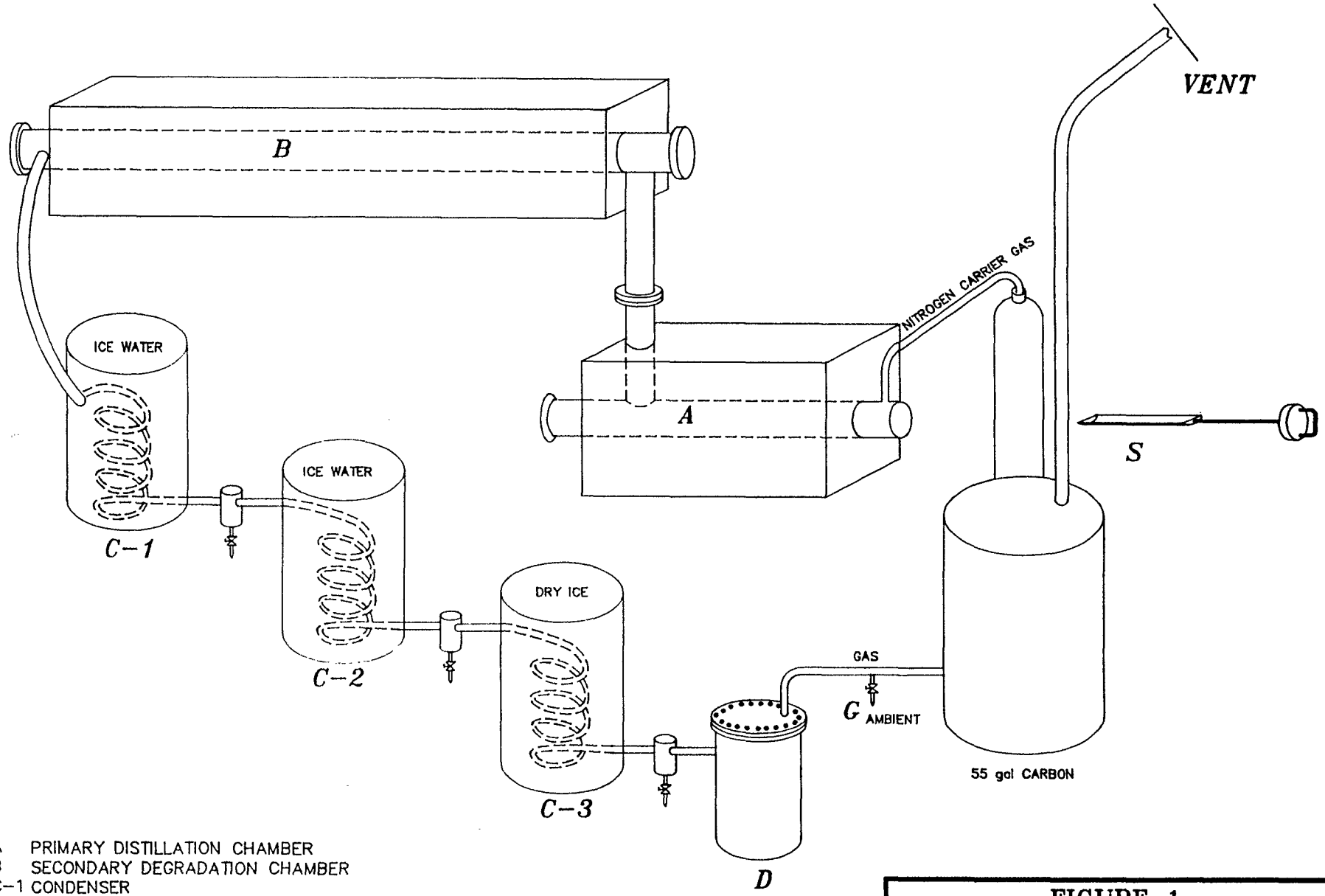


FIGURE 1
HT-6 PROCESS DIAGRAM
PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER 1992

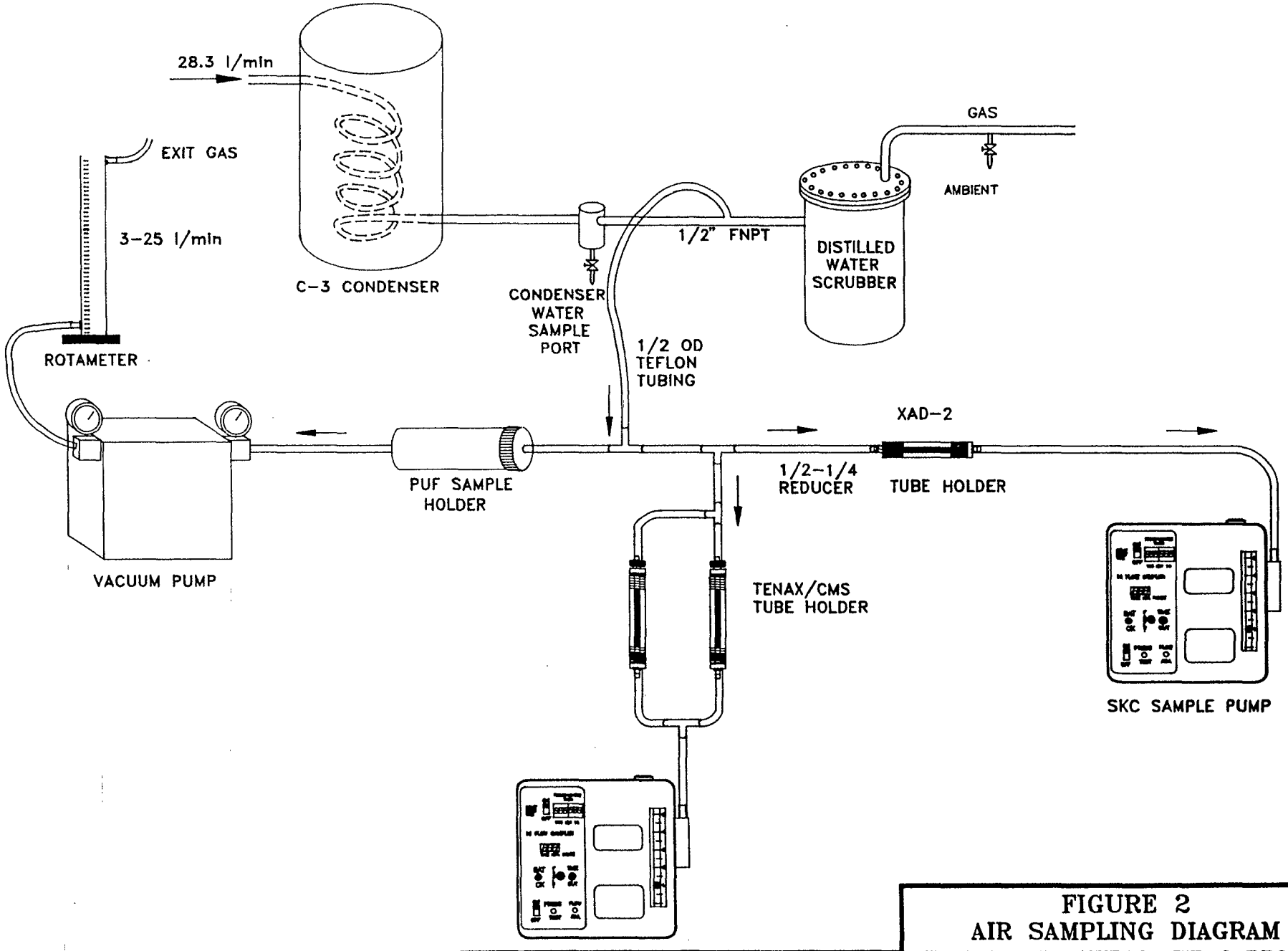


A PRIMARY DISTILLATION CHAMBER
B SECONDARY DEGRADATION CHAMBER
C-1 CONDENSER
C-2 CONDENSER
C-3 CONDENSER
D DISTILLED WATER SCRUBBER
S SAMPLE TRAY
G NON-CONDENSIBLE GASES
SOURCE: SEAVIEW THERMAL SYSTEMS

U.S. EPA ENVIRONMENTAL RESPONSE TEAM
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
68-03-3482
W.O.# 03347-033-001-4590-01

FIGURE 1
HT-6 PROCESS DIAGRAM
PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER 1992

AR302582



U.S. EPA ENVIRONMENTAL RESPONSE TEAM
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
68-03-3482
W.O.# 03347-033-001-4590-01

FIGURE 2
AIR SAMPLING DIAGRAM
PILOT-SCALE STUDIES HT-6 PROCESS
PENSACOLA, FLORIDA
NOVEMBER 1992

AR302583

APPENDIX F

Results of Creosote/PCP Treatability Study

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

TABLE 3
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
COMPOST PILE 3
August, 1993

COMPOUND	DAY 0 Compost 3	DAY 10 Compost 3	DAY 20 Compost 3	DAY 40 Compost 3	DAY 80 Compost 3	DAY 120 Compost 3	DAY 180 Compost 3	DAY 230 Compost 3	DAY 250 Compost 3	DAY 285 Compost 3
NON-CARCINOGENIC										
Naphthalene	390	46	17	6	6	6	7	3	4	5
Acenaphthene	510	460	423	300	107	84	197	34	50	31
Fluorene	420	380	367	287	190	167	300	76	100	70
Phenanthrene	1000	870	910	637	433	317	757	140	197	105
Anthracene	1300	1300	1100	1020	1097	937	1700	700	1023	907
Carbazole	340	267	207	207	193	177	157	116	137	117
Fluoranthene	800	780	673	723	650	577	1030	517	687	620
SUB-TOTAL	4760	4102	3697	3179	2676	2265	4148	1586	2198	1855
CARCINOGENIC										
Pyrene	550	497	473	513	457	413	723	413	543	503
Benzo(a)anthracene	120	130	150	113	110	100	136	101	110	96
Chrysene	170	163	160	150	203	140	250	113	147	127
Benzo(b)fluoranthene	61	59	66	65	65	55	67	36	76	49
Benzo(k)fluoranthene	65	60	65	65	61	59	78	45	75	47
Benzo(a)pyrene	57	50	55	54	53	48	57	39	64	39
SUB-TOTAL	1022	959	970	960	948	815	1311	747	1015	861
TOTAL	5782	5062	4667	4139	3625	3080	5459	2333	3213	2716
Pentachlorophenol	76	35	33	21	46	54	77	40	25	51

AR302587

TABLE 4
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
COMPOST PILE 4
August, 1993

COMPOUND	DAY 0 Compost 4	DAY 10 Compost 4	DAY 20 Compost 4	DAY 40 Compost 4	DAY 80 Compost 4	DAY 120 Compost 4	DAY 180 Compost 4	DAY 230 Compost 4	DAY 250 Compost 4	DAY 285 Compost 4
NON-CARCINOGENIC										
Naphthalene	140	5	4	5	3	5	3	2	3	2
Acenaphthene	310	165	240	187	127	141	77	84	118	86
Fluorene	220	129	190	167	129	147	89	86	117	83
Phenanthrene	510	283	360	340	287	267	280	190	260	163
Anthracene	810	720	683	713	610	643	790	503	657	560
Carbazole	150	103	125	122	121	120	85	91	109	79
Fluoranthene	560	493	537	513	377	420	573	360	433	417
SUB-TOTAL	2700	1898	2139	2046	1654	1743	1897	1316	1697	1390
CARCINOGENIC										
Pyrene	390	333	387	373	320	330	450	293	340	347
Benzo(a)anthracene	88	84	99	82	84	83	70	59	76	68
Chrysene	130	117	117	113	157	113	130	86	113	93
Benzo(b)fluoranthene	53	45	52	53	54	48	45	38	57	35
Benzo(k)fluoranthene	55	45	52	50	51	52	57	37	56	35
Benzo(a)pyrene	47	37	42	41	43	41	40	31	48	30
SUB-TOTAL	764	661	749	712	709	667	792	544	690	608
TOTAL	3464	2559	2888	2758	2364	2410	2689	1860	2387	1998
Pentachlorophenol	53	19	22	28	28	41	33	26	14	19

AR302588

TABLE 5
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 1
August, 1993

COMPOUND	DAY 0 LTC1	DAY 10 LTC1	DAY 20 LTC1	DAY 40 LTC1	DAY 80 LTC1	DAY 120 LTC1	DAY 180 LTC1	DAY 230 LTC1	DAY 250 LTC1	DAY 285 LTC1
NON-CARCINOGENIC										
Naphthalene	110	244	35	115	86	302	13	92	7	182
Acenaphthene	73	253	357	327	191	353	126	203	104	211
Fluorene	67	267	397	300	251	360	153	193	89	224
Phenanthrene	190	687	957	757	610	853	320	457	193	522
Anthracene	120	677	1023	743	607	773	643	550	457	483
Carbazole	41	201	303	197	154	237	193	153	100	256
Fluoranthene	80	313	390	577	403	527	403	380	337	350
SUB-TOTAL	681	2642	3462	3016	2301	3405	1851	2028	1287	2228
CARCINOGENIC										
Pyrene	54	197	223	373	273	337	297	253	227	232
Benzo(a)anthracene	14	55	89	75	73	74	66	54	56	47
Chrysene	17	84	91	90	122	94	90	73	78	63
Benzo(b)fluoranthene	6 J	22	36	36	39	37	35	37	45	24
Benzo(k)fluoranthene	6 J	24	37	36	37	45	38	37	44	24
Benzo(a)pyrene	5 J	23	35	31	33	38	28	35	42	23
SUB-TOTAL	102	405	512	642	577	625	554	489	492	413
TOTAL	783	3047	3973	3657	2878	4030	2405	2517	1779	2641
Pentachlorophenol	8	17	43	63	44	42	33	35	23	24

AR302589

TABLE 6
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 2
August, 1993

COMPOUND	DAY 0 LTC2	DAY 10 LTC2	DAY 20 LTC2	DAY 40 LTC2	DAY 80 LTC2	DAY 120 LTC2	DAY 180 LTC2	DAY 230 LTC2	DAY 250 LTC2	DAY 285 LTC2
NON-CARCINOGENIC										
Naphthalene	200	46	13	54	14	40	10	170	165	53
Acenaphthene	140	250	253	137	183	117	126	164	154	89
Fluorene	130	247	233	135	169	124	119	161	159	89
Phenanthrene	340	567	487	347	430	249	253	38	387	163
Anthracene	240	510	573	497	760	367	570	423	563	390
Carbazole	78	104	157	99	216	182	154	137	164	99
Fluoranthene	160	333	380	360	447	296	410	287	347	320
SUB-TOTAL	1288	2057	2096	1628	2219	1375	1642	1380	1939	1203
CARCINOGENIC										
Pyrene	100	160	267	263	307	247	293	210	233	217
Benzo(a)anthracene	25	64	87	63	77	57	71	49	58	44
Chrysene	31	74	89	79	140	75	97	58	79	57
Benzo(b)fluoranthene	11	26	36	36	39	32	37	33	43	23
Benzo(k)fluoranthene	12	27	36	36	37	40	40	33	42	22
Benzo(a)pyrene	10	25	34	30	34	30	31	32	39	20
SUB-TOTAL	189	376	548	508	633	481	569	415	494	383
TOTAL	1477	2432	2644	2136	2852	1856	2211	1795	2433	1586
Pentachlorophenol	18	30	80	50	55	34	39	24	17	24

AR302590

TABLE 7
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 3
August, 1993

COMPOUND	DAY 0 LTC3	DAY 10 LTC3	DAY 20 LTC3	DAY 40 LTC3	DAY 80 LTC3	DAY 120 LTC3	DAY 180 LTC3	DAY 230 LTC3	DAY 250 LTC3	DAY 285 LTC3
NON-CARCINOGENIC										
Naphthalene	130	70	13	115	11	52	11	9	7	11
Acenaphthene	66	317	293	333	190	210	66	75	115	54
Fluorene	79	287	257	310	157	253	112	98	108	101
Phenanthrene	210	800	489	790	343	580	250	176	213	169
Anthracene	280	727	531	524	683	910	477	522	657	787
Carbazole	110	187	101	115	183	287	152	152	124	163
Fluoranthene	74	343	483	460	417	497	357	345	507	400
SUB-TOTAL	948	2730	2167	2648	1984	2789	1425	1377	1731	1685
CARCINOGENIC										
Pyrene	48	223	257	187	293	320	260	250	383	297
Benzo(a)anthracene	12	63	90	74	72	73	55	45	75	52
Chrysene	15	79	89	86	126	98	92	63	103	73
Benzo(b)fluoranthene	5 J	27	37	35	35	33	28	33	52	32
Benzo(k)fluoranthene	6 J	30	37	36	33	44	33	34	52	22
Benzo(a)pyrene	4	26	34	30	31	33	23	32	47	26
SUB-TOTAL	90	449	545	448	590	601	491	457	712	502
TOTAL	1038	3179	2712	3096	2575	3390	1916	1834	2443	2187
Pentachlorophenol	8	42	78	58	64	50	9	34	69	28

AR302591

TABLE 8
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 4
August, 1993

COMPOUND	DAY 0 LTC4	DAY 10 LTC4	DAY 20 LTC4	DAY 40 LTC4	DAY 80 LTC4	DAY 120 LTC4	DAY 180 LTC4	DAY 230 LTC4	DAY 250 LTC4	DAY 285 LTC4
NON-CARCINOGENIC										
Naphthalene	830	10	11	11	11	10	7	33	34	27
Acenaphthene	480	273	307	203	180	108	58	94	187	203
Fluorene	470	227	260	193	159	119	88	107	141	210
Phenanthrene	1300	570	261	423	340	240	177	227	370	513
Anthracene	960	593	284	640	567	497	400	407	463	517
Carbazole	180	123	120	190	159	140	127	121	121	140
Fluoranthene	520	353	347	450	393	363	270	307	340	417
SUB-TOTAL	4740	2150	1589	2111	1809	1477	1127	1296	1656	2027
CARCINOGENIC										
Pyrene	340	233	263	307	293	237	200	210	233	260
Benzo(a)anthracene	93	68	93	73	69	57	44	44	56	55
Chrysene	110	82	93	91	102	74	70	61	73	65
Benzo(b)fluoranthene	41	29	41	39	35	30	22	26	38	25
Benzo(k)fluoranthene	45	32	41	40	34	35	26	28	40	24
Benzo(a)pyrene	39	28	36	33	30	27	20	26	36	21
SUB-TOTAL	667	473	567	583	564	460	382	395	476	450
TOTAL	5407	2623	2156	2694	2374	1937	1509	1691	2132	2477
Pentachlorophenol	66	36	93	57	64	36	11	25	20	16

AR302592

TABLE 9
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 5
August, 1993

COMPOUND	DAY 0 LTC5	DAY 10 LTC5	DAY 20 LTC5	DAY 40 LTC5	DAY 80 LTC5	DAY 120 LTC5	DAY 180 LTC5	DAY 230 LTC5	DAY 250 LTC5	DAY 285 LTC5
NON-CARCINOGENIC										
Naphthalene	160	160	533	160	218	126	142	237	108	47
Acenaphthene	120	257	340	220	243	170	181	350	217	123
Fluorene	120	233	343	213	273	183	197	340	207	144
Phenanthrene	310	643	920	487	490	413	510	800	533	323
Anthracene	260	460	750	380	527	450	500	757	637	507
Carbazole	79	142	177	121	173	147	140	237	173	135
Fluoranthene	150	260	197	230	283	277	203	517	474	297
SUB-TOTAL	1199	2155	3260	1811	2208	1766	1873	3238	2349	1576
CARCINOGENIC										
Pyrene	98	197	167	177	210	187	149	360	270	180
Benzo(a)anthracene	24	221	77	46	64	45	43	69	68	43
Chrysene	28	276	78	59	77	58	62	88	88	55
Benzo(b)fluoranthene	10	90	33	22	32	22	19	42	42	25
Benzo(k)fluoranthene	10	88	33	23	31	25	22	43	42	27
Benzo(a)pyrene	9	76	29	19	25	21	17	41	38	21
SUB-TOTAL	178	948	417	345	440	358	312	643	548	351
TOTAL	1377	3103	3677	2156	2647	2124	2185	3881	2897	1927
Pentachlorophenol	17	59	52	25	44	20	18	38	12	11

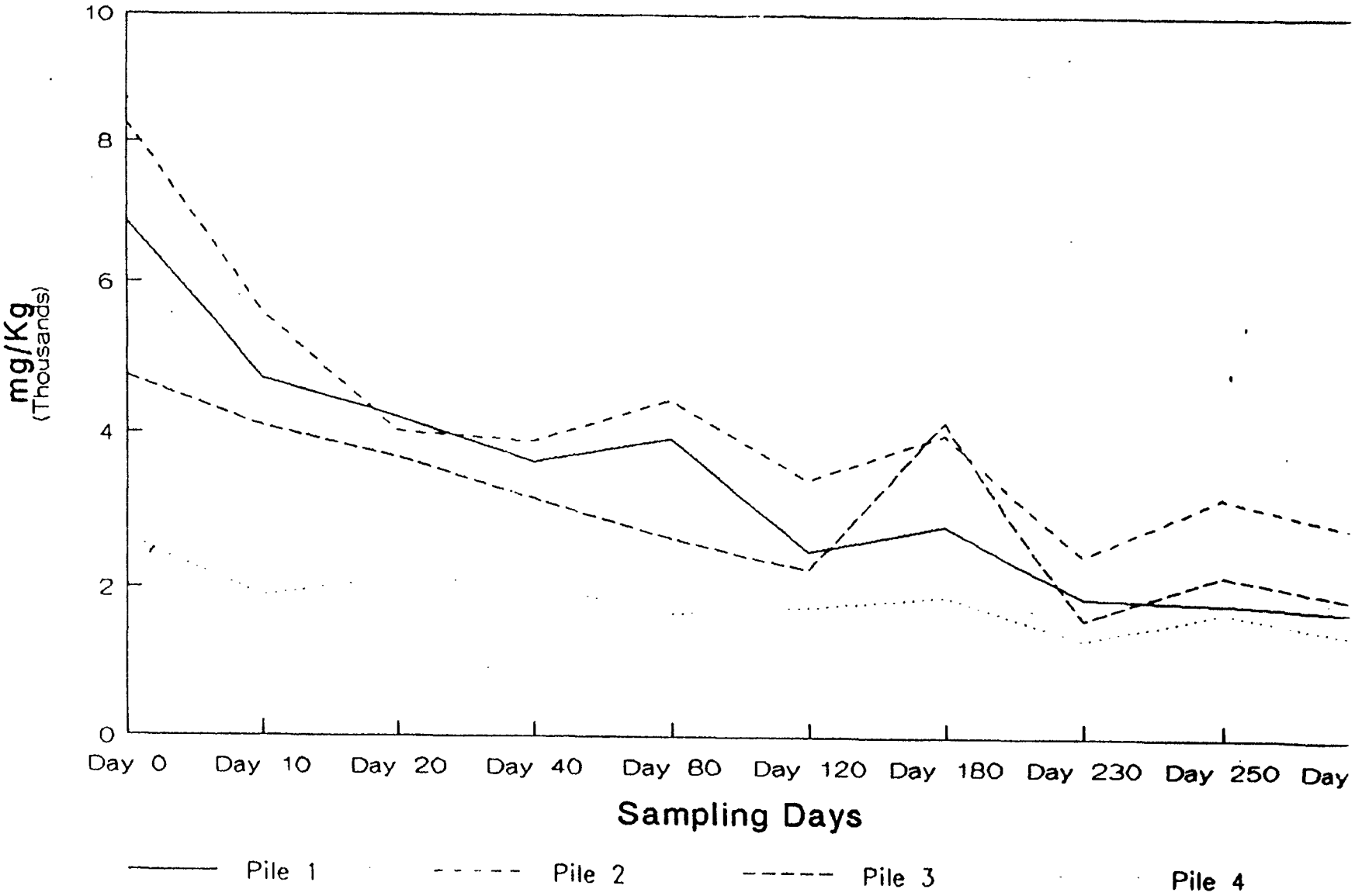
AR302593

TABLE 10
SOUTHERN MARYLAND WOODTREATING SITE
Results based on dry weight of soil (parts per million)
LAND TREATMENT CELL 6
August, 1993

COMPOUND	DAY 0 LTC6	DAY 10 LTC6	DAY 20 LTC6	DAY 40 LTC6	DAY 80 LTC6	DAY 120 LTC6	DAY 180 LTC6	DAY 230 LTC6	DAY 250 LTC6	DAY 285 LTC6
NON-CARCINOGENIC										
Naphthalene	180	27	287	89	81	107	5	88	110	33
Acenaphthene	120	263	353	197	213	187	47	160	210	143
Fluorene	120	230	340	193	203	220	47	170	197	143
Phenanthrene	320	577	927	420	264	470	101	390	557	417
Anthracene	250	547	833	460	290	580	145	477	600	483
Carbazole	83	116	133	163	107	200	42	150	153	123
Fluoranthene	140	360	203	297	253	373	99	313	393	283
SUB-TOTAL	1213	2119	3076	1819	1413	2137	486	1748	2220	1625
CARCINOGENIC										
Pyrene	92	220	167	227	187	250	66	220	233	183
Benzo(a)anthracene	22	64	93	48	62	57	15	45	60	45
Chrysene	28	72	95	60	77	74	23	61	75	58
Benzo(b)fluoranthene	10	27	40	23	34	30	8	27	35	22
Benzo(k)fluoranthene	10	28	41	24	35	35	8	29	36	27
Benzo(a)pyrene	9	23	38	21	27	29	7	27	33	21
SUB-TOTAL	171	435	474	403	422	475	127	409	472	356
TOTAL	1384	2554	3550	2222	1835	2612	613	2157	2692	1981
Pentachlorophenol	13	44	56	26	45	27	5	20	8	10

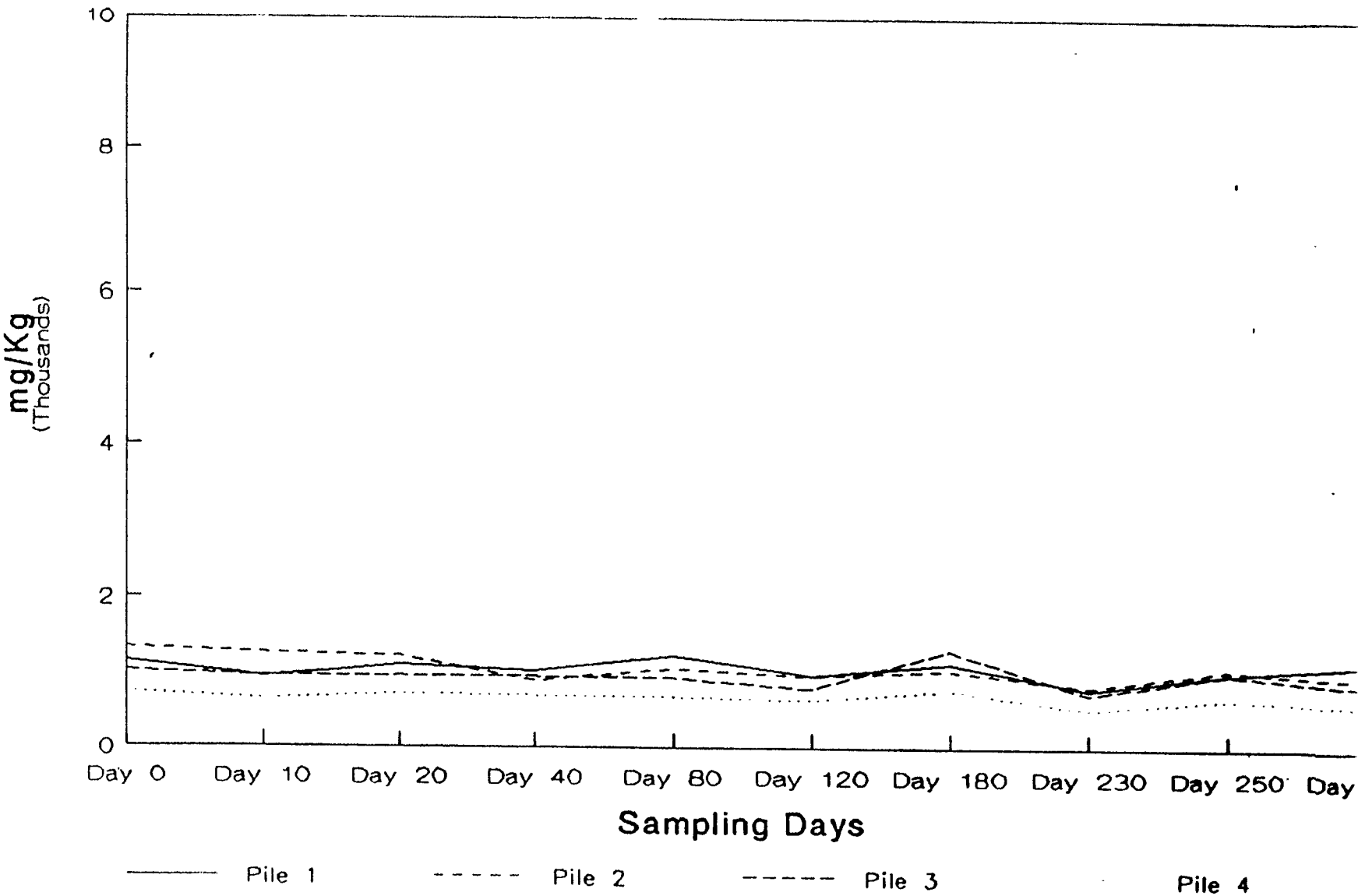
AR302594

Non-Carcinogenic Results
Compost Piles



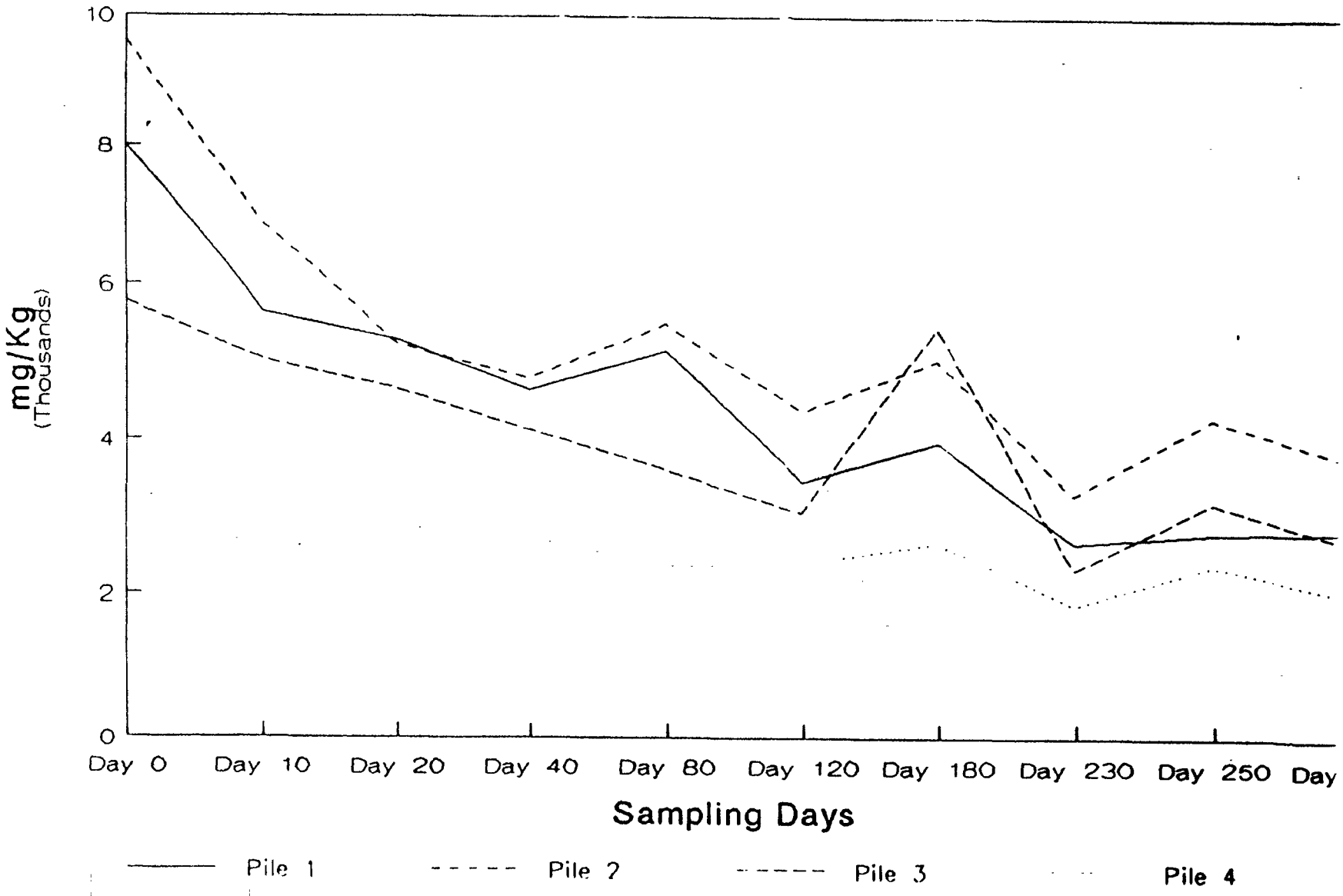
AR302595

Carcinogenic Results
Compost Piles



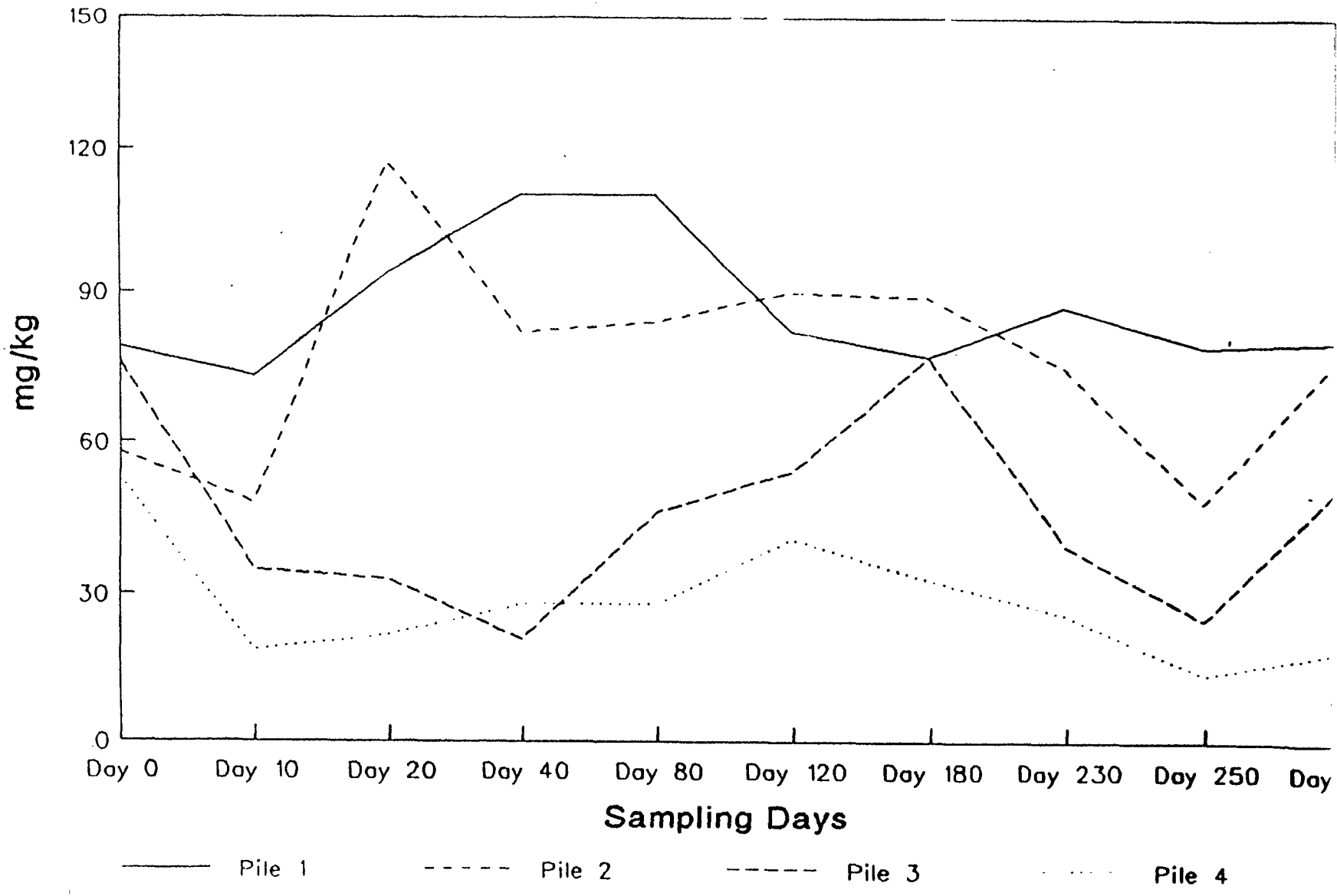
AR302596

Total Creosote Results
Compost Piles



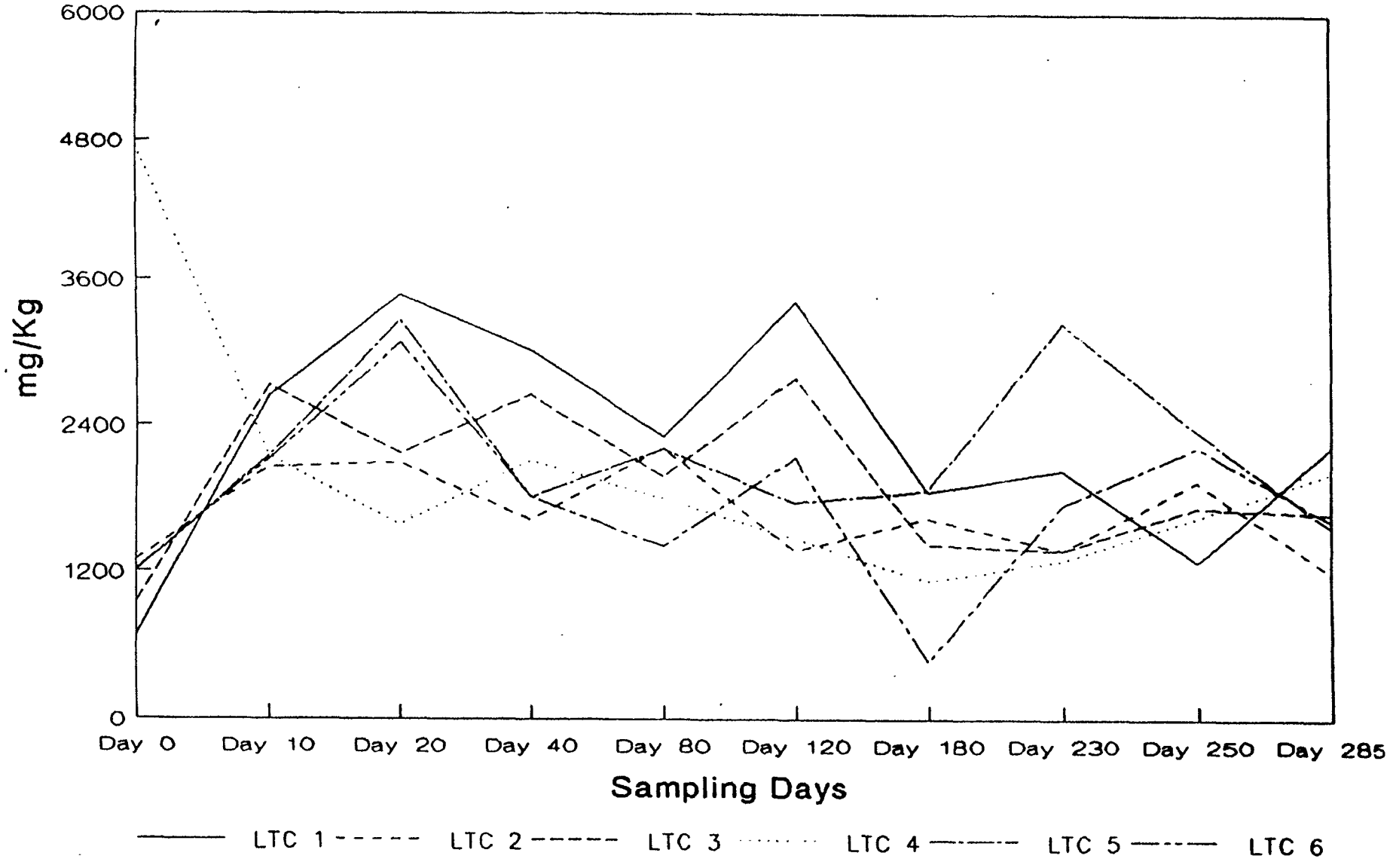
AR302597

Pentachlorophenol Results
Compost Piles



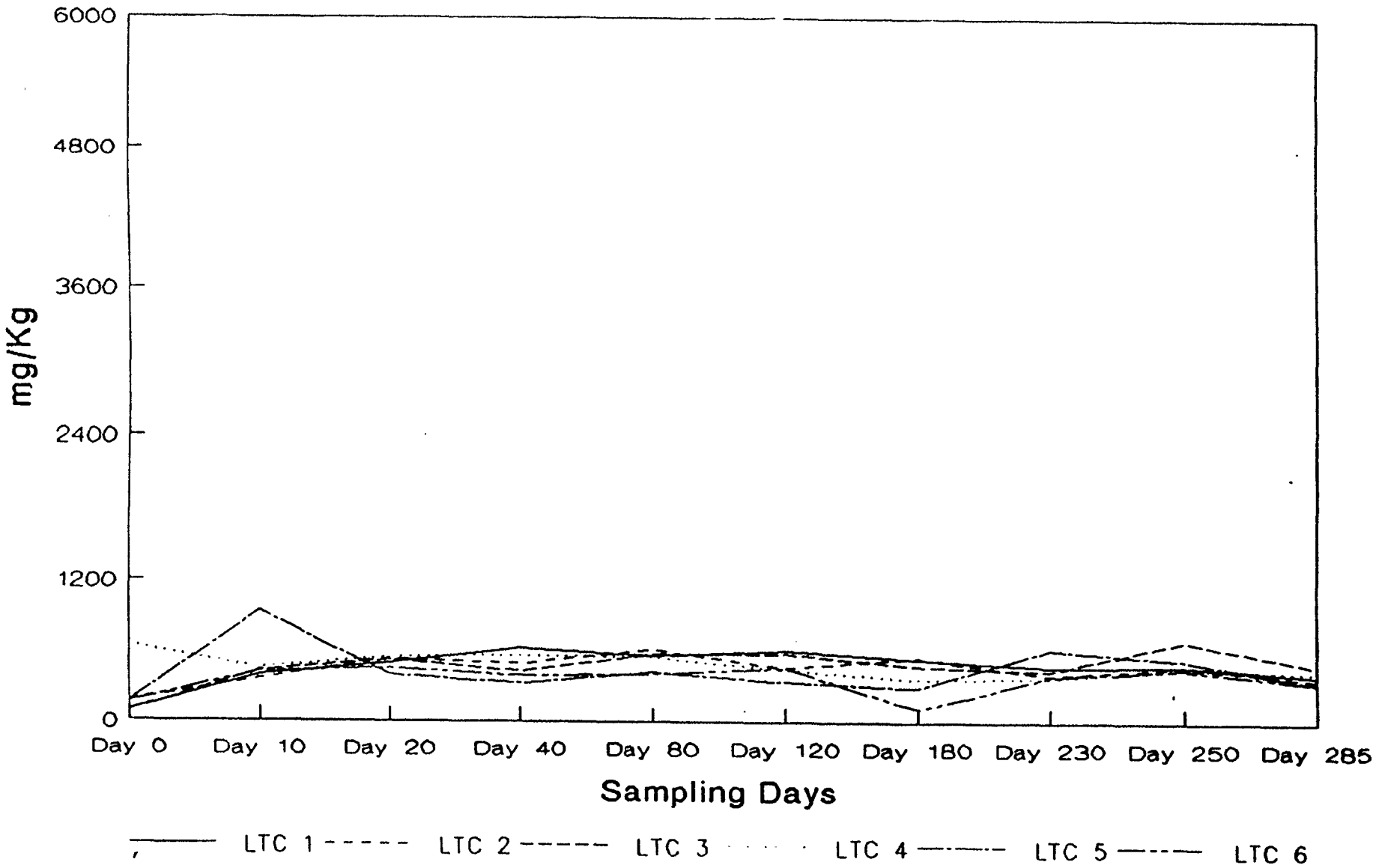
AR302598

Non-Carcinogenic Results
Land Treatment Cells



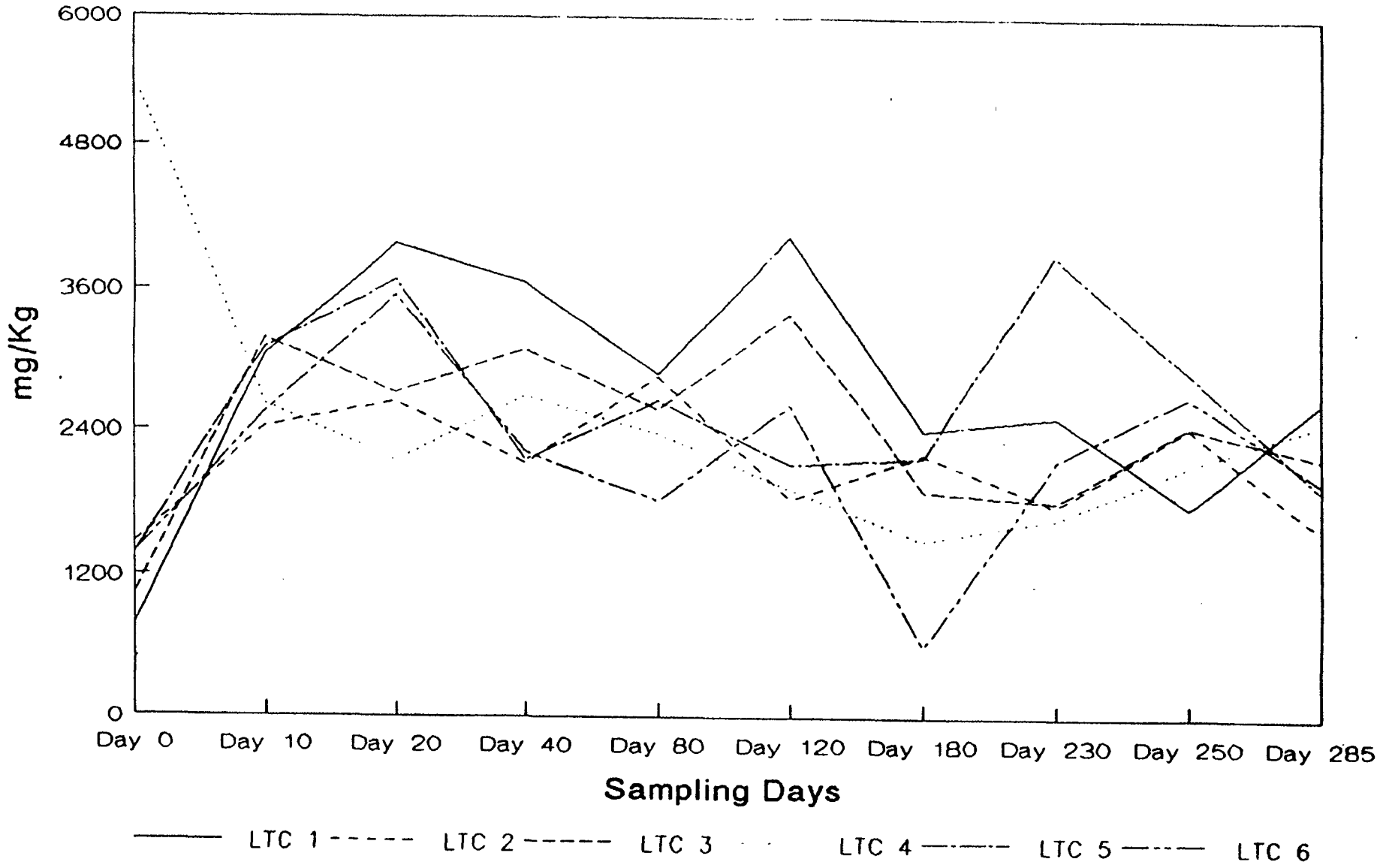
AR302599

Carcinogenic Results
Land Treatment Cells



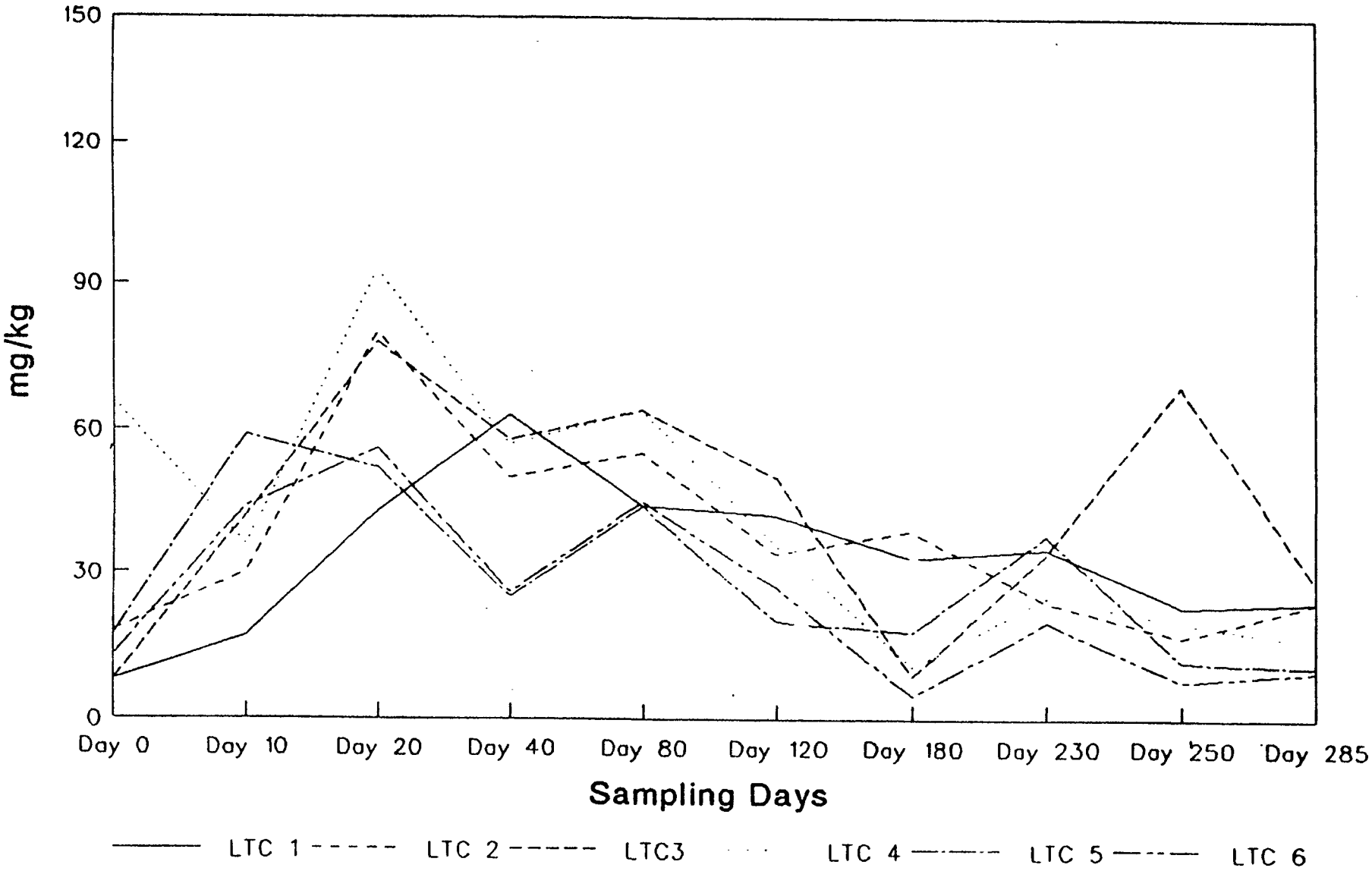
AR302600

Total Creosote Results
Land Treatment Cells



AR302601

Pentachlorophenol Results
Land Treatment Cells



AR302602

APPENDIX G

Slurry-Phase Bioremediation Test

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

1.0 OBJECTIVE

The objective of this phase of the Southern Maryland Woodtreating Project was to conduct a slurry phase bioremediation test to determine whether soils and sediments obtained from the site contained PCP- and creosote-degrading microbes.

2.0 METHODOLOGY

2.1 Wastewater Preparation

Pentachlorophenol (PCP) and creosote-contaminated wastewater was prepared by washing contaminated soil with a wash solution composed of 0.50% volume/volume (v/v) Tween 80 dissolved in 0.10N sodium hydroxide. Soil was obtained from the Escambia Treating Company site in Pensacola, Florida. Previous bench-scale soil washing studies conducted by REAC personnel had shown that surfactant solutions were effective in removing creosote and PCP from these soils[1].

Two-hundred grams of soil was suspended in the wash solution to a final volume of 1-liter in a 2-liter amber glass bottle, fitted with a teflon lined cap, and stirred overnight. The larger soil particles were allowed to settle and the wash liquid containing soil fines was decanted into another 2-liter amber glass bottle.

The wastewater was then supplemented with naphthalene since analysis of the wastewater indicated that this analyte was not present. To aseptically add naphthalene to wastewater, the following procedures were used. A 2-liter amber glass bottle, fitted with a rubber stopper/glass tubing assembly, was prepared and sterilized. The glass tubing consisted of an entry tube and exit tube. The entry tube was fitted with a membrane filter (0.2 microns(u), Millipore) to sterilize gases introduced into the bottle while the exit tube allowed venting of introduced gases. A small amount of glass wool was added to the exit tube to maintain sterility within the amber bottle. To the empty bottle was added 6 milliliters (ml) of a 0.50% weight/volume (w/v) naphthalene stock. The naphthalene stock was prepared by dissolving 0.10 grams purified naphthalene in 20 ml methylene chloride. The stock solution was assumed to be sterile due to the presence of methylene chloride. The methylene chloride was evaporated to dryness by introducing a stream of sterile nitrogen gas into the bottle through the entry tube. One liter of alkaline wastewater was then added to the bottle containing the dried naphthalene. The wastewater was further supplemented by the addition of 10 ml 1.0% w/vpentachlorophenol (PCP) and diluted to two liters with alkaline wash solution. The stock solution of PCP was prepared by dissolving 1.0 gram purified PCP (>99% purity) in 0.046 N sodium hydroxide. The solution was sterilized by membrane filtration. The wastewater was then stirred overnight to dissolve the naphthalene supplement.

2.2 Soil as Sources of Microbes

Nineteen soil and sediment samples were obtained from the Southern Maryland Woodtreating site. These soil and sediment samples were used as possible sources of PCP- and creosote-degrading microbes. The samples were obtained from five different locations at the site: (1) compost piles, (2) drainage ponds and streams, (3) contaminated soil piles, (4) telephone pole piles, and (5) land treatment units. Each of these areas was known to be contaminated with significant levels of PCP and creosote[2,3]. The soil samples and their location are summarized in Table 1.

2.3 Wastewater Medium Preparation

One-hundred eighty ml aliquots of alkaline wastewater were dispensed into each of four sterile amber glass bottles fitted with teflon lined caps. The wastewater was neutralized with 2.5N sulfuric acid to a pH of approximately 8.5-9.0. The wastewater was supplemented with inorganic nutrients according to the formulation of Bushnell and Haas[4]. The nutrient formulation is shown in Table 2. The pH of the medium was adjusted to a final pH of 7.3-7.4 with sterile 0.5N sulfuric acid or sodium hydroxide stocks. The medium volume in each bottle was brought to 200 ml with sterile deionized water. Soils or sediments from each site location were then added to respective bottles and stirred for 15 minutes. The slurries from each bottle were dispensed in 25 ml aliquots into each of five sterile 125 ml erlenmeyer flasks fitted with teflon lined screwcaps. Control flasks were prepared by the addition of 2.5 ml 37% formaldehyde to designated flasks. Matrix spikes were prepared by adding 40 ml of inoculated wastewater medium to a sterile 250 ml erlenmeyer flask fitted with a teflon lined screwcap. The amounts of soil or sediment added to respective bottles is shown in Table 3.

2.4 Fermentation Procedures

Three sampling times were chosen for the growth experiments: (a) day 0, (b) day 14, and (c) day 23. Each set of flasks contained 2 test flasks (day 14 and day 23) and three control flasks (day 0, day 14, and day 23). The matrix spike flasks were treated as day 23 test flasks.

The flasks were placed on a gyratory shaker (New Brunswick Scientific, Model G-10) at an agitation rate of 200 revolutions per minute (rpm) and at a temperature of 30°C. At the time of sampling, 20 ml from each test flask was removed and added to 1-ounce amber glass bottles. The sample was rendered sterile by the addition of 2 ml of 37% formaldehyde. A 22 ml aliquot was removed from control flasks and added to 1-ounce amber glass bottles. On day 23, the entire contents of each matrix spike flask was dispensed into 250 ml amber glass bottles and sterilized with 4 ml of 37% formaldehyde.

2.5 Analytical Procedures

2.5.1 PCP Analysis

PCP was analyzed in supplemented wastewater medium by a U.S. EPA approved method[5]. A 0.50 part per million (ppm) detection limit was used for test flasks and a 5 ppm detection limit for control flasks. Analyte levels were corrected for the dilution effect caused by the addition of formaldehyde.

2.5.2 Creosote analysis

A target list of polycyclic aromatic hydrocarbons (PAHs), phenols, and heterocycles was analyzed in supplemented wastewater medium by a U.S. EPA approved method[5]. A 0.5 ppm detection limit was used for test flasks and a 5 ppm detection limit for control flasks. Analyte levels were corrected for the dilution effect caused by the addition of formaldehyde.

To simplify data interpretation, the PAHs were grouped by the number of rings associated with the molecule as suggested by Mueller et al[4]. In this approach, the Group 1 PAHs have 2 rings, Group 2 PAHs with 3 rings, and the Group 3 PAHs with 4 or more rings.

3.0 RESULTS

3.1 PCP and Creosote Degradation by Microbes from Soil Composite #1

As shown in Table 4, the Groups 1 and 2 PAHs were completely degraded by day 14 although a trace of anthracene was found in wastewater medium and remained non-degraded for the length of the study. Considerable degradation of the Group 3 PAHs also occurred. Greater than 99% and 59% of the available fluoranthene and chrysene, respectively, were removed by day 23. By contrast, pyrene, benzo(b)fluoranthene and benzo(k)fluoranthene were not degraded to any extent throughout the study. PCP was also not degraded but the heterocycle, dibenzofuran, was completely removed by day 14.

Analysis of control flask broths showed that there was no significant losses of analytes during the test period (Table 5). Variations in analyte levels did occur but was not considered due to abiotic or biotic means.

3.2 PCP and Creosote Degradation by Microbes from Soil Composite #2

Results showed that the Group 1 PAHs were completely degraded by day 14 (Table 6). Significant levels of the Group 2 PAHs were also degraded although detectable levels of acenaphthene were present at day 23. The Group 3 PAHs were relatively non-degraded after 23 days. The only Group 3 PAH that was degraded in significant levels was fluoranthene where 39% of the analyte was degraded by day 23. Other Group 3 PAHs present in significant quantities such as pyrene and chrysene were not degraded. Pentachlorophenol was not utilized after 23 days while dibenzofuran was completely degraded by day 14. Control flasks showed similar patterns as those observed for control flasks inoculated with soil composite #1 (Table 7).

3.3 PCP and Creosote Degradation by Microbes from Soil/Sediment Composite #3

Results showed that significant degradation of the Group 1 PAHs occurred although biodegradation levels were not consistent when day 14 and day 23 test data were compared (Table 8). Group 2 PAHs were significantly degraded by day 14 although inconsistent biodegradation results again occurred when comparing day 14 and day 23 data. Measurable levels of acenaphthene were present at both sampling times. Group 3 PAHs were relatively non-degraded throughout the test period. Analyte concentrations in control flasks were consistent at all sampling times (Table 9).

3.4 PCP and Creosote Degradation by Microbes from Soil Composite #4

Group 1 and Group 2 PAHs were completely degraded by day 14 although a trace of anthracene still remained at day 23 (Table 10). The Group 3 PAHs were significantly degraded with greater than 98% and 94% of fluoranthene and pyrene, respectively, degraded by day 23. Benzo(b)fluoranthene and benzo(k)fluoranthene were not degraded during the study. The heterocycles, dibenzofuran and carbazole, were completely degraded by day 14 while PCP remained non-degraded throughout the test period. Analyte levels in control flasks were relatively constant throughout the 23 day test period (Table 11).

4.0 DISCUSSION OF RESULTS

Creosote components were divided into five analyte groups: (a) Group 1 PAHs (two rings), (b) Group 2 PAHs (three rings), (c) Group 3 PAHs (four or more rings), (d) phenols, and (e) heterocycles (dibenzofuran and carbazole) with PCP being the remaining analyte measured.

Data in Table 4 show that microbes in the compost piles show excellent activity in degrading Groups 1 and 2 PAHs (98-100% degradation) and target heterocycles (100% degradation). Of the three Group 3 PAHs present in the highest concentrations in the test wastewater (fluoranthene, pyrene, and chrysene), the microbial population showed good activity against fluoranthene (>99% degradation) and chrysene (> 59% degradation) but showed little activity against pyrene.

Results in Tables 6 and 8 show that microbes in the soils or sediments of the drainage ponds and streams or the soils used from the soil pile, pressure treatment area, and the telephone pole pile showed good activity against Groups 1 and 2 PAHs (48-99% degradation) and heterocycles (100% degradation) but showed little activity against Group 3 PAHs. Inconsistent biodegradation data noted in Table 8 may be due to incomplete slurrying of the inoculated wastewater suspensions prior to dispensing into test flasks.

Results from Table 10 clearly indicate that soils obtained from the Land Farm Units were the most active soils and contained microbes capable of degrading the majority of the target analytes in the test wastewater. Results showed that all PAH groups and heterocycles were either completely or significantly (>90%) degraded by day 23. Target analytes not degraded were present at very low concentrations initially and may not have been at high enough levels to initiate enrichment of microbes capable of degrading these compounds. PCP was not degraded in this soil enrichment culture or any of the other enrichment cultures.

Control flasks showed relatively consistent levels of target analytes at the three sampling times indicating that no biodegradation or abiotic losses of volatile analytes occurred. The sludge accumulating on the sides of the shake flasks was resuspended into the wastewater media prior to sampling so that abiotic losses due to adsorption to wastewater solids was minimized.

5.0 CONCLUSIONS

It is concluded that the soils from the land farm units would represent an excellent source of microbes capable of degrading most of the target analytes of creosote which were evaluated in contaminated wastewater. Further studies of site soils would have to be conducted to identify a PCP-degrading microbe indigenous to the site. An alternative approach would be to use a non-indigenous PCP-degrading microbe capable of coexisting with the indigenous creosote-degrading population.

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TABLE 1.
Location of Soil Samples Collected at the Southern Maryland Woodtreating Site
Southern Maryland Woodtreating Site
Hollywood, Maryland
November, 1993

Sample #	Sample Location
SOMAS-1	Compost Pile #1
SOMAS-2	Compost Pile #2
SOMAS-3	Compost Pile #3
SOMAS-4	Compost Pile #4
SOMAS-5	Pressure Treatment Area
SOMAS-6	Soil Pile
SOMAS-7	Drainage Pond #1 (Dam Area)
SOMAS-8	Drainage Pond #1
SOMAS-9	Drainage Stream #1
SOMAS-10	Drainage Stream #1
SOMAS-11	Drainage Stream #2
SOMAS-12	Drainage Pond #2
SOMAS-13	Telephone Pole Pile
SOMAS-14	Land Farm Unit #1
SOMAS-15	Land Farm Unit #2
SOMAS-16	Land Farm Unit #3
SOMAS-17	Land Farm Unit #4
SOMAS-18	Land Farm Unit #5
SOMAS-19	Land Farm Unit #6

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TABLE 2.
Nutrient Additions Used in Preparation of Wastewater Medium
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Ingredient	Conc. (g/l)	Conc. (ml/l)	Conc. (ml/200 ml)	Stock Sol.(%)
NH_4NO_3[a]	1.0	10.0	2.0	10.0
KH_2PO_4[b]	1.0	10.0	2.0	10.0
K_2HPO_4[b]	1.0	10.0	2.0	10.0
$MgSO_4 \cdot 7H_2O$[b]	0.20	10.0	2.0	2.0
$CaCl_2 \cdot 2H_2O$[b]	0.020	10.0	2.0	0.20
$FeCl_3 \cdot 6H_2O$[c]	0.0050	1.0	0.20	0.50

[a] The stock solution was sterilized by filtration.
[b] The stock solutions was sterilized by autoclaving at 121°C for 15 minutes.
[c] The stock solution was prepared fresh and sterilized by filtration.

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TABLE 3.
Soil Combinations Used in Inoculating Growth Flasks
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Sample#	Location	Composite #	Inoculum Amt. (grams)
SOMAS-1	Compost Pile #1	1	1.0
SOMAS-2	Compost Pile #2	1	1.0
SOMAS-3	Compost Pile #3	1	1.0
SOMAS-4	Compost Pile #4	1	1.0
SOMAS-5	Pressure Treatment	2	1.3
SOMAS-6	Soil Pile	2	1.3
SOMAS-13	Telephone Pole Pile	2	1.3
SOMAS-7	Drainage Pond #1	3	0.7
SOMAS-8	Drainage Pond #1	3	0.7
SOMAS-9	Drainage Stream #1	3	0.7
SOMAS-10	Drainage Stream #1	3	0.7
SOMAS-11	Drainage Stream #2	3	0.7
SOMAS-12	Drainage Pond #2	3	0.7
SOMAS-14	Land Farm Unit #1	4	0.7
SOMAS-15	Land Farm Unit #2	4	0.7
SOMAS-16	Land Farm Unit #3	4	0.7
SOMAS-17	Land Farm Unit #4	4	0.7
SOMAS-18	Land Farm Unit #5	4	0.7
SOMAS-19	Land Farm Unit #6	4	0.7

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TABLE 4.
Biodegradation of PCP and Creosote Components by Soil Composite #1
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[b]	Day 23[b]
Naphthalene	6.4	-[c]	-
1-Methylnaphthalene	7.6	-	-
2-Methylnaphthalene	3.8 J	-	-
Biphenyl	1.1 J	-	-
2,6-Dimethylnaphthalene	1.7 J	-	-
Acenaphthylene	-	-	-
Acenaphthene	10.7	-	-
Fluorene	13.9	-	-
Phenanthrene	32.6	-	-
Anthracene	4.7 J	0.1 J	0.1 J
2-Methylanthracene	1.6 J	-	-
Fluoranthene	23.3	14.6	0.2 J
Pyrene	12.3	13.6	11.1
Chrysene	3.2 J	4.1	1.3
Benzo(a)pyrene	-	1.5	1.7
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	3.7	-
Benzo(b)fluoranthene	1.5 J	2.2	2.0
Benzo(k)fluoranthene	1.2 J	2.0	2.0
Indeno(1,2,3-c,d)pyrene	-	0.7	-
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	20.9	28.9	34.7
Dibenzofuran	10.5	-	-
Carbazole	-	-	-

[a] Limit of Detection (LOD) - 5 ppm, [b] LOD - 0.5 ppm, [c] not detected, J - estimated value

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TABLE 5.
PCP and Creosote Component Levels in Control Flasks Inoculated With Soil Composite #1
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[a]	Day 23[a]
Naphthalene	6.4	9.8	4.0 J
1-Methylnaphthalene	7.6	14.5	6.6
2-Methylnaphthalene	3.8 J	8.0	3.2 J
Biphenyl	1.1 J	2.6 J	1.1 J
2,6-Dimethylnaphthalene	1.7 J	-[b]	1.7 J
Acenaphthylene	-	0.8 J	-
Acenaphthene	10.7	19.6	11.2
Fluorene	13.9	22.0	14.7
Phenanthrene	32.6	51.9	34.9
Anthracene	4.7 J	18.7	9.3
2-Methylanthracene	1.6 J	8.0	2.0 J
Fluoranthene	23.3	42.1	25.0
Pyrene	12.3	26.2	14.0
Chrysene	3.2 J	8.3	4.2 J
Benzo(a)pyrene	-	3.2 J	-
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	-	-
Benzo(b)fluoranthene	1.5 J	3.5 J	1.0 J
Benzo(k)fluoranthene	1.2 J	3.9 J	0.8 J
Indeno(1,2,3-c,d)pyrene	-	-	-
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	20.9	43.5	18.0
Dibenzofuran	10.5	16.5	11.1
Carbazole	-	23.3	-

[a] - Limit of Detection (LOD) - 5 ppm, [b] - not detected, J - estimated value

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TABLE 6.
Biodegradation of PCP and Creosote Components by Soil Composite #2
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[b]	Day 23[b]
Naphthalene	8.3	-[c]	-
1-Methylnaphthalene	10.4	-	-
2-Methylnaphthalene	5.1	-	-
Biphenyl	1.7 J	-	-
2,6-Dimethylnaphthalene	2.5 J	-	-
Acenaphthylene	-	0.2 J	0.2 J
Acenaphthene	14.0	3.3	3.6
Fluorene	17.9	0.2 J	0.2 J
Phenanthrene	42.1	-	0.2 J
Anthracene	3.1 J	0.4 J	0.4 J
2-Methylanthracene	2.3 J	0.7	0.7
Fluoranthene	23.3	15.5	14.2
Pyrene	14.4	12.4	10.9
Chrysene	3.7 J	3.6	3.2
Benzo(a)pyrene	-	1.6	1.4
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	3.4	2.8
Benzo(b)fluoranthene	1.5 J	1.7	1.8
Benzo(k)fluoranthene	1.5 J	2.1	1.4
Indeno(1,2,3-c,d)pyrene	-	0.7	0.7
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	22.2	27.6	29.0
Dibenzofuran	14.3	-	-
Carbazole	-	-	-

[a] - Limit of Detection (LOD) - 5 ppm, [b] LOD - 0.5 ppm, [c] - not detected, J - estimated value

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TABLE 7.
PCP and Creosote Component Levels in Control Flasks Inoculated With Soil Composite #2
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[a]	Day 23[a]
Naphthalene	8.3	8.2	4.0 J
1-Methylnaphthalene	10.4	10.9	6.4
2-Methylnaphthalene	5.1	5.9	3.2 J
Biphenyl	1.7 J	2.0 J	1.0 J
2,6-Dimethylnaphthalene	2.5 J	-[b]	1.6 J
Acenaphthylene	-	-	-
Acenaphthene	14.0	13.3	8.7
Fluorene	17.9	13.9	9.4
Phenanthrene	42.1	33.7	24.1
Anthracene	3.1 J	3.7 J	2.2 J
2-Methylanthracene	2.3 J	2.4 J	1.4 J
Fluoranthene	23.3	21.0	17.4
Pyrene	14.4	17.2	9.8
Chrysene	3.7 J	5.1	2.9 J
Benzo(a)pyrene	-	2.3 J	-
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	2.8 J	2.4 J
Benzo(b)fluoranthene	1.5 J	2.2 J	2.4 J
Benzo(k)fluoranthene	1.5 J	3.2 J	-
Indeno(1,2,3-c,d)pyrene	-	-	-
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	22.2	22.4	19.1
Dibenzofuran	14.3	11.7	7.5
Carbazole	-	16.3	-

[a] Limit of Detection (LOD) - 5 ppm, [b] not detected, J - estimated value

ml/fr-670

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TABLE 8.
Biodegradation of PCP and Creosote Components by Soil Composite #3
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[b]	Day 23[b]
Naphthalene	8.7	-[c]	-
1-Methylnaphthalene	10.9	-	0.5
2-Methylnaphthalene	6.1	-	1.0
Biphenyl	1.9 J	-	1.3
2,6-Dimethylnaphthalene	-	-	-
Acenaphthylene	-	0.2 J	-
Acenaphthene	13.4	5.9	8.3
Fluorene	13.6	0.8 J	8.7
Phenanthrene	34.4	0.2 J	31.6
Anthracene	3.8 J	1.6	2.5
2-Methylanthracene	2.5 J	1.3	1.8
Fluoranthene	18.7	15.0	12.7
Pyrene	12.9	9.9	8.2
Chrysene	3.7 J	2.7	2.2
Benzo(a)pyrene	-	1.0	0.8
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	2.9	2.6
Benzo(b)fluoranthene	1.8 J	1.0	0.8
Benzo(k)fluoranthene	1.2 J	1.3	1.1
Indeno(1,2,3-c,d)pyrene	-	0.4 J	0.3
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	23.5	29.9	21.8
Dibenzofuran	11.8	-	8.0
Carbazole	-	1.3	10.9

[a] Limit of Detection (LOD) - 5 ppm, [b] LOD - 0.5 ppm, [c] not detected, J - estimated value

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TABLE 9.
PCP and Creosote Component Levels in Control Flasks Inoculated With Soil Composite #3
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[a]	Day 23[a]
Naphthalene	8.7	7.0	7.9
1-Methylnaphthalene	10.9	9.3	10.8
2-Methylnaphthalene	6.1	4.6 J	5.4
Biphenyl	1.9 J	1.3 J	1.5 J
2,6-Dimethylnaphthalene	-[b]	2.1 J	2.6 J
Acenaphthylene	-	-	-
Acenaphthene	13.4	11.0	12.7
Fluorene	13.6	11.9	14.1
Phenanthrene	34.4	31.5	35.4
Anthracene	3.8 J	2.8 J	3.2 J
2-Methylanthracene	2.5 J	2.1 J	2.2 J
Fluoranthene	18.7	18.2	19.9
Pyrene	12.9	9.4	11.9
Chrysene	3.7 J	2.4 J	2.7 J
Benzo(a)pyrene	-	-	-
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	-	-	-
Benzo(b)fluoranthene	1.8 J	1.2 J	1.2 J
Benzo(k)fluoranthene	1.2 J	-	1.5 J
Indeno(1,2,3-c,d)pyrene	-	-	-
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	23.5	24.4	27.9
Dibenzofuran	11.8	9.8	11.6
Carbazole	-	-	-

[a] Limit of Detection (LOD) - 5 ppm, [b] not detected, J - estimated value

ml/fr-670

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TABLE 10.
Biodegradation of PCP and Creosote Components by Soil Composite #4
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[b]	Day 23[b]
Naphthalene	6.2	-[c]	-
1-Methylnaphthalene	8.1	-	-
2-Methylnaphthalene	4.5 J	-	-
Biphenyl	1.5 J	-	-
2,6-Dimethylnaphthalene	-	-	-
Acenaphthylene	-	-	-
Acenaphthene	11.3	-	-
Fluorene	11.3	-	-
Phenanthrene	28.4	-	-
Anthracene	5.2	0.2 J	0.1 J
2-Methylanthracene	2.3 J	-	-
Fluoranthene	17.2	4.3	0.2 J
Pyrene	11.9	11.4	0.3 J
Chrysene	3.8 J	2.2	1.1
Benzo(a)pyrene	-	1.8	1.7
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	3.5 J	0.9	-
Benzo(b)fluoranthene	1.1 J	0.7	2.0
Benzo(k)fluoranthene	2.6 J	4.0	1.7
Indeno(1,2,3-c,d)pyrene	-	0.6	0.7
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	16.0	34.3	32.3
Dibenzofuran	9.1	-	-
Carbazole	13.4	-	-

[a] Limit of Detection (LOD) - 5 ppm, [b] LOD - 0.5 ppm, [c] not detected, J - estimated value

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TABLE 11.
PCP and Creosote Component Levels in Control Flasks With Soil Composite #4
Southern Maryland Woodtreating
Hollywood, Maryland
November, 1993

Analyte	Analyte Concentration (ppm) as a function of time (days)		
	Day 0[a]	Day 14[a]	Day 23[a]
Naphthalene	6.2	6.6	8.6
1-Methylnaphthalene	8.1	10.1	11.0
2-Methylnaphthalene	4.5 J	-[b]	6.0
Biphenyl	1.5 J	1.8 J	2.0 J
2,6-Dimethylnaphthalene	-	-	3.5 J
Acenaphthylene	-	-	0.7 J
Acenaphthene	11.3	14.2	14.7
Fluorene	11.3	16.1	16.0
Phenanthrene	28.4	37.4	37.2
Anthracene	5.2	10.3	9.4
2-Methylanthracene	2.3 J	2.7 J	3.3
Fluoranthene	17.2	23.3	20.5
Pyrene	11.9	14.6	16.6
Chrysene	3.8 J	4.8 J	4.7 J
Benzo(a)pyrene	-	1.9 J	1.8 J
Benzo(e)pyrene	-	-	-
Benzo(a)anthracene	3.5 J	-	-
Benzo(b)fluoranthene	1.1 J	1.4 J	2.0 J
Benzo(k)fluoranthene	2.6 J	2.4 J	2.3 J
Indeno(1,2,3-c,d)pyrene	-	-	-
o-Cresol	-	-	-
m-Cresol	-	-	-
p-Cresol	-	-	-
Pentachlorophenol	16.0	31.2	23.5
Dibenzofuran	9.1	12.8	12.7
Carbazole	13.4	17.1	19.4

[a] Limit of Detection (LOD) - 5 mg/kg, [b] not detected, J - estimated value

ml/fr-670

AR302619

APPENDIX H

Statistical Analysis

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

Statistical Analysis of Biodegradation Results

Southern Maryland Woodtreating Site

Bacterial degradation of organic matter normally occurs at a constant rate, unless there is some intervening environmental factor or the supply of available nutrients diminishes. This phenomenon expresses itself in a set of paired data of substrate concentration and time, which when plotted on regular graph paper produces a characteristic die-off curve. When the same data are expressed as the logarithm of the concentration against time, a straight line is often formed, the declining slope of which defines the degradation rate. If the data meet various tests of reliability, the degradation rates (or slopes) of the decay curves for the individual constituents may be compared statistically, and various inferences may be made as to their meaning.

These principles are expressed in the following methodology, which was used to compare the rates of degradation of polynuclear aromatic hydrocarbons (PAHs) among the treatment units at the Southern Maryland Woodtreating (SMWT) site. Plots of the day of sampling versus concentration were created and examined for all compounds in all compost piles and in the land treatment cells. Initial observation of the plots for the compost piles indicated a curvilinear relationship between the time expressed as "DAY" and the non-carcinogenic PAH concentrations. Relationships between "DAY" and the carcinogenic PAHs were less clearly defined. The performance of the land treatment cells was so poor that the data could not be modeled.

A linear regression analysis was then performed on the log-transformation of concentrations for each compound, and "DAY." In all cases, "DAY" was the independent variable, and the log transformed concentration was the dependent variable. The degree of fit, or R^2, and the degradation rate, or slope, were examined for each analysis. R^2, which is also known as the coefficient of determination, represents the percentage of variation within the log of the concentrations which can be explained by the fitted regression model. The closer the R^2 is to 1.0, the stronger the relationship between time and the concentrations. The slope represents the change in DAY relative to the change in concentration. This is sometimes confusing, since we would normally state this the other way around to imply the reduction in concentration with time. The confusion is an artifact of mathematical logic. It should be noted also that the degradation rate slope only enables us to describe a simple relationship and not to make a deterministic statement of cause and effect.

A regression model also includes a test of significance to determine the probability of the relationship between the two variables occurring purely by chance, as opposed to a true relationship existing. A probability value (p-value or α) is chosen *a priori* to perform the regression analysis, in this case 0.05 was chosen, because we are willing to accept no more than a 5% probability of having the relationship between "DAY" and log (concentration) occur simply by chance. If the p-value is calculated to be ≤ 0.05, the regression model is considered to be significant, that is not occurring by chance at the 95% confidence level. The R^2 value and slopes for all significant models are listed in Table 1.

Significant log-linear models were found primarily for the non-carcinogenic compounds. Because the plots of the carcinogenic compounds indicated that they were not behaving in a logarithmic relationship, other transformations including inverse, square root, and polynomial were attempted for the non-carcinogenic compounds to obtain a significant model, but none of these proved successful.

In order to determine whether different treatments affect the degradation rates of individual PAHs, it is necessary to compare the degradation rates (slopes) of the different compost piles. Actually, the statistical analysis of these data only shows us whether the slopes are different, it does not tell us that these differences are caused by different conditions in the piles. Just as was indicated before in the discussion of the degradation slope, it is perceived causality in the results which the statistics only describe. The process is called a test of homogeneity. Following the calculation of the regression models, degradation rate slopes of

those compounds with significant models (i.e., p-values ≤ 0.05) for all four compost piles were compared. A test for homogeneity of slopes was used to determine whether the rates of degradation were statistically different. A 95% confidence level was also used for the comparisons. The compounds tested were acenaphthene, fluorene, and phenanthrene. In all three cases, significance was found with p-values ≤ 0.0001 (Table 1). This would indicate that the different compost piles produced significantly different results in terms of degradation rate for these three compounds. Moreover, since turning of the piles was the only common denominator among the more rapidly degraded test compounds, we may infer that turning significantly accelerates biodegradation of these PAHs.

GCL Site

A similar methodology was followed for the GCL Site in Sydney, NY. However, prior to plotting the data, averages per compound per compost pile per day were calculated. These averages were utilized for all the statistical analyses and plots.

Upon plotting each compound's concentration against DAY for each of the eight compost piles from the GCL Site, a logarithmic relationship was determined to exist. Regression analyses were run on all compounds for all compost piles, with DAY as the independent variable, and the logarithmic transformation of the compound concentration as the dependent variable. Results were similar to those obtained at the SMWT site, with the non-carcinogenic compounds making up the majority of the significant models (Table 2, Figures 8-11). Significant models were determined using the same methodology as that used at the SMWT site.

A comparison of the rates of degradation (slopes) across compost piles was performed for phenanthrene. Results indicated no significant difference among the rates of degradation (p-value = 0.6299) for this non-carcinogenic compound. This indicated that the treatments had no statistically significant effect on the rate of degradation for phenanthrene. Statistical comparisons were not performed for naphthalene, fluoranthene, and pyrene because all compost piles could not be modeled to attain a slope. Although a statistical comparison of slopes could not be performed for naphthalene, fluoranthene, and pyrene, those which were modeled showed rates of degradation with differences across compost piles of no greater than 0.0015. This would indicate that treatments of the compost piles had little effect on the rate of degradation for naphthalene, fluoranthene, pyrene, and phenanthrene.

Eastern Maryland Woodtreating Site

A similar methodology was also followed for the Eastern Maryland Woodtreating Site. However, prior to performing any analyses, sample A14856 collected at compost pile 2 on Day 20 was removed. This decision was based on the examination of the other two samples collected at the same pile on the same day, which showed concentrations of one to two orders of magnitude less. Dibenzofuran at compost pile 3 was also not modeled due to the high number of non-detects present in the data.

Instead of a simple logarithmic transformation, an additive logarithmic transformation was utilized because of values less than one contained in the data set. This does not alter the calculation of the slopes. Significant models determined by the regression analyses can be found in Table 3 and are plotted in Figures 12-22.

The slopes of acenaphthene, dibenzofuran, fluorene, fluoranthene, and pyrene, with results for all compost piles, were compared using the same methodology as that used at the SMWT site (Table 3). For acenaphthene, dibenzofuran, fluorene, and pyrene, no statistically significant difference could be found among rates of degradation (p-value ≥ 0.05). Fluoranthene, however, indicated a difference in rates across compost piles with a p-value = 0.0433.

Table 1
Results of Regression Analyses and Comparison of Slopes
Only Significant Regression Models Listed
Southern Maryland Site

Compounds Transformed Prior to Analyses

COMPOUND	COMPOST PILE 1		COMPOST PILE 2		COMPOST PILE 3		COMPOST PILE 4		P-VALUE SLOPE COMPARISON
	R^2	SLOPE	R^2	SLOPE	R^2	SLOPE	R^2	SLOPE	
NON-CARCINOGENIC									
NAPHTHALENE	0.5368	-0.00394	0.6555	-0.00378					
ACENAPHTHENE	0.9772	-0.00588	0.9066	-0.00243	0.8355	-0.00402	0.7229	-0.00159	0.0001
FLUORENE	0.9560	-0.00324	0.8630	-0.00166	0.8055	-0.00247	0.7114	-0.00115	0.0002
PHENANTHRENE	0.9369	-0.00368	0.7909	-0.00193	0.7786	-0.00295	0.6911	-0.00107	0.0002
ANTHRACENE	0.8299	-0.00131							
CARBAZOLE	0.7559	-0.00156			0.8616	-0.00129	0.5826	-0.00061	
FLUORANTHENE									
CARCINOGENIC									
PYRENE									
BENZO(A)ANTHRACENE							0.6620	-0.00049	
CHRYSENE									
BENZO(B)FLUORANTHENE									
BENZO(K)FLUORANTHENE									
BENZO(A)PYRENE									

AR302623

Table 2
Results of Regression Analyses and Comparison of Slopes
Only Significant Regression Models Listed
GCL Site

Compounds Transformed Prior to Analyses

COMPOUND	COMPOST 1		COMPOST 2		COMPOST 3		COMPOST 4		COMPOST 5		COMPOST 6		COMPOST 7		COMPOST 8	
	R^2	Slope	R^2	Slope	R^2	Slope	R^2	Slope	R^2	Slope	R^2	Slope	R^2	Slope	R^2	Slope
NON-CARCINOGENIC																
NAPHTHALENE			0.95	-0.005	0.53	-0.003			0.52	-0.004	0.85	-0.004			0.84	-0.004
PHENANTHRENE*	0.54	-0.003	0.95	-0.003	0.86	-0.003	0.73	-0.003	0.83	-0.003	0.77	-0.002	0.82	-0.004	0.95	-0.003
FLUORANTHENE	0.56	-0.002	0.84	-0.001	0.63	-0.001	0.80	-0.001	0.72	-0.001			0.77	-0.002		
CARCINOGENIC																
PYRENE	0.54	-0.002	0.67	-0.001			0.75	-0.001	0.58	-0.001			0.77	-0.002		
CHRYSENE																
BENZO(A)PYRENE																

* Comparison of slopes resulted in a probability value of 0.6299, which indicates no statistical difference existed among slopes.

AR 0 3 9 5 2 4

Table 3
Results of Regression Analyses and Comparison of Slopes
Only Significant Regression Models Listed
Eastern Maryland Site

Compounds Transformed Prior to Analysis

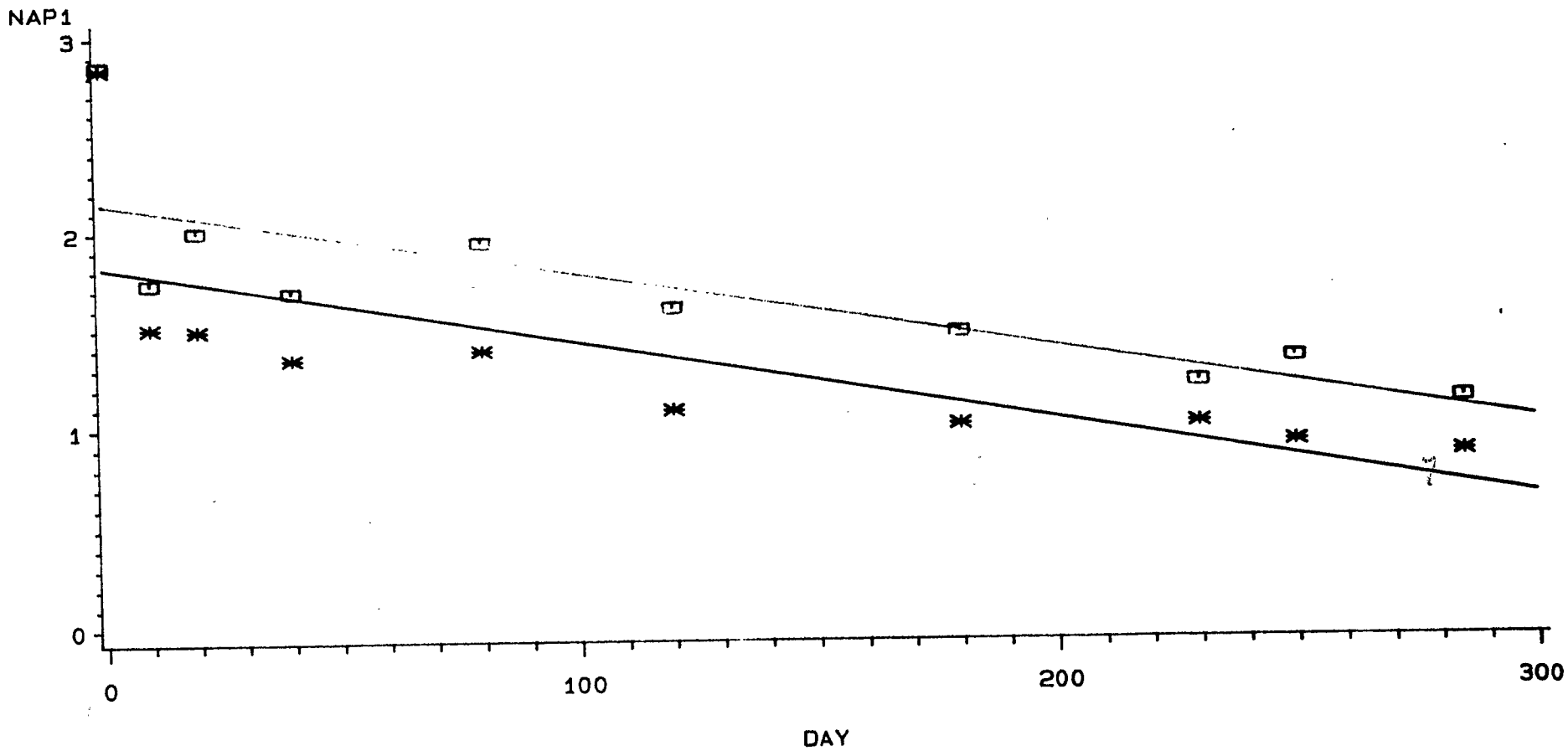
COMPOUND	COMPOST PILE 1		COMPOST PILE 2		COMPOST PILE 3		P-VALUE SLOPE COMPARISON
	R^2	SLOPE	R^2	SLOPE	R^2	SLOPE	
NON-CARCINOGENIC							
ACENAPHTHENE	0.7373	-0.009062	0.7348	-0.012756	0.7543	-0.010789	0.8499
DIBENZOFURAN	0.6615	-0.008956	0.7286	-0.007884	**	**	0.7958
FLUORENE	0.7585	-0.010273	0.7018	-0.008759	0.8686	-0.011481	0.3081
PHENANTHRENE			0.7420	-0.011198	0.7246	--0.016898	
ANTHRACENE	0.6754	-0.008161			0.7591	-0.009681	
CARBAZOLE							
FLUORANTHENE	0.9055	-0.006775	0.8178	-0.013924	0.9108	-0.012549	0.0433
CARCINOGENIC							
PYRENE	0.9136	-0.007654	0.9072	-0.014209	0.9053	-0.012483	0.0751
BENZO(A)ANTHRACENE			0.9212	-0.008419	0.7630	-0.004034	
CHRYSENE			0.9142	-0.007208	0.7440	-0.003628	
BENZO(B)FLUORANTHENE			0.8336	-0.005669	0.7523	-0.005523	
BENZO(K)FLUORANTHENE							
BENZO(E)PYRENE							
BENZO(A)PYRENE			0.8767	-0.002020			

** Inicates that no statistics were run due to the high number of non-detects.

AR302625

Figure 1

Significant Regression Models for Log (Naphthalene)
Southern Maryland Site



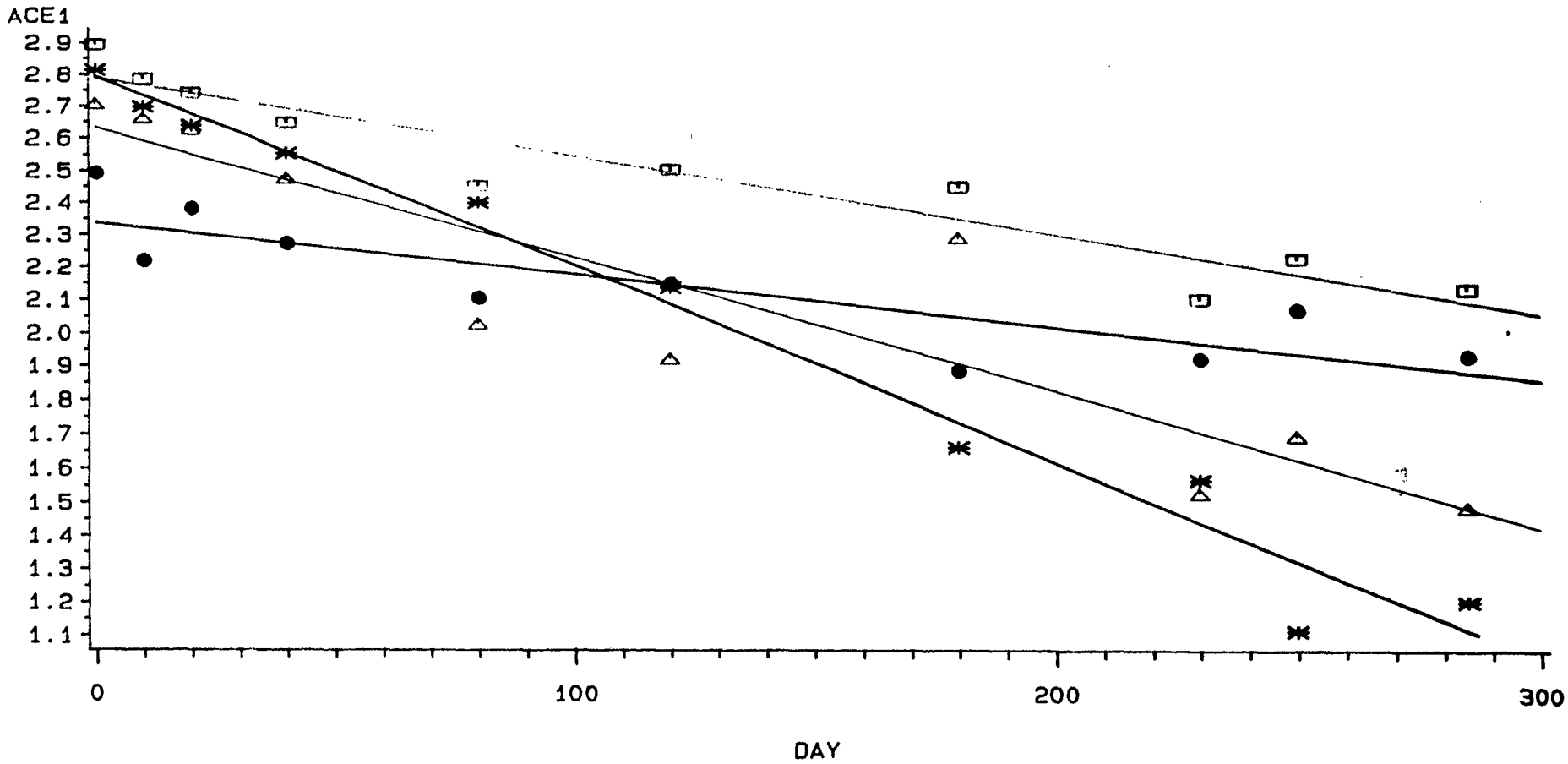
RED = COMPOST 1
GREEN = COMPOST 2

Significance Determined by P-Value<0.05

AR302626

Figure 2

Significant Regression Models for Log(Acenaphthene)
Southern Maryland Site

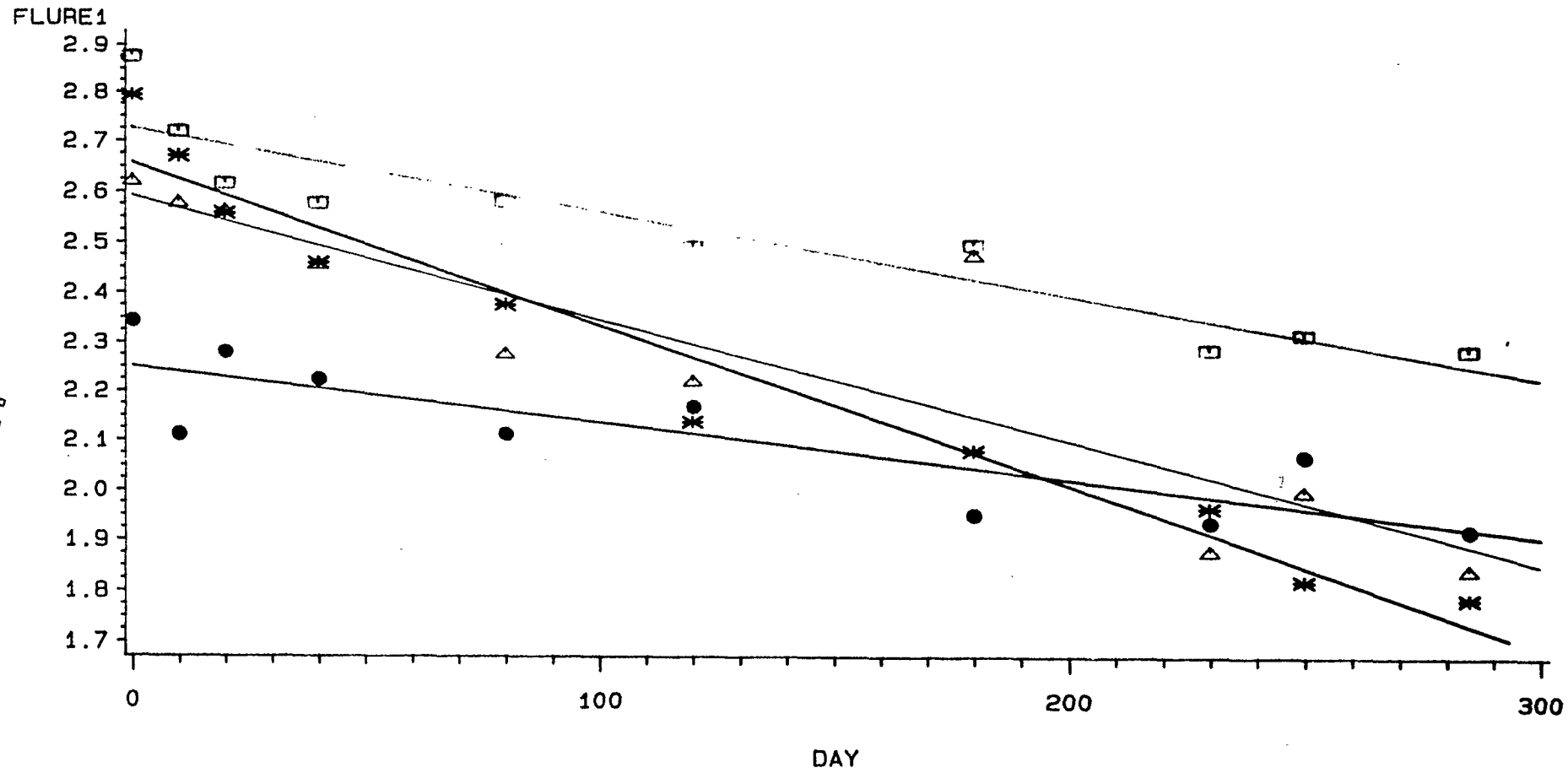


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
ORANGE = COMPOST 4
Significance Determined by P-Value<0.05

AR302627

Figure 3

Significant Regression Models for Log(Fluorene)
Southern Maryland Site

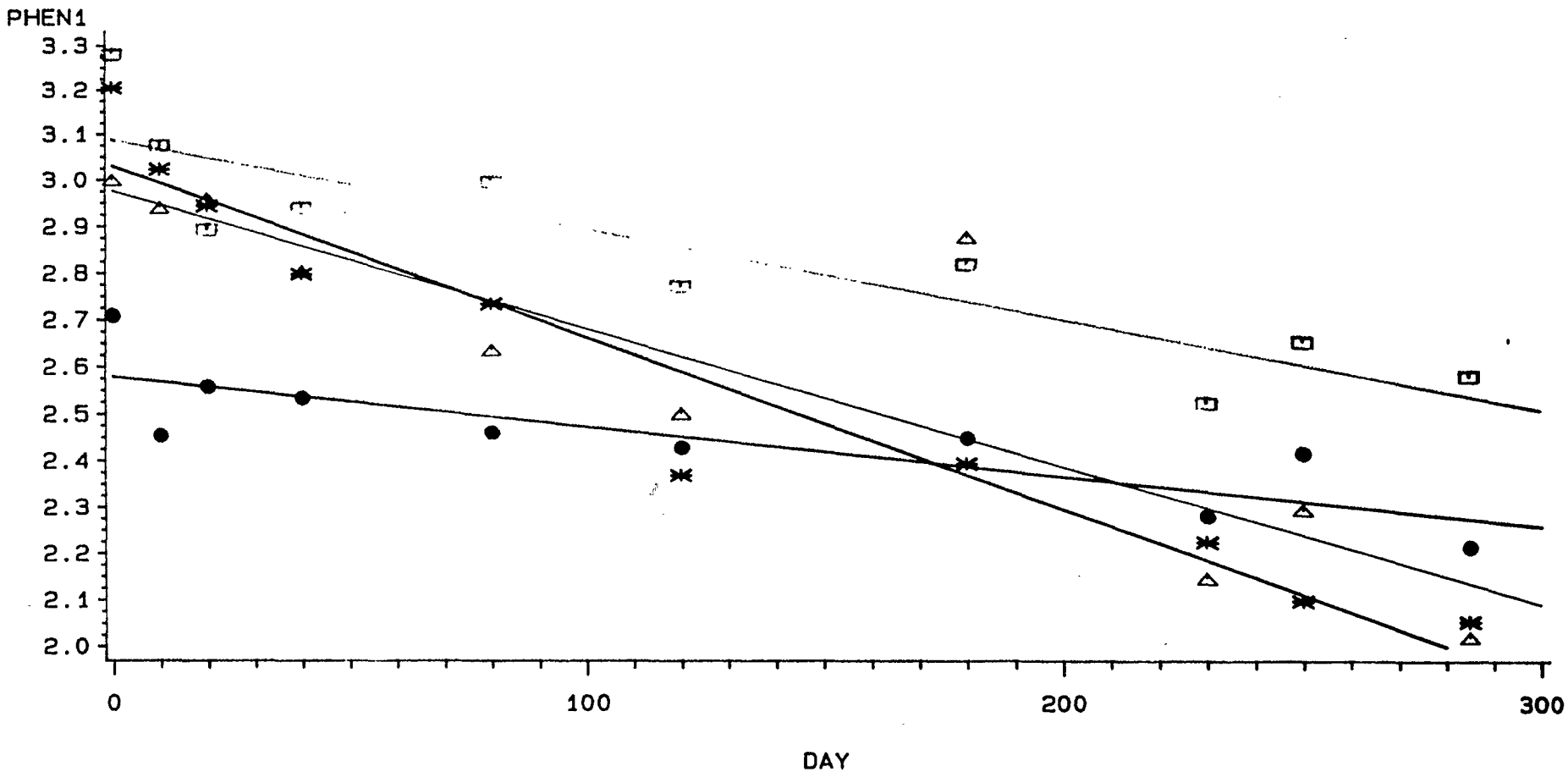


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
ORANGE = COMPOST 4
Significance Determined by P-Value<0.05

AR302628

Figure 4

Significant Regression Models for Log (Phenanthrene)
Southern Maryland Site

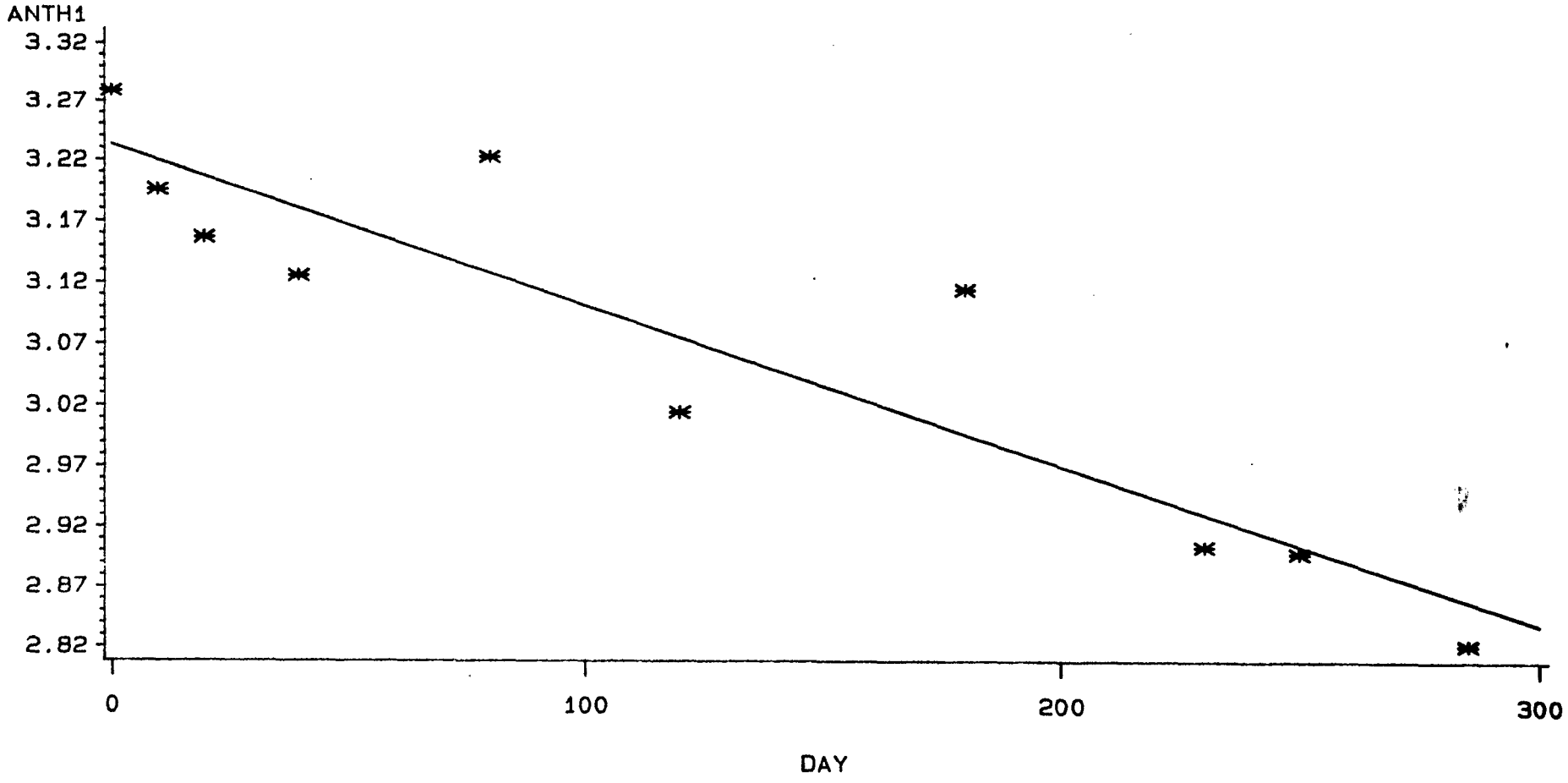


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
ORANGE = COMPOST 4
Significance Determined by P-Value<0.05

AR302629

Figure 5

Significant Regression Models for Log(Anthracene)
Southern Maryland Site



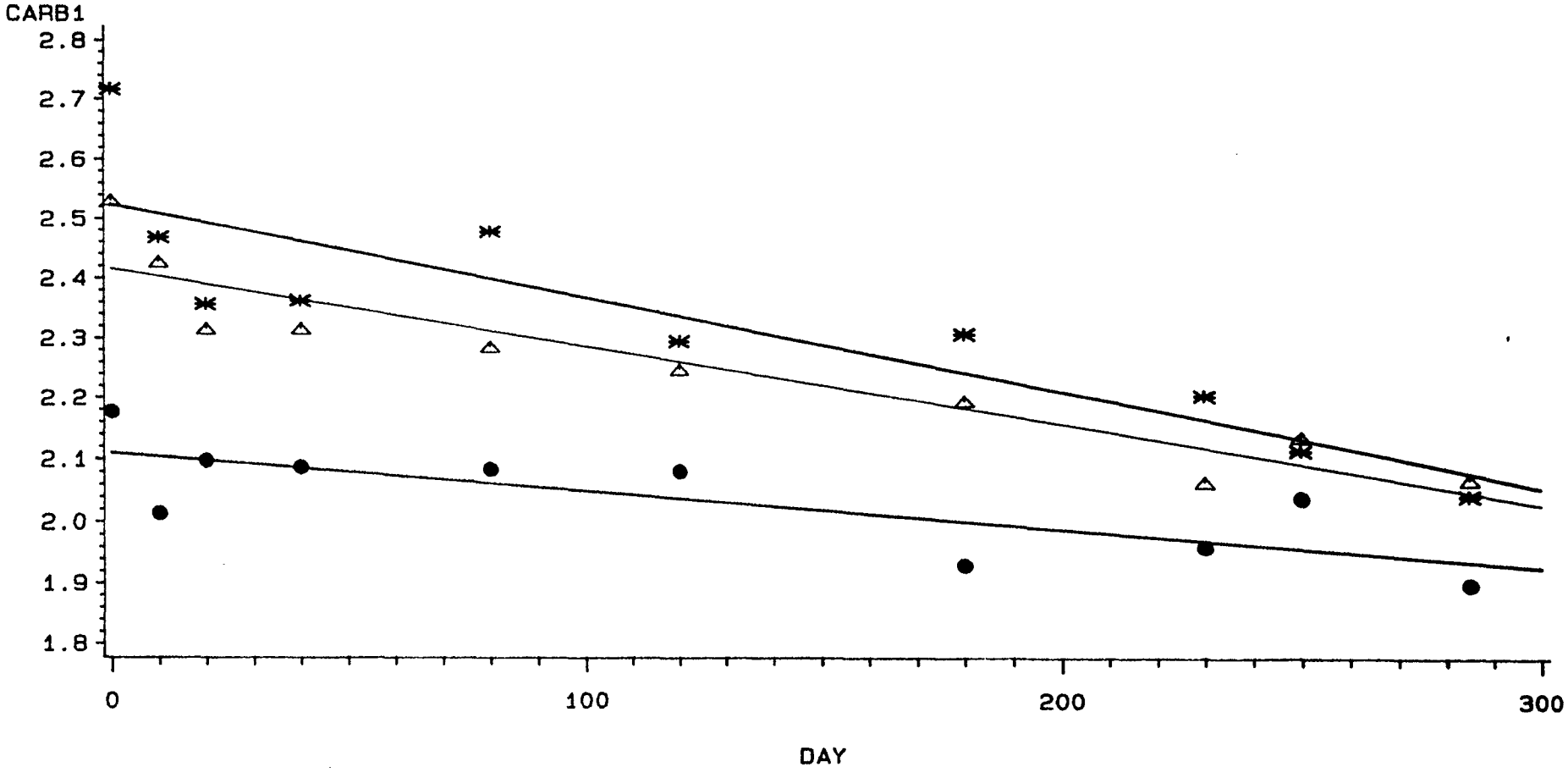
RED = COMPOST 1

Significance Determined by P-Value<0.05

AR302630

Figure 6

Significant Regression Models for Log (Carbazole)
Southern Maryland Site



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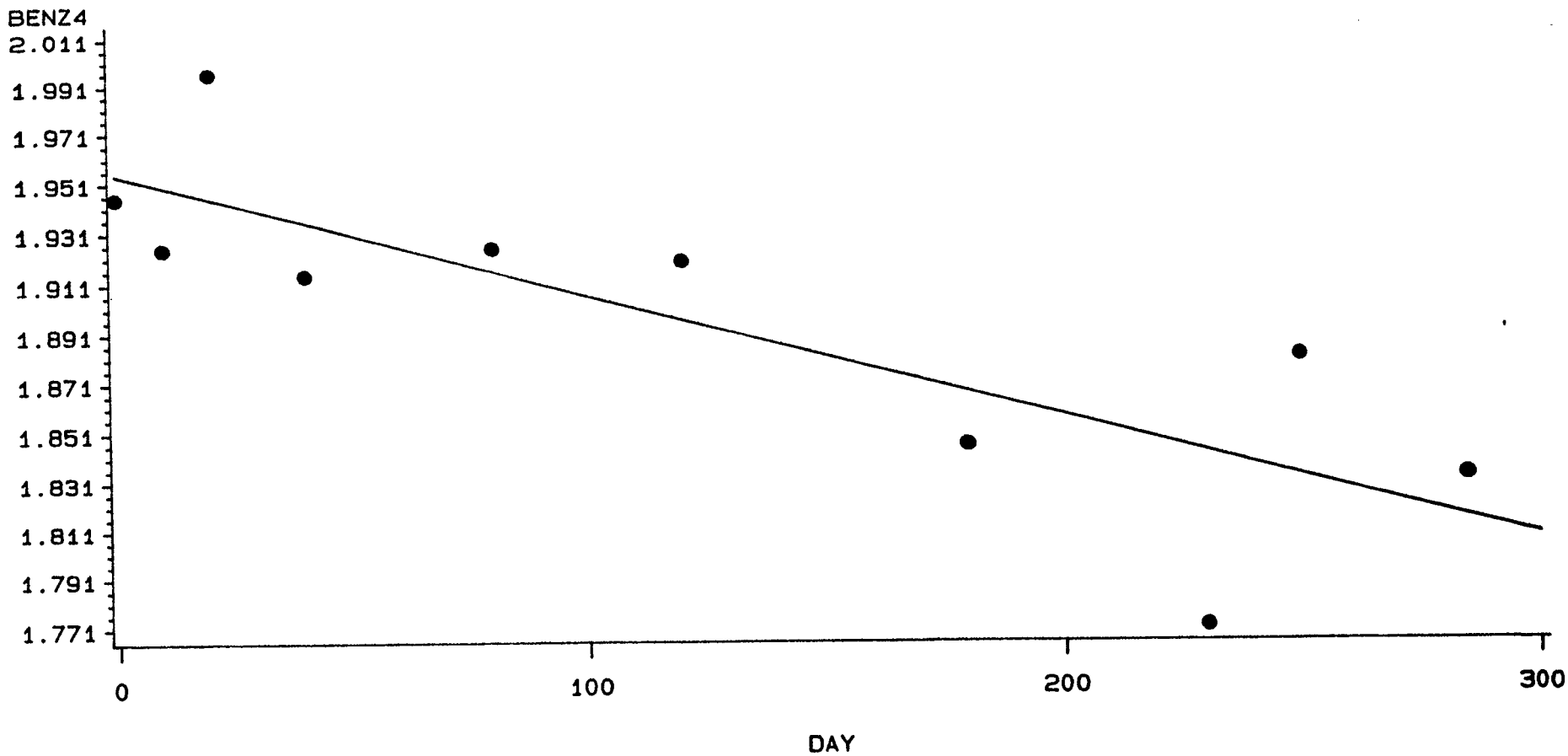
BLUE = COMPOST 3
ORANGE = COMPOST 4

Significance Determined by P-Value<0.05

AR302631

Figure 7

Significant Regression Models for Log (Benzo (a) Anthracene)
Southern Maryland Site



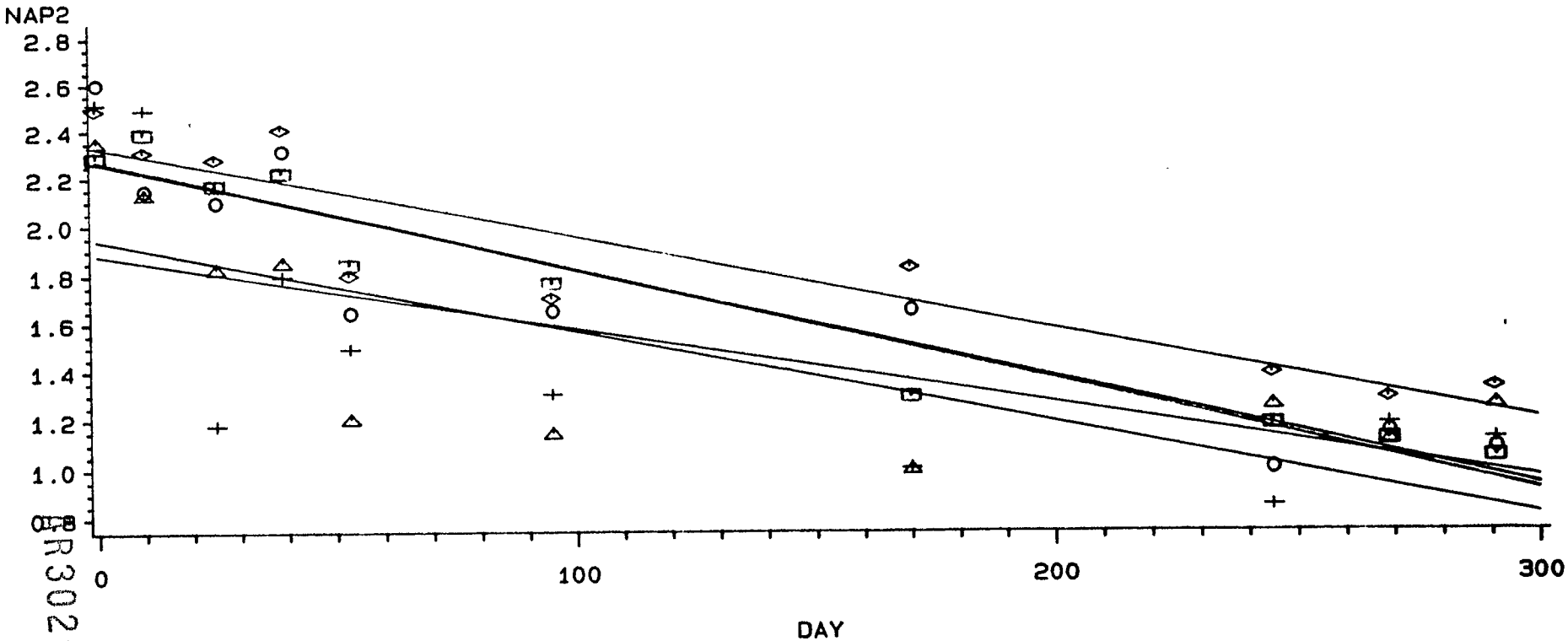
ORANGE = COMPOST 4

Significance Determined by P-Value<0.05

AR302632

Figure 8

Significant Regression Models for Log (Naphthalene)
GCL Site



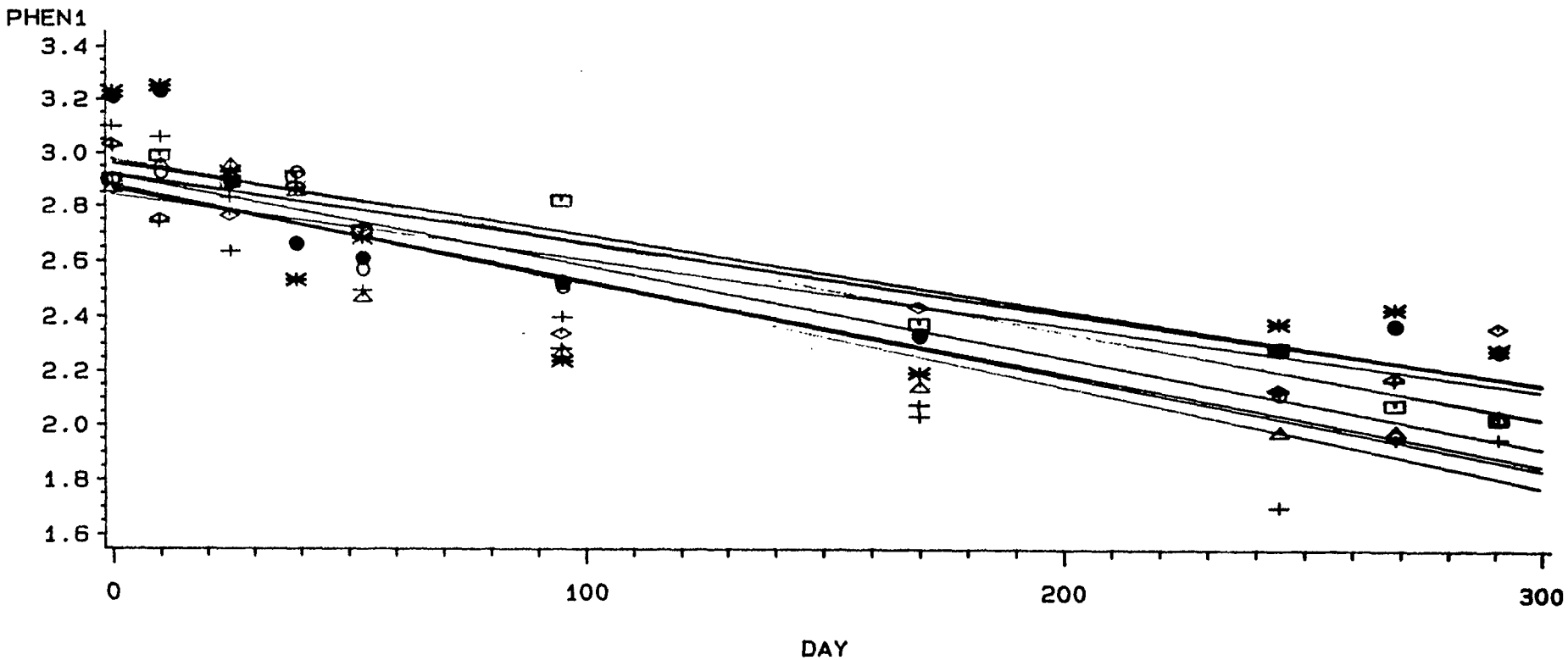
GREEN = COMPOST 2
BLUE = COMPOST 3
PURPLE = COMPOST 5
PINK = COMPOST 6
BLACK = COMPOST 8

Significance Determined by P-Value<0.05

ER302633

Figure 9

Significant Regression Models for Log (Phenanthrene)
GCL Site



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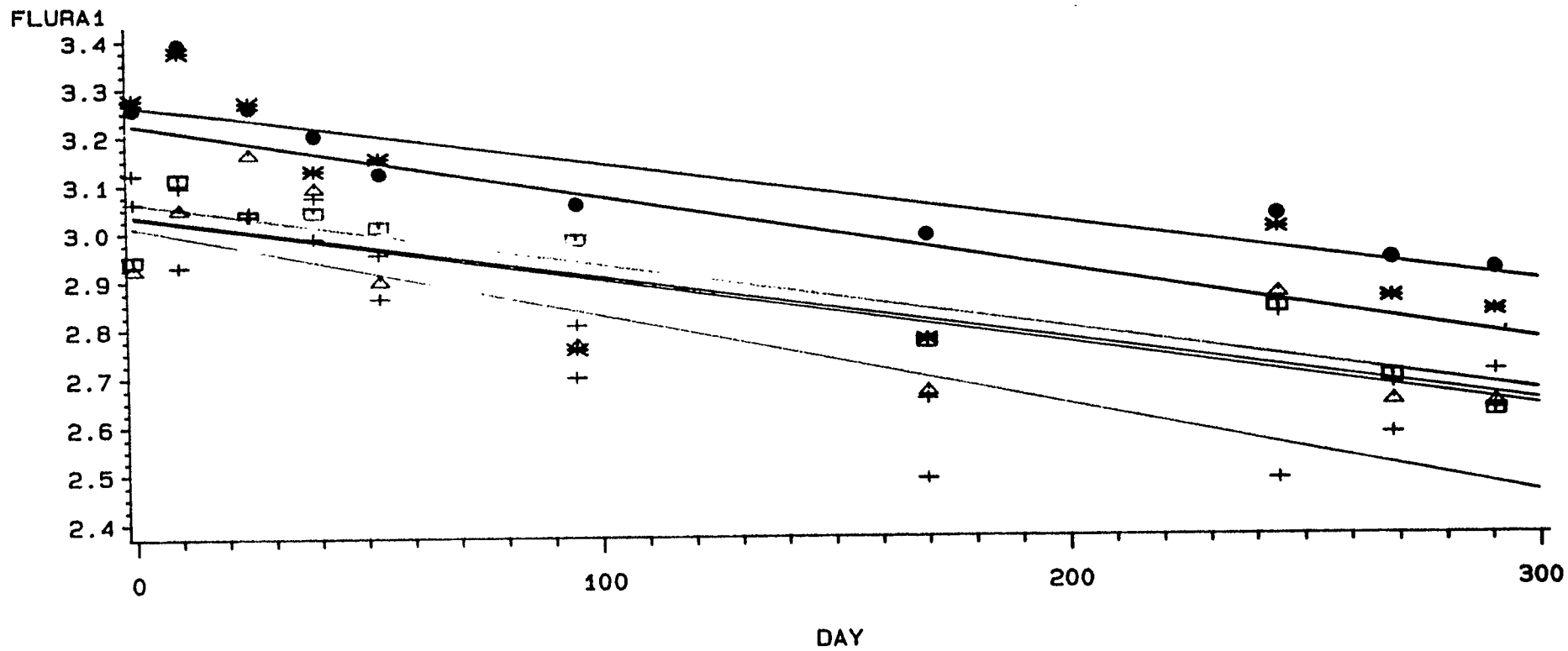
BLUE = COMPOST 3
ORANGE = COMPOST 4
PURPLE = COMPOST 5
PINK = COMPOST 6
CYAN = COMPOST 7
BLACK = COMPOST 8
Significance Determined by P-Value<0.05

AR302634

Figure 10

Significant Regression Models for Log (Fluoranthene)
GCL Site



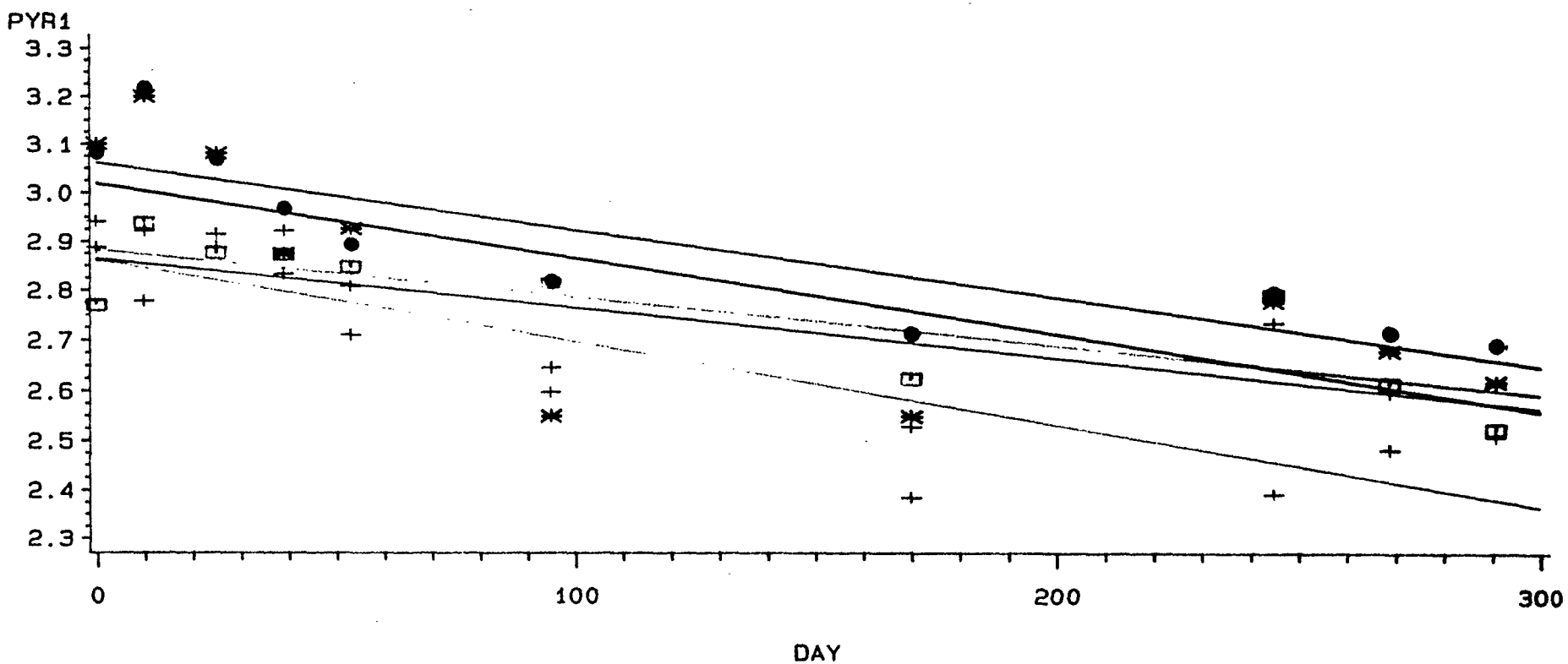
RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
ORANGE = COMPOST 4
PURPLE = COMPOST 5
CYAN = COMPOST 7

Significance Determined by P-Value<0.05

AR302635

Figure 11

Significant Regression Models for Log(Pyrene)
GCL Site



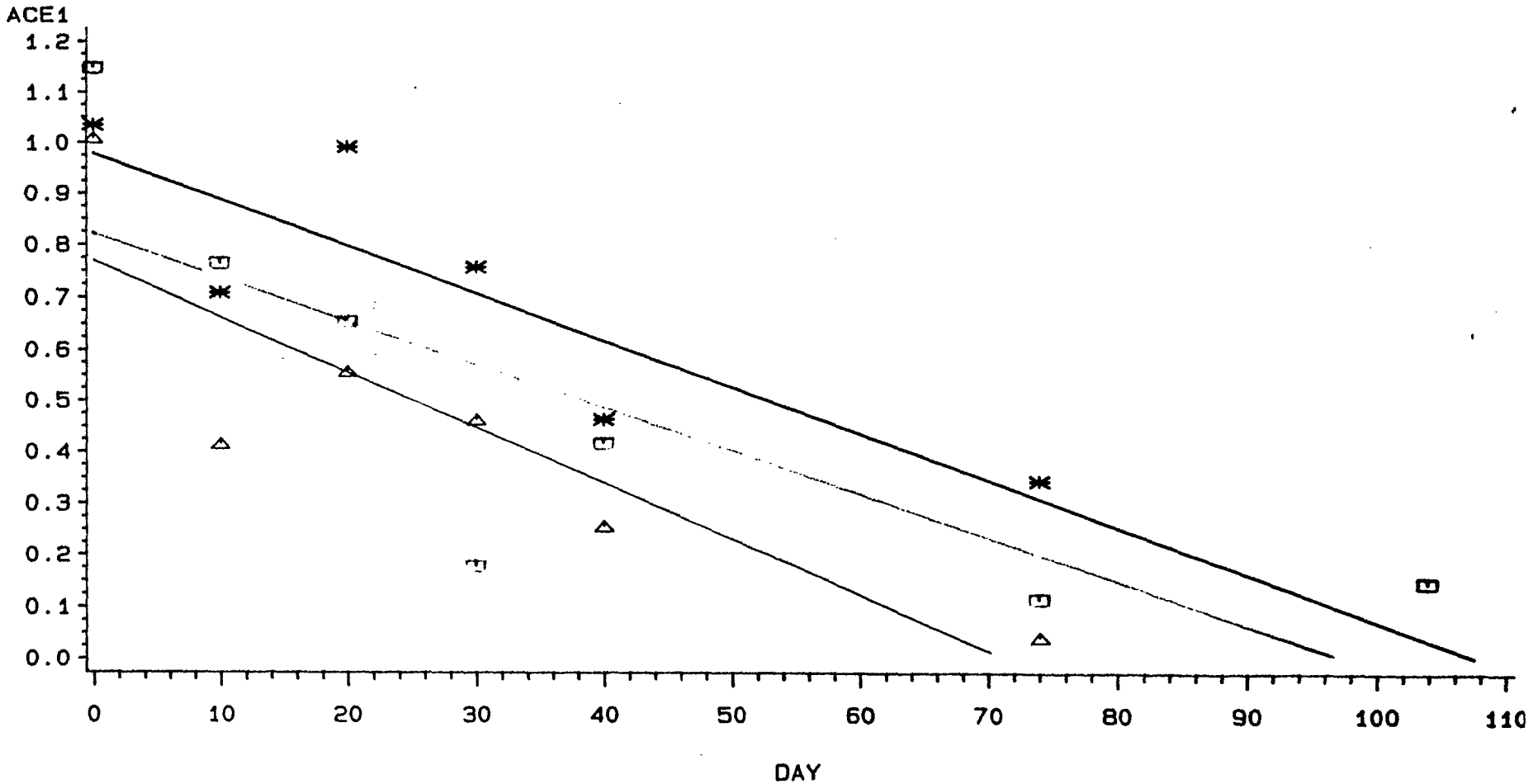
RED = COMPOST 1
GREEN = COMPOST 2
ORANGE = COMPOST 4
PURPLE = COMPOST 5
CYAN = COMPOST 7

Significance Determined by P-Value<0.05

AR302636

Figure 12

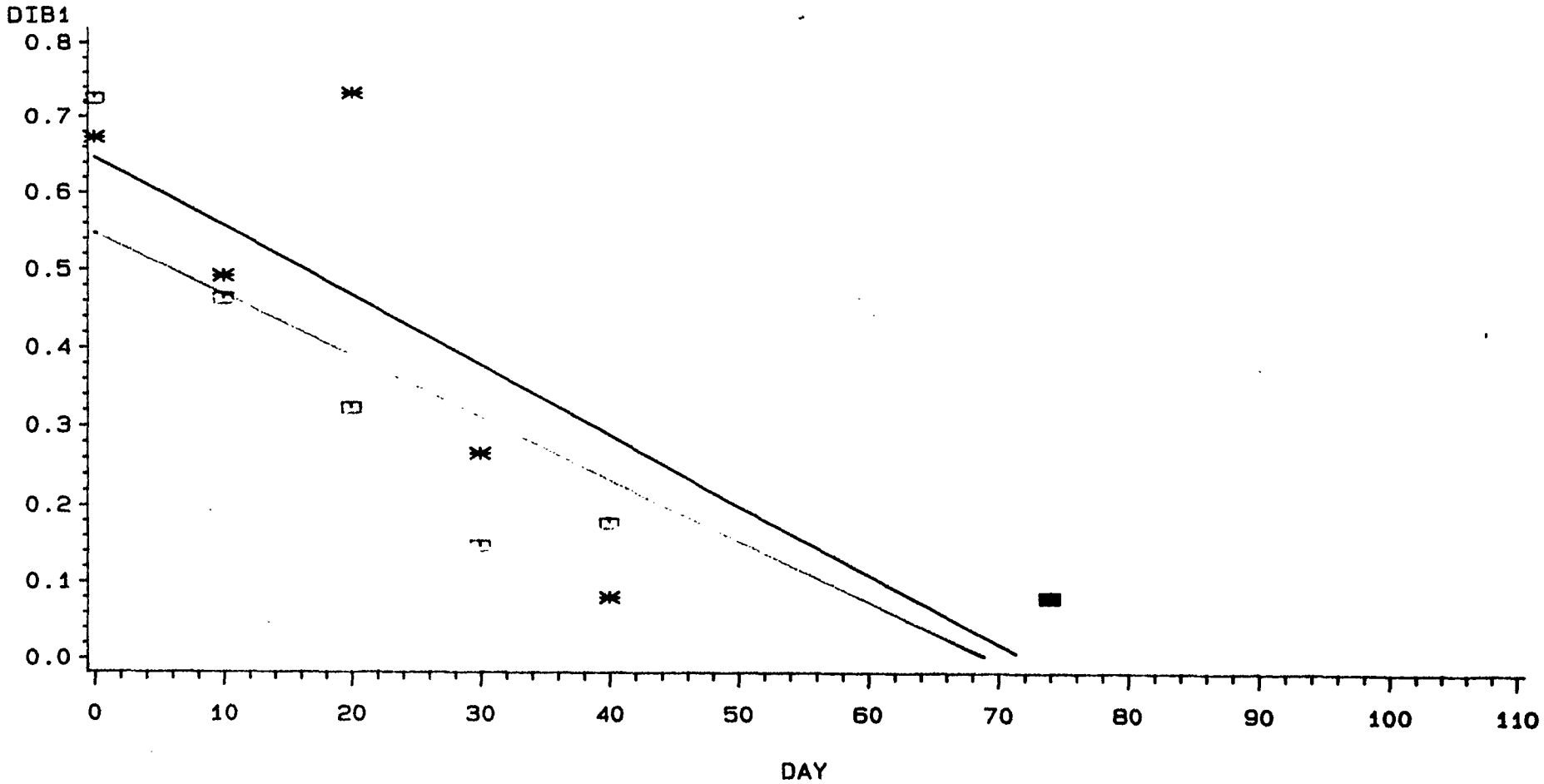
Significant Regression Models for Log(Acenaphthene + 1)
Eastern Maryland Site



RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
Significance Determined by P-Value<0.05

Figure 13

Significant Regression Models for Log(Dibenzofuran + 1)
Eastern Maryland Site



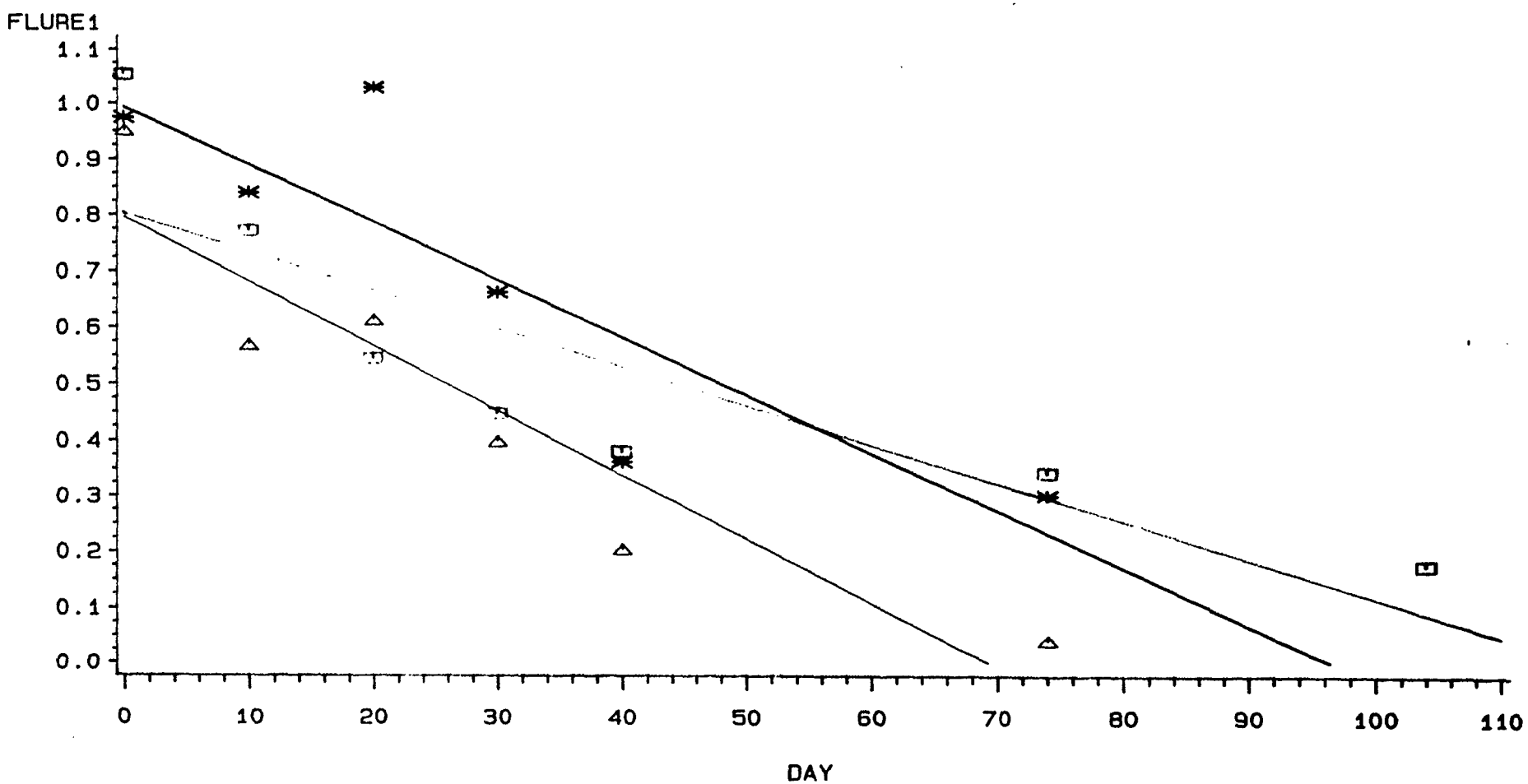
RED = COMPOST 1
GREEN = COMPOST 2

Significance Determined by P-Value<0.05

AR302638

Figure 14

Significant Regression Models for Log(Fluorene + 1)
Eastern Maryland Site

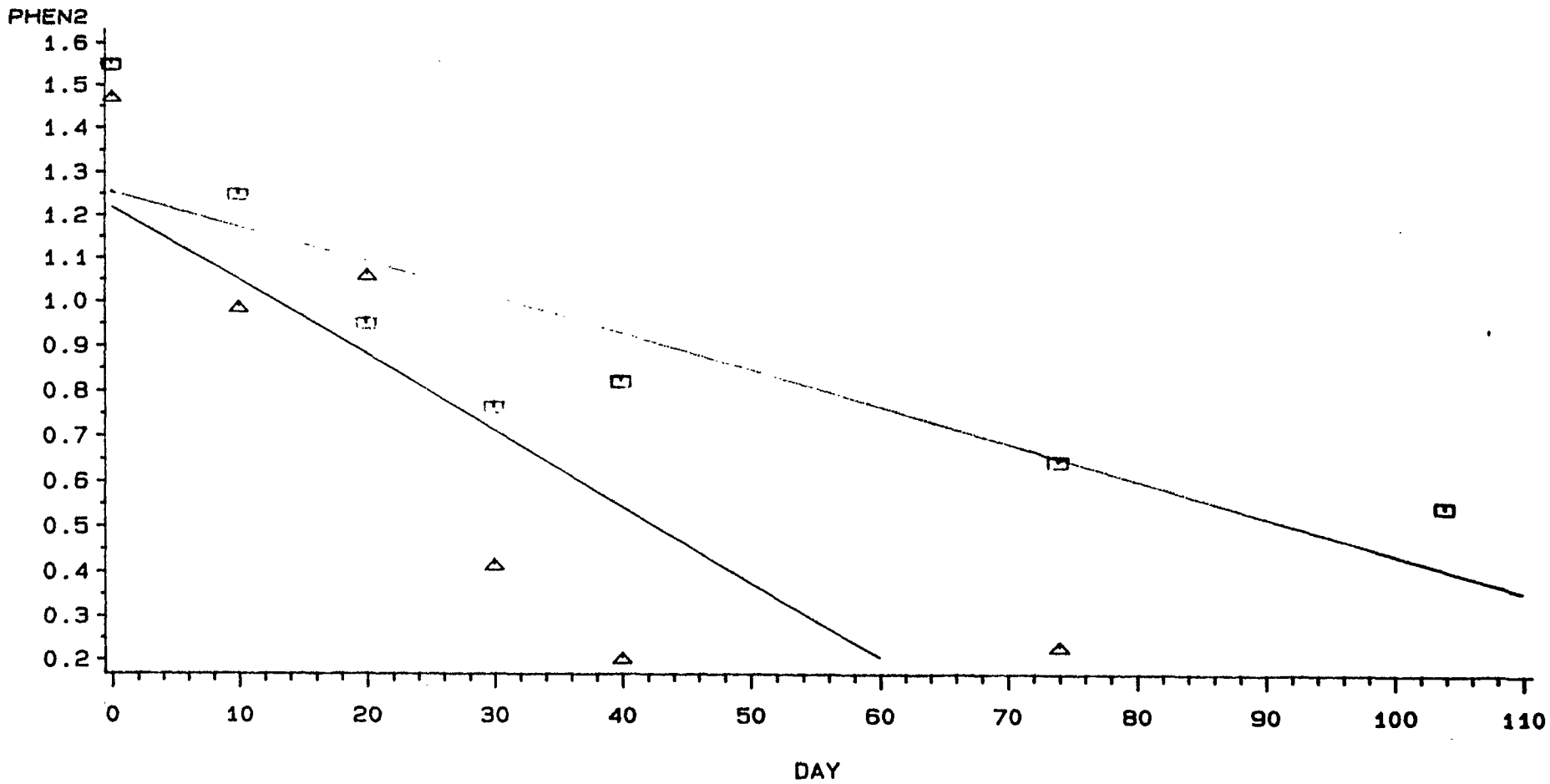


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
Significance Determined by P-Value<0.05

AR302639

Figure 15

Significant Regression Models for Log (Phenanthrene + 1)
Eastern Maryland Site



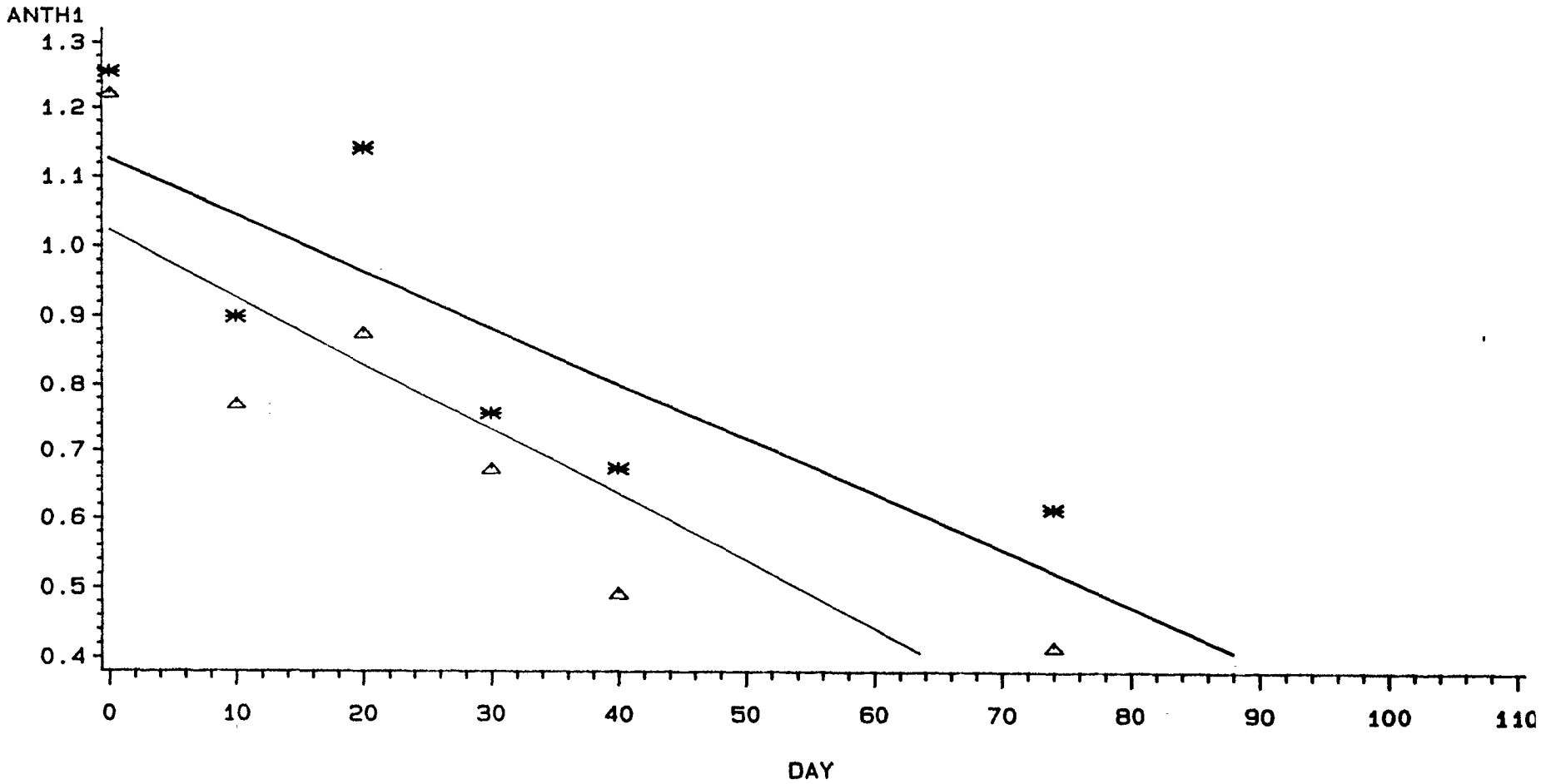
GREEN = COMPOST 2
BLUE = COMPOST 3

Significance Determined by P-Value<0.05

AR302640

Figure 16

Significant Regression Models for Log (Anthracene + 1)
Eastern Maryland Site



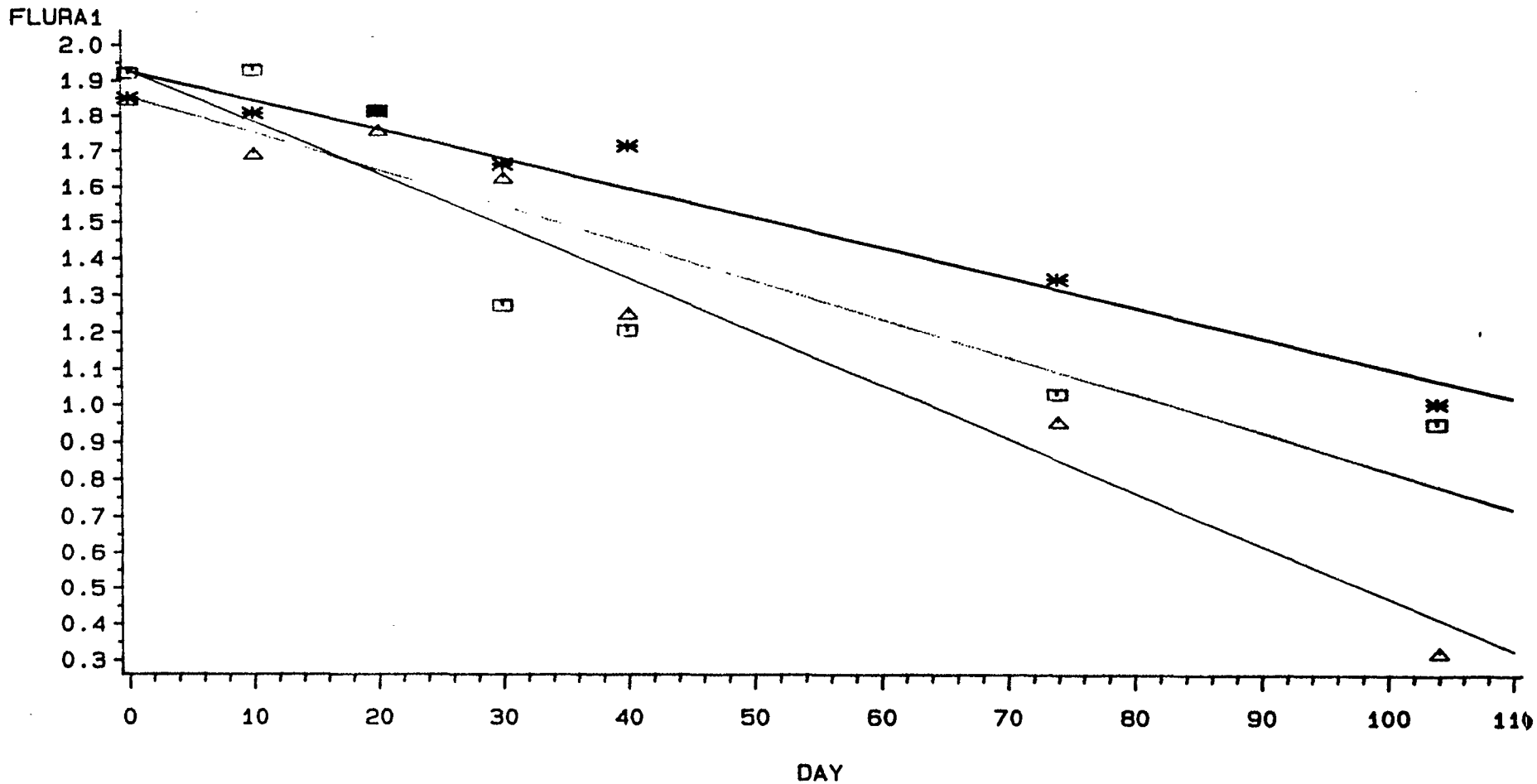
RED = COMPOST 1
BLUE = COMPOST 3

Significance Determined by P-Value<0.05

AR302641

Figure 17

Significant Regression Models for Log(Fluoranthene + 1)
Eastern Maryland Site

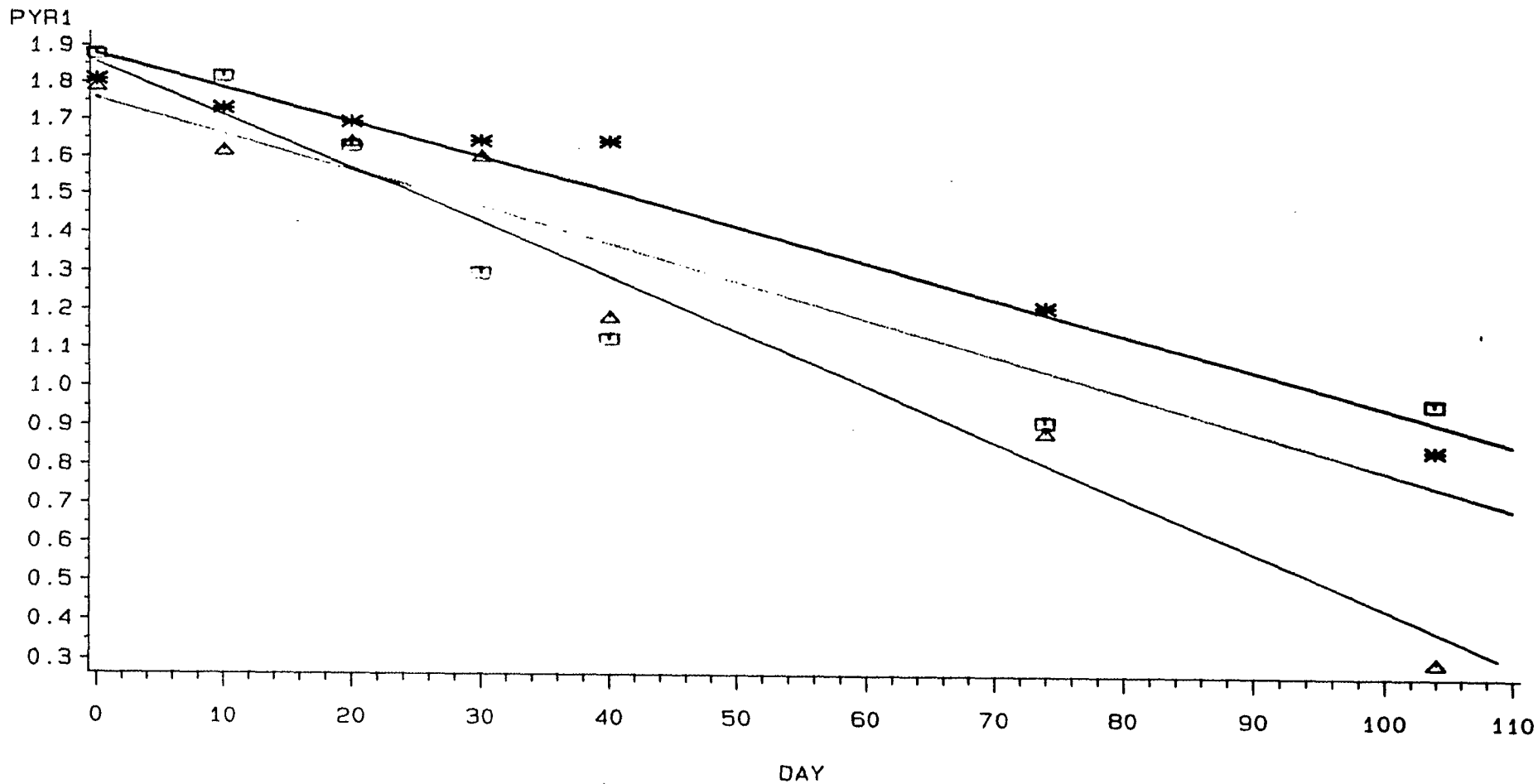


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
Significance Determined by P-Value<0.05

AR302642

Figure 18

Significant Regression Models for Log(Pyrene + 1)
Eastern Maryland Site

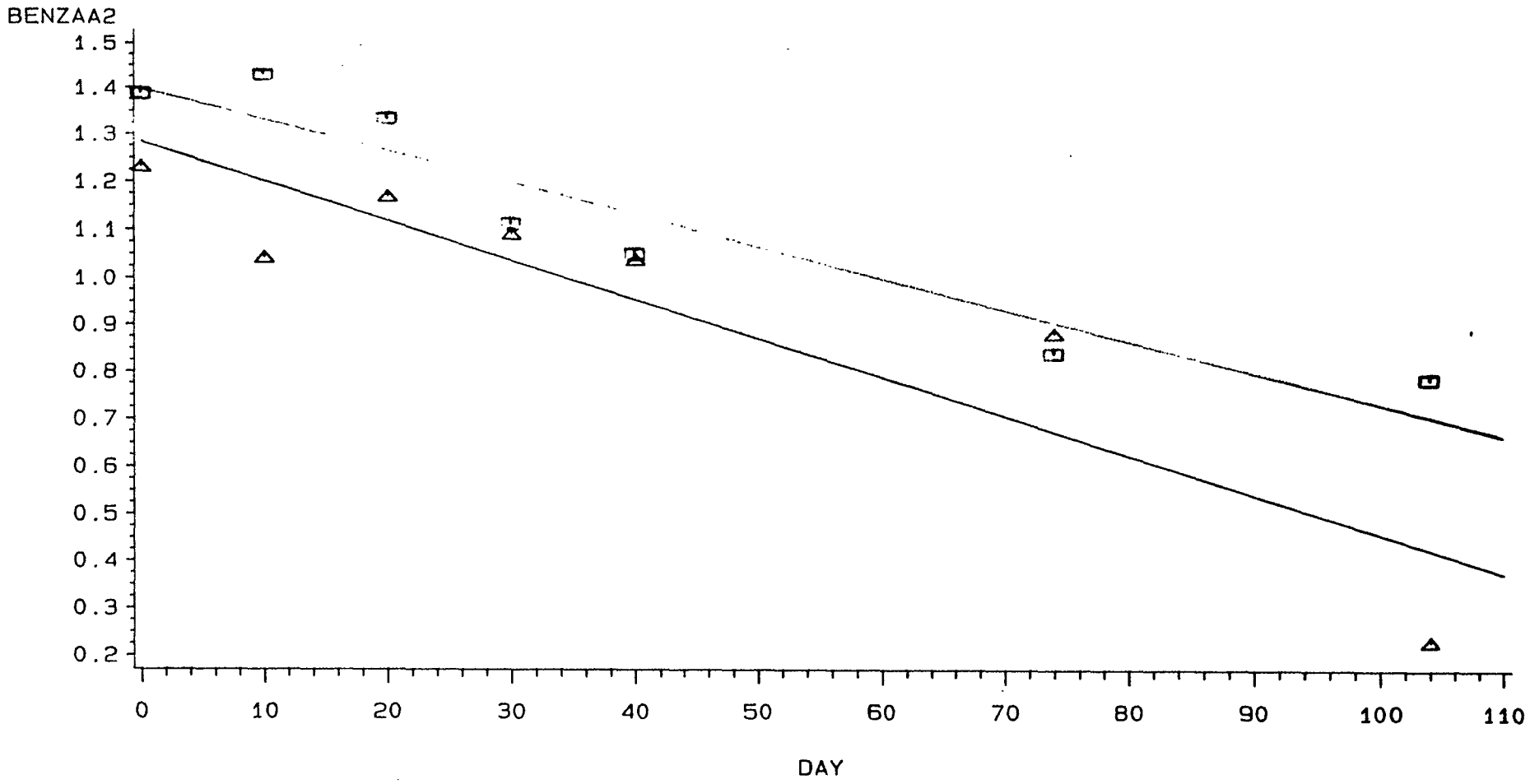


RED = COMPOST 1
GREEN = COMPOST 2
BLUE = COMPOST 3
Significance Determined by P-Value<0.05

AR302643

Figure 19

Significant Regression Models for Log (Benzo (a) Anthracene + 1)
Eastern Maryland Site



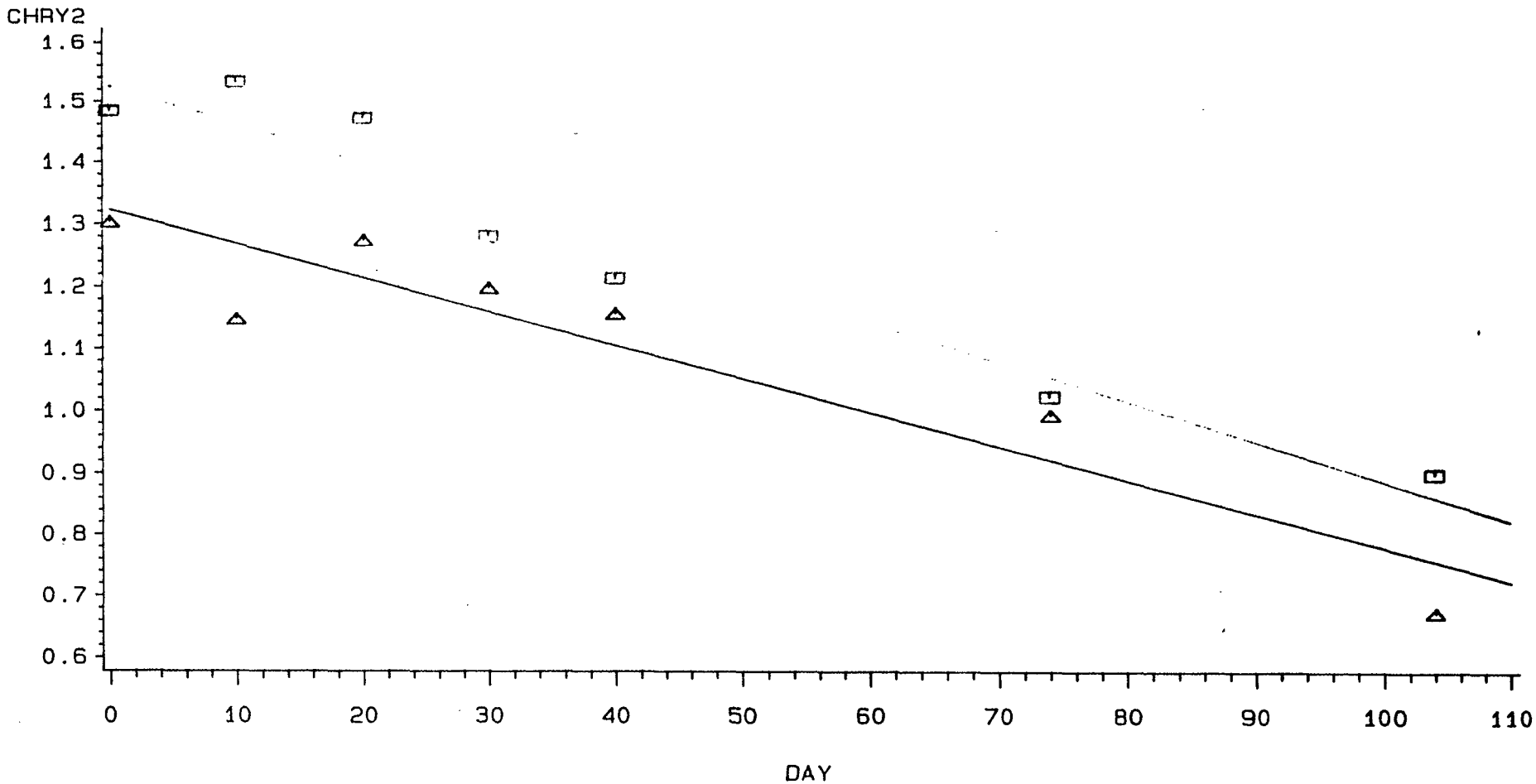
GREEN = COMPOST 2
BLUE = COMPOST 3

Significance Determined by P-Value<0.05

AR302644

Figure 20

Significant Regression Models for Log (Chrysene + 1)
Eastern Maryland Site



GREEN = COMPOST 2
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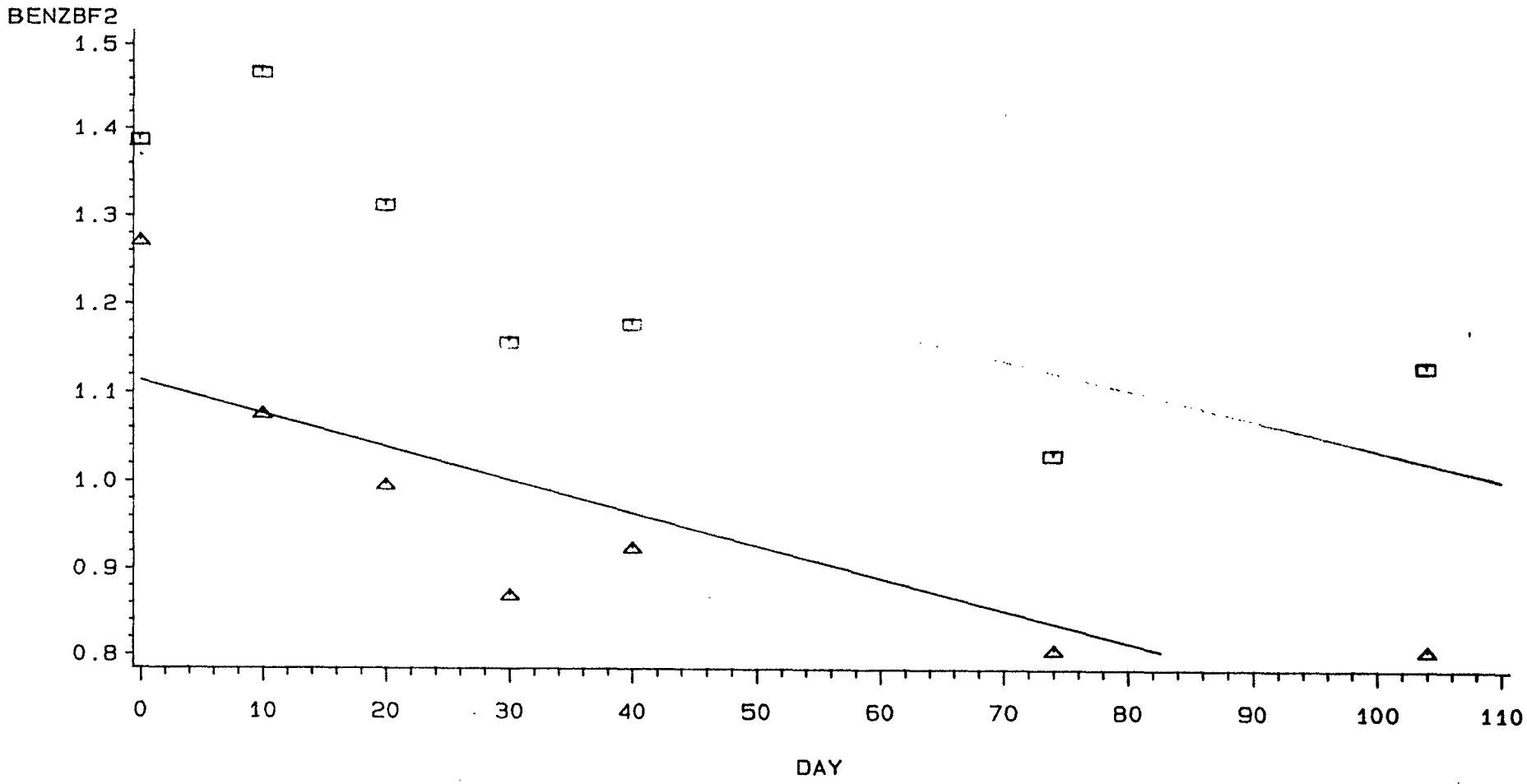
Significance Determined by P-Value<0.05

AR302645

Figure 21

Significant Regression Models for Log(Benzo(b)Fluoranthene + 1)
Eastern Maryland Site



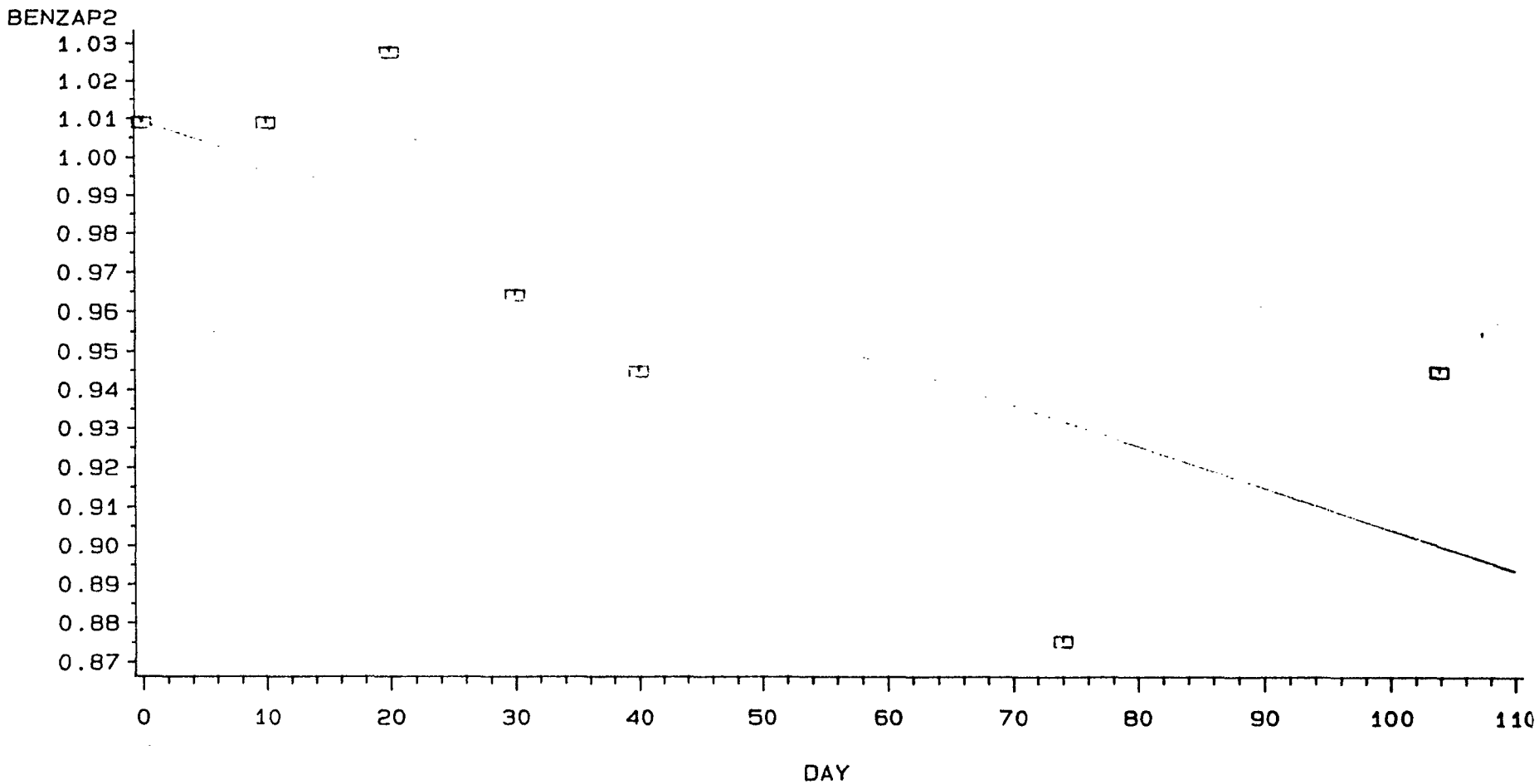
GREEN = COMPOST 2
BLUE = COMPOST 3

Significance Determined by P-Value<0.05

AR302646

Figure 22

Significant Regression Models for Log(Benzo(a)Pyrene + 1)
Eastern Maryland Site



GREEN = COMPOST 2

Significance Determined by P-Value<0.05

AR302647

APPENDIX I

Report on the Base-Catalyzed Decomposition (BCD) Studies

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

WRIGHT STATE

Wright State University
Dayton, Ohio 45435

Brehm Laboratory
513/873-2202

April 28, 1993

Ms. Mary Lee Caruso
Project Engineer
Roy F. Weston - REAC
GSA Raritan Depot - 209F
2890 Woodbridge Ave.
Edison, NJ 08837-3679

Re: Roy F. Weston, Inc. Purchase Order No. 08-83866

Dear Ms. Caruso:

Enclosed herewith is our Final Report on the results of a bench-scale treatability study which we accomplished using the Base-Catalyzed Dechlorination (BCD) process for the treatment of a pentachlorophenol (PCP) sludge sample from the Southern Maryland Woodtreating site. This study was accomplished under Roy F. Weston, Inc. Purchase Order No. 08-83866. If you have any further questions or comments regarding this report, please don't hesitate to contact us.

Under separate cover, the Wright State University Office of Financial Services will submit an invoice for this work. We look forward to the possibility of future interactions with your organization.

Sincerely,

Thomas O. Tiernan, Ph.D.
Professor of Chemistry and Director,
Toxic Contaminant Research Program

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Enclosures

FINAL REPORT

ON

BENCH-SCALE TREATABILITY STUDY USING THE BASE-CATALYZED DECHLORINATION (BCD) PROCESS FOR TREATMENT OF PENTACHLOROPHENOL (PCP) SLUDGE FROM THE SOUTHERN MARYLAND WOODTREATING SITE

ACCOMPLISHED UNDER ROY F. WESTON INC. PURCHASE ORDER NO. 08-83866

Submitted to

Ms. Mary Lee Caruso
Roy F. Weston - REAC
GSA Raritan Depot - 209F
2890 Woodbridge Avenue
Edison, NJ 08837-3679

Submitted by

Professor Thomas O. Tiernan
Wright State University
Department of Chemistry
and Toxic Contaminant Research Program
175 Brehm Laboratory
3640 Colonel Glenn Highway
Dayton, Ohio 45435

April 28, 1993

AR302650

I. INTRODUCTION

Under Purchase Order No. 08-83866 issued to Wright State University (WSU), by Roy F. Weston, Inc., the Toxic Contaminant Research Program (TCRP) Laboratory of WSU, directed by Professor Thomas O. Tiernan, has conducted a bench-scale treatability study. This treatability study was accomplished on a sample of pentachlorophenol (PCP) sludge from the Southern Maryland Woodtreating site. This sludge was reported to contain chlorophenols, polyaromatic hydrocarbons (PAH), polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF). The sludge sample treated in this study was provided to our laboratory by the U.S. EPA/Risk Reduction Engineering Laboratory (RREL), Cincinnati, Ohio.

The chemical treatment process which was evaluated in this study is the Base-Catalyzed Dechlorination (BCD) process, which was initially developed by the U.S. EPA/RREL, (Cincinnati), and which has been extensively tested and refined by Professor Thomas O. Tiernan's laboratory (TCRP) at Wright State University. The objective of the present BCD treatability study was to demonstrate complete dechlorination of the chlorinated phenols, polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) contained in the PCP sludge, hopefully reducing the concentrations of these toxic constituents to non-detectable levels, with detection limits at low parts-per-trillion levels.

The present report describes in detail the treatability test conducted in this study, including the treatment procedures and analytical methodology utilized, and the measured concentrations of the target toxic components in the starting material and in the treated products.

II. SLUDGE SAMPLE RECEIVED BY WSU FOR USE IN TREATABILITY STUDY

The PCP sludge sample from the Southern Maryland Woodtreating site which was received by our laboratory from the U.S. EPA/RREL (Cincinnati), for use in the treatability test reported herein, is described in detail in the Wright State Sample Receipt memorandum, prepared by the WSU Sample Custodian, copies of which are shown in Attachment A to this report. This memorandum shows dates of sample shipment and receipt; the assigned Wright State sample number, as well as the originating organization's sample designation; the type of sample matrix; the approximate quantity of the sample, as estimated when the sample was unpacked; the condition of the sample upon receipt; and references to the WSU Sample Logbook where the sample receipt documentation is permanently recorded. Also shown in the Sample Receipt documentation are copies of relevant Chain-

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of-Custody information, including custody forms and shipping container seals, which accompanied the sample. An aliquot of the final reaction product from BCD treatment was also shipped to TMS Laboratories, Indianapolis, Indiana, as requested by Roy F. Weston in a letter of February 1, 1993 from Mary Lee Caruso. Copies of the Chain-of-Custody documentation prepared by WSU, which accompanied this shipment, are also provided in Attachment A to this report.

III. ANALYSES OF SLUDGE SAMPLE RECEIVED FOR TREATMENT AND PRODUCTS RESULTING FROM BCD TREATMENT OF THIS SAMPLE

The analytical procedures utilized to quantitate polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in the sediment sample received and in the products resulting from BCD treatment of the sediment sample are essentially those which are described in detail in U.S. EPA Method 8280, which appears in the compilation, "Test Methods for Evaluating Solid Waste," U.S. EPA SW-846, Vol. IB, Third Edition, November, 1986. Analyses of the same samples for chlorophenols and PAH were accomplished by using a modified U.S. EPA Method 8270 which is also provided in the SW-846 compilation.

The results of the analyses of the homogenized sludge sample received from the U.S. EPA/RREL (Cincinnati) for PCDD, PCDF, chlorophenols and PAH are presented in Tables 1-4 which are shown in the Tables of Data section of this report. Table 1 shows the measured concentrations of each of the total congener groups (tetra-through octachlorinated) of the PCDD and PCDF, while Table 2 shows the measured concentrations of the 2,3,7,8-chlorine substituted isomers of these compounds (the more toxic isomers) which were found in the sludge. Table 3 shows measured concentrations of the trichlorophenols, tetrachlorophenols and pentachlorophenol, and Table 4 shows the measured concentrations of the PAH.

IV. BCD-TREATMENT TEST

Several versions of the BCD process, which utilize rather different combinations of alkaline reagents, catalysts and dispersants/carriers, have been applied by the U.S. EPA/RREL and by our laboratory for dechlorinating chemical waste. One version of the process which has been successfully implemented previously by our laboratory for treating waste oils and contaminated soils containing PCP utilizes a high-boiling hydrocarbon oil and two catalysts in combination with sodium hydroxide (NaOH). It was decided, therefore, to conduct the present treatment test using this combination of reagents. The reactor used in this test is

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shown schematically in Figure 1. As can be seen from the schematic, this reactor consists of the following components:

1. A 250 mL single-neck round bottom treatment flask fitted with a standard taper ground glass joint

2. A recycling Dean & Stark type condenser and receiver fitted with a three-way stopcock for collecting and removing or recycling the distillate

3. Heating mantles for both the top and bottom of the treatment flask and separate temperature monitors for each of the mantles

4. A stirbar in the bottom of treatment flask which is turned by a magnetic stirplate located beneath the lower heating mantle

5. A stainless-steel encased thermocouple and digital meter for monitoring the reaction mixture temperature

6. A carbon trap attached to the exit of the condenser

For the test described herein, an aliquot of the homogenized sludge (203.34g) was combined with NaOH (53.56g), a high-boiling hydrocarbon oil (LW-110, 84.52g), a solid catalyst (6.67g) and a liquid catalyst (27.81g), both proprietary to the U.S. EPA, in the reactor flask. The reactor was heated to a temperature of 320°C, during which time both aqueous and organic condensate were collected in the Dean & Stark receiver. The aqueous fraction of the condensate (24.59g) settled to the bottom of the collector and was removed via the stopcock and transferred to a separate bottle. After the reactor had been heated to the final desired temperature, this temperature (320-350°C) was maintained for a period of 16.25 hours, during which the organic condensate remaining in the Dean & Stark collector, after the aqueous fraction had been removed, was recycled slowly and continuously back into the reactor. Also during this period, an additional 1.96g of aqueous condensate was collected and removed. Upon completion of the reaction period and cooling of the reactor flask to ambient temperature, all of the organic condensate had been transferred back into the reactor flask. The residual reaction product in the flask separated into two phases, one being an apparently homogenous black liquid, constituting 46% by weight of the total reaction products. The second phase of the reaction products consisted of black, apparently organic-saturated solid particles, constituting 54% by weight of the total reaction products. Both phases of the final reaction products exhibited pH ≥10. Aliquots of both phases of the reaction products were removed from the reactor after it had cooled to ambient temperature. The solid phase was ground in a mortar to uniform particle size and portions of the solid and liquid phases were then recombined in the same proportions as found in the final reaction products. This combined sample of reaction products was

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extracted and analyzed for PCDD, PCDF, chlorophenols and PAH using the analytical methods described in Section III. of this report.

The results of analyses of the reaction product from the BCD-treatment of the sludge sample are shown in Tables 1-4. As can be seen from the data presented in Tables 1 and 2, no measurable concentrations of total PCDD/PCDF congeners or of the 2,3,7,8-substituted isomers of these could be found in the residual reaction products. In addition, as indicated by the data in Table 3, with the exception of a very small residue of one trichlorophenol isomer, no detectable chlorophenols were found in the residual reaction products. The BCD treatment appears to have little effect on the PAH present in the sludge, although some PAH show reductions. It is not clear from these results whether these compounds are being decomposed or simply removed from the sludge. Obviously, the present BCD-treatment test was highly successful in dechlorinating the PCDD, PCDF and chlorophenols present in the sludge and high destruction efficiencies were achieved for these compounds (Tables 1 and 2).

VI. SUPPORTING ANALYTICAL DATA

Additional details relating to the analytical procedures utilized in this study are provided in the Intralaboratory Sample Tracking Forms which are presented in Attachment B to this report. These forms show the quantities of each sample which were analyzed; the amounts of internal and surrogate standards which were added to the samples prior to analyses; the identities of the analysts who accomplished sample extraction and cleanup, and the GC-MS analyses; the dates of analyses; and citations to the WSU Laboratory Notebooks where the detailed analytical procedures are recorded.

The detailed GC-MS analytical data which are the basis for the results summarized in earlier sections of this report and in the Tables of Data, are provided in Attachments C and D to this report. Attachment C contains the analytical data package obtained in the PCDD/PCDF analyses, while Attachment D contains the analytical data packages for the chlorophenol and PAH analyses. Copies of the raw selected ion mass chromatograms are provided along with additional raw and reduced tabular data.

VII. CONCLUSION

The BCD-treatment tests accomplished in this study, clearly demonstrate the efficacy of this process for destroying/dechlorinating chlorophenols and PCDD/PCDF present in PCP sludge from a wood treatment facility. Obviously, this process, which is both highly effective for treatment and reasonable in terms of cost, is an excellent candidate for remediation of such wastes at sites contaminated with these. It appears that additional pilot-

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scale studies of treatment of this sediment are warranted in order to obtain data useful for scale-up of the process for full-scale application at the site.

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WRIGHT STATE UNIVERSITY REPORT OF APRIL 28, 1993
TO ROY F. WESTON

TABLES OF DATA

TABLE 1

WRIGHT STATE UNIVERSITY

RESULTS OF BENCH-SCALE BASE-CATALYZED DECHLORINATION TEST ON SLUDGE SAMPLE COLLECTED AT THE SOUTHERN MARYLAND WOODTREATING SITE

Measurement Concentrations of Total PCDD/PCDF Congener Groups

PCDD/PCDF	SAMPLE PRIOR TO TREATMENT (ng/g)	TREATED REACTION MIXTURE (ng/g)
Total TCDFs	ND (1.92)	ND (0.0168)
Total TCDDs	ND (3.23)	ND (0.0395)
Total PeCDFs	84.8	ND (0.0326)
Total PeCDDs	ND (4.29)	ND (0.0486)
Total HxCDFs	804	ND (0.0624)
Total HxCDDs	541	ND (0.107)
Total HpCDFs	5160	ND (0.216)
Total HpCDDs	8540	ND (0.322)
OCDF	5660	ND (1.04)
OCDD	43100	ND (0.888)

Treatment Summary - Total Quantities of PCDD/PCDF Congener Groups and Calculated Percent Destruction

PCDD/PCDF	Total Quantity in Sample Prior to Treatment (ng)	Total Quantity in BCD-Treated Reaction Products (ng)	Percent Destruction Achieved
Total TCDFs	ND (390)	ND (5.87)	a.
Total TCDDs	ND (657)	ND (13.8)	a.
Total PeCDFs	17200	ND (11.4)	> 99.934
Total PeCDDs	ND (872)	ND (17.0)	a.
Total HxCDFs	163000	ND (21.8)	> 99.987
Total HxCDDs	110000	ND (37.4)	> 99.966
Total HpCDFs	1050000	ND (75.5)	> 99.993
Total HpCDDs	1740000	ND (112)	> 99.994
OCDF	1150000	ND (363)	> 99.968
OCDD	8760000	ND (310)	> 99.996

a. The percent destruction was not calculated because this PCDD/PCDF congener group was not detected in the sample prior to treatment.

TABLE 2

WRIGHT STATE UNIVERSITY

RESULTS OF BENCH-SCALE BASE-CATALYZED DECHLORINATION TEST ON SLUDGE SAMPLE COLLECTED AT THE SOUTHERN MARYLAND WOODTREATING SITE

Measured Concentrations of 2,3,7,8-Chlorine Substituted PCDD/PCDF Isomers

PCDD/PCDF	Sample Prior to Treatment	Treated Reaction Mixture
2378-TCDF[a]	ND (1.92)	ND (0.0168)
2378-TCDD	ND (3.23)	ND (0.0395)
12378-PeCDF[a]	12.5	ND (0.0390)
23478-PeCDF[a]	4.46	ND (0.0279)
12378-PeCDD	ND (4.29)	ND (0.0486)
123478-HxCDF[a]	28.1	ND (0.0489)
123678-HxCDF[a]	ND (10.7)	ND (0.0916)
234678-HxCDF[a]	ND (4.57)	ND (0.0548)
123789-HxCDF[a]	ND (3.18)	ND (0.0689)
123478-HxCDD	ND (7.34)	ND (0.109)
123678-HxCDD	241	ND (0.112)
123789-HxCDD[a]	ND (19.5)	ND (0.101)
1234678-HpCDF	855	ND (0.168)
1234789-HpCDF	107	ND (0.352)
1234678-HpCDD	5510	ND (0.322)
OCDF	5660	ND (1.04)
OCDD	43100	ND (0.888)

Treatment Summary - Total Quantities of 2,3,7,8-Chlorine Substitutedd PCDD/PCDF Isomers and Calculated Percent Destruction

PCDD/PCDF	Total Quantity in Sample Prior to Treatment (ng)	Total Quantity in BCD-Treated Reaction Products (ng)	Percent Destruction Achieved
2378-TCDF[a]	ND (390)	ND (5.87)	b.
2378-TCDD	ND (657)	ND (13.8)	b.
12378-PeCDF[a]	2540	ND (13.6)	> 99.464
23478-PeCDF[a]	907	ND (9.75)	> 98.925
12378-PeCDD	ND (872)	ND (17.0)	b.
123478-HxCDF[a]	5710	ND (17.1)	> 99.701
123678-HxCDF[a]	ND (2180)	ND (32.0)	b.
234678-HxCDF[a]	ND (929)	ND (19.1)	b.
123789-HxCDF[a]	ND (647)	ND (24.1)	b.
123478-HxCDD	ND (1490)	ND (38.1)	b.
123678-HxCDD	49000	ND (39.1)	> 99.920
123789-HxCDD[a]	ND (3970)	ND (35.3)	b.
1234678-HpCDF	174000	ND (58.7)	> 99.966
1234789-HpCDF	21800	ND (122)	> 99.436
1234678-HpCDD	1120000	ND (112)	> 99.990
OCDF	1150000	ND (363)	> 99.968
OCDD	8760000	ND (310)	> 99.996

a. These isomers may be convoluted with other isomers of their congener group.

b. The percent destruction was not calculated because this PCDD/PCDF congener group was not detected in the sample prior to treatment.

TABLE 3
WRIGHT STATE UNIVERSITY

RESULTS OF BENCH-SCALE BASE-CATALYZED DECHLORINATION TEST ON SLUDGE SAMPLE COLLECTED AT THE SOUTHERN MARYLAND WOODTREATING SITE

Roy F. Weston / EPA			
Project Number: 2581A and 2581D		Phenol's	
	LB03053-1CR Lab Blank	RWA3-1ADAD Treated Sludge	RWA3-1FD Untreated Sludge
µg/g Levels			
2,4,6-Tribromophenol	1705 [93.8]	1260 [69.3]	12633 [33.1]
2,4,6-Trichlorophenol	ND (18)	485	458
2,4,5-Trichlorophenol	ND (18)	ND (18)	ND (381)
2,3,4,6-Tetrachlorophenol	ND (18)	ND (18)	ND (381)
2,3,4,5-Tetrachlorophenol	ND (18)	ND (18)	1908
Pentachlorophenol	ND (18)	ND (18)	42099

TABLE 4
WRIGHT STATE UNIVERSITY

RESULTS OF BENCH-SCALE BASE-CATALYZED DECHLORINATION TEST ON SLUDGE SAMPLE COLLECTED AT THE SOUTHERN MARYLAND WOODTREATING SITE

Roy F. Weston / EPA			
Project Number: 2581A and 2581D		PAH's	
	LB03053-1CR Lab Blank	RWA3-1ADAD Treated Sludge	RWA3-1FD Untreated Sludge
µg/g Levels			
2-Fluorobiphenyl	987 [108.6]	1038 [114.2]	17862 [93.6]
Dibromobiphenyl	678 [74.6]	823 [90.6]	15000 [78.6]
p-Terphenyl-d14	1058 [116.4]	1027 [113]	29618 [155.2]
Naphthalene	ND (18)	227	ND (343.5)
Acenaphthylene	ND (18)	ND (18)	ND (343.5)
Acenaphthene	ND (18)	220	ND (343.5)
Fluorene	ND (18)	243	ND (343.5)
Phenanthrene	ND (18)	712	1030.5
Anthracene	ND (18)	67	992.3
Fluoranthene	ND (18)	338	419.8
Pyrene	ND (18)	327	725.1
Benzo[a]anthracene	ND (18)	50	ND (343.5)
Chrysene	ND (18)	74	ND (343.5)
Benzo[b]fluoranthene	ND (18)	ND (18)	ND (343.5)
Benzo[k]fluoranthene	ND (18)	ND (18)	ND (343.5)
Benzo[a]pyrene	ND (18)	ND (18)	ND (343.5)
Benzo[e]pyrene	ND (18)	ND (18)	ND (343.5)

WRIGHT STATE UNIVERSITY REPORT OF APRIL 28, 1993
TO ROY F. WESTON

FIGURE - SCHEMATIC DIAGRAM OF BENCH-SCALE BCD REACTOR

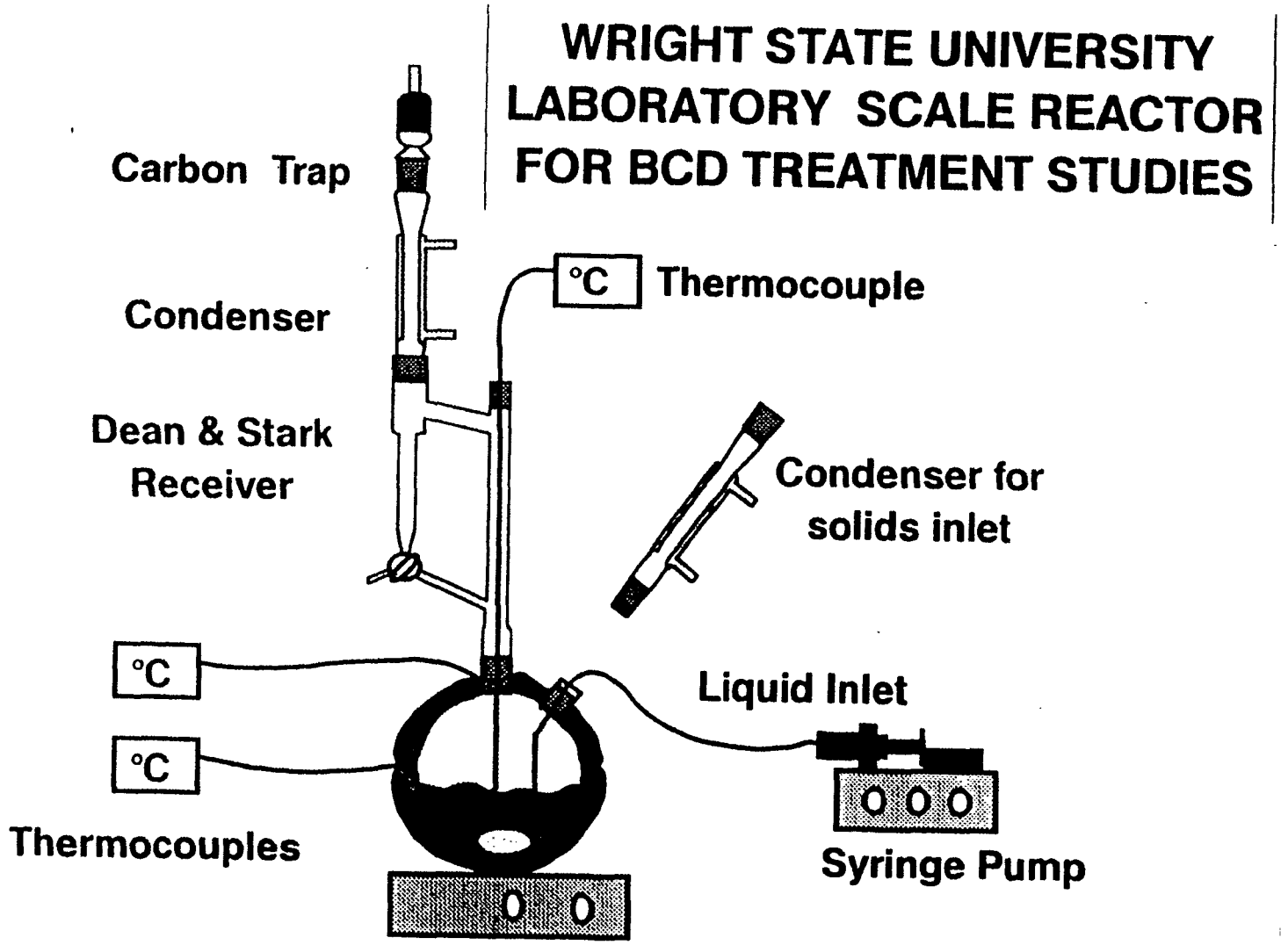


FIGURE 1

AR302662

ATTACHMENT A

TO

WRIGHT STATE UNIVERSITY REPORT OF APRIL 28, 1993
TO ROY F. WESTON

SAMPLE RECEIPT AND CHAIN-OF-CUSTODY DOCUMENTATION

Wright State University

Campus Communication

Date: 1/27/93

To: Dr. T.O. Tiernan

From: Garrett VanNess

Subject: Receipt of Samples

PROJECT: ROY F. WESTON/EPA
Received from: Charles Rogers
U.S. E.P.A.
Cincinnati, OH

Purchase Order No.:
Project No.: 2581
Date Received: 1/27/93
Date Shipped: 1/27/93
Shipped by: Federal Express to Charles Rogers

WSU I.D.: RWA3
Location: 175 Brehm Lab
Airbill No.: 296 1886 782

WSU Sample No.	Customer I.D.	Matrix	Approx. Quantity	Sample Condition
RWA3-1	TANK 9	SLUDGE	1500 g	GOOD

Chain of Custody Records Signed By: G. VANNESS
Sample Log Notebook No.: #15
No. of Samples and Matrix: 1 SLUDGE SAMPLE

Shipping Container Description: NONE, SAMPLE VESSEL WAS SHIPPING CONTAINER

Condition of container: GOOD
Type of packing Material: N/A

Type of Sample Vessel: PLASTIC BUCKET
Cond. of Sample Vessel: GOOD
Is custody seal on sample vessel? YES
Condition of seal: REMOVED INTACT

Type of Sample Identification: CHAIN OF CUSTODY FORM
Overall Condition of Samples: GOOD
Miscellaneous Comments:

Approved By: [signature] Date: 1/27/93

D:\LUCID\LOGIN\PRO2581\L2581.LCD

AR302664

Roy F. Weston, Inc.
REAC, Edison, N.J.
EPA Contract 68-03-3482

CHAIN OF CUSTODY RECORD/LAB WORK REQUEST

No: 3994

SHEET NO. 1 OF 1

Project Name: Southern MD
Project Number: 3347-33-01-4670-01
RFW Contact: M Lee Phone: 908-604-9465 Due Date:

SAMPLE IDENTFICATION / **ANALYSES REQUESTED**

Sample No.	Sampling Location	Matrix	Date Collected	Container/Preservative	*				
	Tank 9	X	1/4/93	2 1/2 gallon	✓				

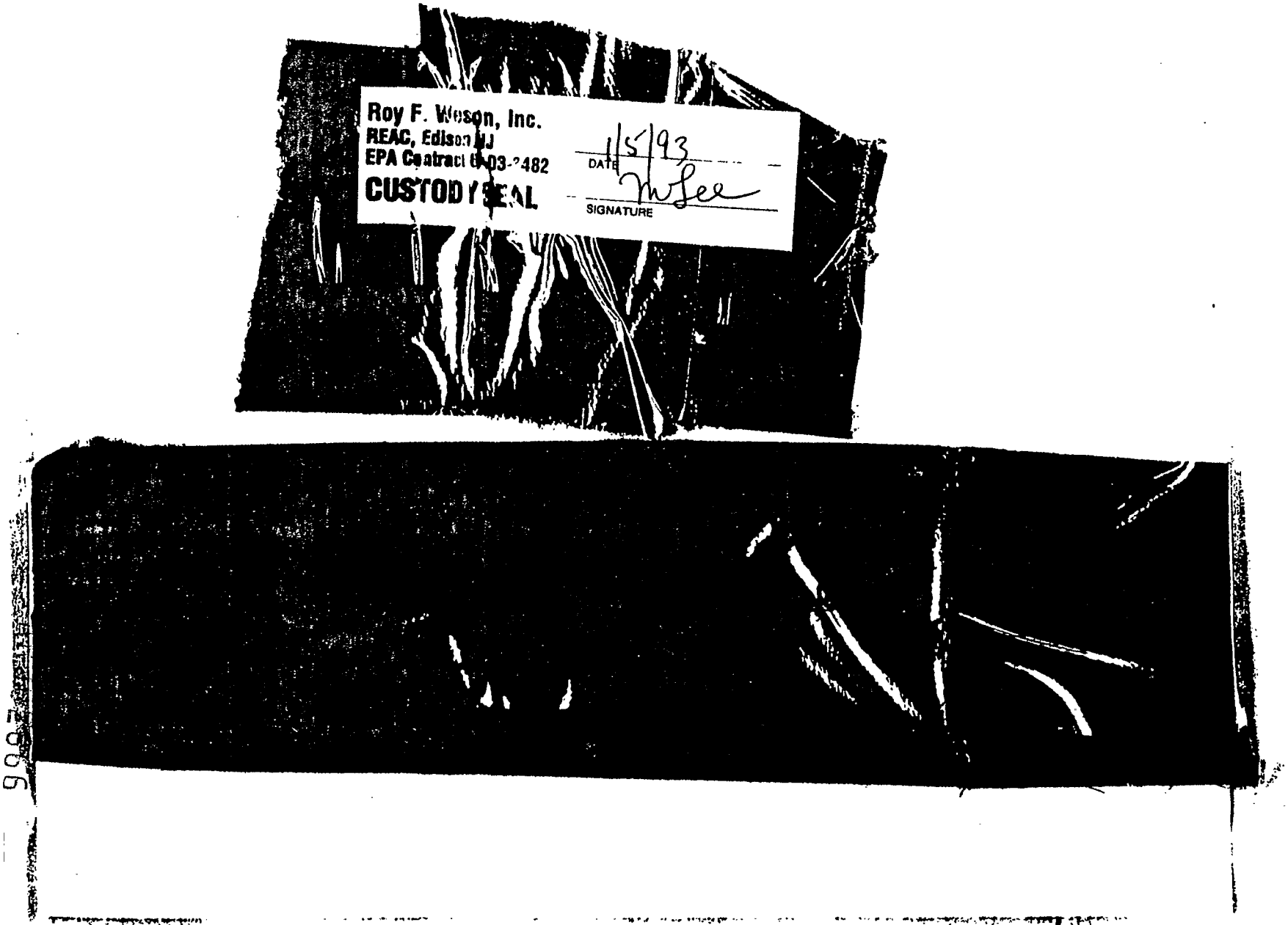
M Lee

Matrix:
S- Soil
W- Water
O- Oil
DS- Drum Solids
DL- Drum Liquids
X- Other

Special Instructions:
X = sludge * BCD treatment process.

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
—	M Lee 1/5/93	Charles Kay	1/6/93		Transfer to Lab	Charles Kay	[illegible]	1/7/93	11:30

AR302665


Roy F. Weston, Inc.
REAC, Edison NJ
EPA Contract 68-03-2482
CUSTODY SEAL
DATE 1/5/93
SIGNATURE

MEMORANDUM:

SUBJECT: Request for Base Catalyzed Dechlorination Bench Scale Project at the Southern Maryland Woodtreating Site

FROM: Harry L. Allen, PhD Harry Allen
Environmental Response Team - Alternative Technology Section

TO: Charles Rogers, PhD
Risk Reduction Engineering Laboratory

DATE: December 30, 1992

The U.S. EPA/Environmental Response Team has tasked the Response Engineering and Analytical Contract (REAC) contractor to contact the Risk Reduction Engineering Laboratory (RREL) to request its involvement in conducting a bench scale Base-Catalyzed Dechlorination (BCD) process for a sample collected from the Southern Maryland Woodtreating Site. Previous data indicates that the sample contains approximately 21,000 parts per million of pentachlorophenol.

A representative sample will be collected and sent to the RREL for treatment on about January 6, 1993. It was agreed that REAC and Wright State University will each analyze a portion of the treated sample. After the treatability test, a portion of the treated sample will be sent by RREL, directly to a subcontract laboratory, specified by REAC. The necessary paperwork (chain of custody sheets, sample documentation) will be sent to you to be filled out, prior to sending the samples for analysis. Our request is that at least a 150 gram sample be treated so that sufficient sample can be analyzed by each laboratory.

Thank you for performing this work within the desired time frame. Should you have any questions regarding the matrix, contaminants or site history, please do not hesitate to call me at FTS-340-6747.

Roy F. Weston, Inc.
REAC, Edison, N.J.
EPA Contract 68-03-3482

CHAIN OF CUSTODY RECORD/LAB WORK REQUEST

No: 5638

SHEET NO. 1 OF 1

Project Name: Southern MD
Project Number: 3347-33-01-4670-01
RFW Contact: M. Lee Phone: 908-604-9465

SAMPLE IDENTIFICATION / ANALYSES REQUESTED

REAC #	Sample No.	Sampling Location	Matrix	Date Collected	# of Bottles	Container/ Preservative				
	Env. Sample	Tank 9	SL		1	0.5L				
	NWA3-IAD	-	X		1	0.25L				
		Samples Shipped per request of: Ms Mary Lee, Roy F. Weston From: Garrett VanNess / Wright State University To: Judy Walker, CCAS/TMS								

Matrix:

SD -	Sediment	PW -	Potable Water	S -	Soil
DS -	Drum Solids	GW -	Groundwater	W -	Water
DL -	Drum Liquids	SW -	Surface Water	O -	Oil
X -	Other	SL -	Sludge	A -	Air

Special Instructions:
X = BCU Treatment Sample.

FOR SUBCONTRACTING USE ONLY
FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished By	Date	Received By	Date	Time	Items/Reason	Relinquished By	Date	Received By	Date	Time
Analysis	[signature] (WSU)	4/1/93									

AR302568

APPENDIX J

Cost Documentation Package

Southern Maryland Woodtreating Site

Hollywood, MD

February 4, 1994

WESTON
MANAGERS DESIGNERS/CONSULTANTS
GSA RARITAN DEPOT
2890 WOODBRIDGE AVENUE
BLDG. 209 ANNEX
EDISON, NJ 08837-3679
908-321-4200 • FAX: 908-494-4021

TO: Harry Allen, U.S. EPA/ERT Work Assignment Manager

THROUGH: Gary Buchanan, REAC Section Chief

FROM: Dan Crouse, REAC Task Leader

SUBJECT: Southern Maryland Woodtreating Site, Hollywood, Maryland, WA# 5-670, Revised Cost Estimates for the Remediation Options

DATE: February 4, 1994

Attached are the revised cost estimates for the remediation options for the Southern Maryland Woodtreating (SMWT) site. The following information has been incorporated into the cost estimates:

1. The fencing costs have been removed from the Option 1 - No Action.
2. Option 2 has been changed to Limited Action which includes adding the fencing and monitoring.
3. The numbering sequence of the remaining 6 options has been changed.
4. The Conceptual Estimates for Remediation Options 1 - 8 have been revised to incorporate the changes.
5. The backup information on the spread sheets have not been changed to reflect the changes. I will contact Gary Stillman to see when he can get these to me.

Copy to: Central File WA # 5-670 (w/ attachments)
W. Scott Butterfield (w/o attachments)

A:\SMP M.\

SO. MARYLA WOOD PRESERVE
SUMMARY OF CONCEPTUAL ESTIMATES

03-Feb-94

OPTION	DESCRIPTION	CAPITAL COST	OPERATING COST
1	NO ACTION	$0	$3,145,000
2	LIMITED ACTION	$9,000	$3,145,000
3	CAP & CONTAIN ENTIRE SITE	$7,809,000	$8,559,000
4	EXCAVATE, CAP & CONTAIN PARTIAL SITE AREA	$2,674,000	$8,559,000
5	EXCAVATE & TRANSPORT/DISPOSE OFF-SITE	$207,437,000	$1,615,000
6	EXC & ON-SITE HIGH TEMP. THERMAL TREATMENT	$53,358,000	$1,615,000
7	EXCAVATE & ON-SITE DESORPTION(SEAVIEW) TREATMENT	$53,890,000	$1,615,000
8A	EXC. & ON-SITE BIOLOGICAL TREATMENT-5 YRS	$24,521,000	$3,712,000
8B	EXC. & ON-SITE BIOLOGICAL TREATMENT-10 YRS	$27,173,000	$6,486,000
8C	EXC. & ON-SITE BIOLOGICAL TREATMENT-15 YRS	$29,826,000	$8,559,000

NOTES:

1. The capital costs are in 1993 dollars and exclude any escalation costs.
2. The Operating Costs are present value based on 15 years of operations for options 1,2,3, and 7C and 2 years of operations for 4,5, and 6. The assumed annual interest rate is 6%. The operations costs exclude the affect of escalation.

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SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 1 – NO ACTION			
1.0	No Work is Required	1 ls	$0	$0
	SUBTOTAL, CAPITAL COSTS			$0
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$0
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$0
	Overhead & Profit at	10.00%		$0
	Contingency on Capital Costs at	25.00%		$0
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$0**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant – Not Required			$0
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$259,000
	Contingency on Operating Costs at	25.00%		$64,800
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$323,800

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 15
Interest Percent = 6.00%

$3,145,000

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 2 – LIMITED ACTION			
1.0	Fence Repair as Required	1 ls	$5,000	$5,000
	SUBTOTAL, CAPITAL COSTS			$5,000
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$1,100
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$1,100
	Overhead & Profit at	10.00%		$500
	Contingency on Capital Costs at	25.00%		$1,300
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$9,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant – Not Required			$0
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$259,000
	Contingency on Operating Costs at	25.00%		$64,800
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$323,800

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 15
Interest Percent = 6.00%

$3,145,000

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 3 – CAP AND CONTAIN ENTIRE SITE			
1.0	Site Preparation and Capping	23 ac	$169,000	$3,887,000
2.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$4,362,200
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$959,700
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$959,700
	Overhead & Profit at	10.00%		$436,200
	Contingency on Capital Costs at	25.00%		$1,091,200
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$7,809,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250
	PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =			
	Years =	15		**$8,559,000**
	Interest Percent =	6.00%		

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS

03-Feb-94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 4 – EXACAVATE, CAP AND CONTAIN PARTIAL SITE			
1.0	Excavation & Placement	25,000 cy	$14.30	$357,500
2.0	Capping	4 ac	$165,200	$660,800
3.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$1,493,500
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$328,570
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$328,570
	Overhead & Profit at	10.00%		$149,350
	Contingency on Capital Costs at	25.00%		$374,010
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$2,674,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250
	PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =			
	Years =	15		**$8,559,000**
	Interest Percent =	6.00%		

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 5 – EXCAVATE, TRANSPORT & DISPOSAL OF MATERIAL OFFSITE			
1.0	Excavation	124,000 cy	$8.00	$992,000
2.0	Transportation & Disposal	124,000 cy	$1,192.50	$147,870,000
3.0	Backfill	124,000 cy	$7.90	$979,600
4.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$150,316,800
	Mobilization/Demobilization, Construction Management and Site Services at	3.00%		$4,509,504
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	5.00%		$7,515,840
	Overhead & Profit at	5.00%		$7,515,840
	Contingency on Capital Costs at	25.00%		$37,579,036
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$207,437,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250
	PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =			
	Years =	2		**$1,615,000**
	Interest Percent =	6.00%		

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 6 – EXCAVATE AND ONSITE HIGH TEMPERATURE THERMAL TREATMENT			
1.0	Excavation	124,000 cy	$13.20	$1,636,800
2.0	Material Prep and Feed	124,000 cy	$17.50	$2,170,000
3.0	Thermal Treatment	124,000 cy	$236.00	$29,264,000
4.0	Ash Handling & Backfill	1 ls	$2,026,000	$2,026,000
5.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$35,572,000
	Mobilization/Demobilization, Construction Management and Site Services at	5.00%		$1,778,600
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	10.00%		$3,557,200
	Overhead & Profit at	10.00%		$3,557,200
	Contingency on Capital Costs at	25.00%		$8,893,000
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$53,358,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 2 **$1,615,000**

Interest Percent = 6.00%

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 7 – EXCAVATE AND ONSITE THERMAL (SEAVIEW) DESORPTION/DISTILLATION			
1.0	Excavation	124,000 cy	$14.40	$1,785,600
2.0	Material Prep and Feed	124,000 cy	$18.60	$2,306,400
3.0	Thermal Treatment	124,000 cy	$235.00	$29,140,000
4.0	Ash Handling & Backfill	1 ls	$2,219,000	$2,219,000
5.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$35,926,200
	Mobilization/Demobilization, Construction Management and Site Services at	5.00%		$1,796,310
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	10.00%		$3,592,620
	Overhead & Profit at	10.00%		$3,592,620
	Contingency on Capital Costs at	25.00%		$8,982,250
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$53,890,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250
	PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =			
	Years =	2		**$1,615,000**
	Interest Percent =	6.00%		

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 8A – EXCAVATE/ON–SITE BIOLOGICAL TREATMENT – 5 YEARS REQUIRED			
1.0	Building of Cells	1 ls	$3,754,000	$3,754,000
2.0	Excavation of Soils	124,000 cy	$10.30	$1,277,200
3.0	Farming	1 ls	$1,658,000	$1,658,000
4.0	Handling & Backfill	1 ls	$674,000	$674,000
5.0	Site Restoration	1 ls	$4,860,000	$4,860,000
6.0	Biological Study	1 ls	$1,000,000	$1,000,000
7.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$13,698,400
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$3,013,650
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$3,013,650
	Overhead & Profit at	10.00%		$1,369,840
	Contingency on Capital Costs at	25.00%		$3,425,460
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$24,521,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 5
Interest Percent = 6.00%

$3,712,000

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 8B – EXCAVATE/ON–SITE BIOLOGICAL TREATMENT – 10 YEARS REQUIRED			
1.0	Building of Cells	1 ls	$3,754,000	$3,754,000
2.0	Excavation of Soils	124,000 cy	$10.30	$1,277,200
3.0	Farming	1 ls	$3,140,000	$3,140,000
4.0	Handling & Backfill	1 ls	$674,000	$674,000
5.0	Site Restoration	1 ls	$4,860,000	$4,860,000
6.0	Biological Study	1 ls	$1,000,000	$1,000,000
7.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$15,180,400
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$3,339,690
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$3,339,690
	Overhead & Profit at	10.00%		$1,518,040
	Contingency on Capital Costs at	25.00%		$3,795,180
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$27,173,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 10 **$6,486,000**

Interest Percent = 6.00%

SOUTHERN MARYLAND WOOD PRESERVE
CONCEPTUAL ESTIMATES FOR REMEDIATION OPTIONS 1 – 8

03–Feb–94

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL
	OPTION 8C – EXCAVATE/ON–SITE BIOLOGICAL TREATMENT – 15 YEARS REQUIRED			
1.0	Building of Cells	1 ls	$3,754,000	$3,754,000
2.0	Excavation of Soils	124,000 cy	$10.30	$1,277,200
3.0	Farming	1 ls	$4,622,000	$4,622,000
4.0	Handling & Backfill	1 ls	$674,000	$674,000
5.0	Site Restoration	1 ls	$4,860,000	$4,860,000
6.0	Biological Study	1 ls	$1,000,000	$1,000,000
7.0	Groundwater Treatment Plant	1 ls	$475,200	$475,200
	SUBTOTAL, CAPITAL COSTS			$16,662,400
	Mobilization/Demobilization, Construction Management and Site Services at	22.00%		$3,665,730
	Technology Implementation: designs, plans, specifications regulatory approval, insurance, bonds, permits at	22.00%		$3,665,730
	Overhead & Profit at	10.00%		$1,666,240
	Contingency on Capital Costs at	25.00%		$4,165,900
	TOTAL, CAPITAL COSTS (1993 COST BASIS)			**$29,826,000**
	OPERATING COSTS (ANNUAL COSTS)			
	Groundwater Treatment Plant			$446,000
	Monitor Wells Sampling/Analysis			$259,000
	SUBTOTAL, OPERATING COSTS			$705,000
	Contingency on Operating Costs at	25.00%		$176,250
	TOTAL, OPERATING COSTS – ANNUAL COSTS			$881,250

PRESENT VALUE OF OPERATING COSTS (EXCLUDING THE AFFECT OF ESCALATION) =

Years = 15
Interest Percent = 6.00%

$8,559,000

Roy F. Weston, Inc.
GSA Raritan Depot
Building 209 Annex (Bay F)
2890 Woodbridge Avenue
Edison, New Jersey 08837-3679
908-321-4200 • Fax 908-494-4021

TO: Andre Zownir, U.S. EPA/ERT Alternative Technologies Section Manager

THROUGH: Gary Buchanan, REAC Section Chief GB

FROM: Dan Crouse, REAC Task Leader Dan Crouse

SUBJECT: Southern Maryland Woodtreating Site, Hollywood, Maryland, WA# 5-670, Revised Cost Estimates for the Remediation Options

DATE: February 9, 1994

Attached are the revised cost estimates for the remediation options for the Southern Maryland Woodtreating (SMWT) site. The following information has been incorporated into the cost estimates:

1. The fencing costs have been removed from the Option 1 - No Action.
2. Option 2 has been changed to Limited Action which includes adding the fencing and monitoring.
3. The numbering sequence of the remaining 6 options has been changed.
4. The Conceptual Estimates for Remediation Options 1 - 8 have been revised to incorporate the changes.
5. The backup information on the spread sheets have been changed to reflect the remediation option numbering sequence.

Copy to: Central File WA # 5-670 (w/ attachments)
W. Scott Butterfield (w/o attachments)

SMWTMEMO.NO4

PRICED BY : MENTA/STILLMAN
APPROVED BY : STILLMAN
ESTIMATE DATE : 12/10/93

WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SUMMARY REPORT

SHEET NO : 1
JOB NO : REAC1
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	LABOR M HRS	LABOR AMOUNT	MATERIAL AMOUNT	SUB CONT AMOUNT	TOTALS
201	CAP & CONTAIN LANDFILL	7096	319330	2505030	1061680	3886040
2	OPT 3 - CAP ENTIRE SITE	7096	319330	2505030	1061680	3886040
301	EXCAVATE OUTSIDE CONTAINMENT	2352	105840	250690		356530
302	CAP & CONTAIN LANDFILL (4 AC)	1256	56520	414290	190140	660950
3	OPT 4 - EXCAVATE & CAP	3608	162360	664980	190140	1017480
401	EXCAVATE & BACKFILL OF SITE	15376	691920	1280590		1972510
402	TRANSPORT & DISPOSAL				147870000	147870000
4	OPT 5-EXCAVATE/TRANS OFFSITE	15376	691920	1280590	147870000	149842510
501	EXCAVATION	16800	756000	616200	268300	1640500
502	MATERIAL PREP/FEED	25200	1134000	970500	60000	2164500
503	THERMAL OPERATIONS			35000	29245000	29280000
504	ASH HANDLING & BACKFILLING	26280	1182600	749750	93400	2025750
5	OPT 6 - ONSITE THERMAL TRTMT	68280	3072600	2371450	29666700	35110750
601	EXCAVATION	18400	828000	676200	285300	1789500
602	MATERIAL PREP/FEED	27600	1242000	1007500	60000	2309500
603	SEAVIEW OPERATIONS			35000	29100000	29135000
604	ASH HANDLING & BACKFILLING	29400	1323000	802750	93400	2219150
6	OPT 7 - ONSITE SEAVIEW TRTMT	75400	3393000	2521450	29538700	35453150
701	BUILDING OF CELLS	1260	56710	2427000	1269900	3753610
702	EXCAVATION OF SOIL	5360	241200	550000	486000	1277200
703	FARMING ACTIVITY - 5 YEARS	22320	1004400	654000		1658400
704	BACKFILLING	10800	486000	187500		673500
705	SITE RESTORATION	3150	141750	178500	4540000	4860250
706	BIOLOGICAL TREATMENT STUDY				1000000	1000000
713	FARMING ACTIVITY - 10 YEARS	43920	1976400	1164000		3140400
723	FARMING ACTIVITY - 15 YEARS	65520	2948400	1674000		4622400
7	OPT 8 - BIOLOGICAL TRMT	152330	6854860	6835000	7295900	20985760
801	EQUIPMENT	416	18720	123600		142320

PRICED BY : MENTA/STILLMAN
APPROVED BY : STILLMAN
ESTIMATE DATE : 12/10/93

WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SUMMARY REPORT

SHEET NO : 2
JOB NO : REAC1
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	LABOR M HRS	LABOR AMOUNT	MATERIAL AMOUNT	SUB CONT AMOUNT	TOTALS
802	OTHER ITEMS				255000	255000
803	EXTRACTION SYSTEM	120	5400	17500	55000	77900
8	GROUNDWATER TREATMENT PLANT	536	24120	141100	310000	475220
901	GWTP OPERATIONS	3640	163800	195150	87000	445950
902	MONITORING WELL SAMPLING	128	5760	3700	250000	259460
9	OPERATIONS	3768	169560	198850	337000	705410
****	GRAND TOTAL	326394	14687750	16518450	216270120	247476320

PRICED BY : MENTA/STILLMAN
APPROVED BY : STILLMAN
ESTIMATE DATE : 12/10/93

WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 1
JOB NO : REAC1
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
2	OPT 3 - CAP ENTIRE SITE											
201	CAP & CONTAIN LANDFILL											
20101	INSTALL SILT FENCING	2300	LF		48	45.00	2160	1.00	2300			4460
20102	INSTALL SAFETY FENCING	2300	LF		48	45.00	2160	2.50	5750			7910
20103	LOADER/BACKHOE	6	DY					200.00	1200			1200
20110	CLEANING & GRUBBING	23	AC							2600.00	59800	59800
20115	EXTEND EXISTING WELLS	24	EA					500.00	12000			12000
20120	FINE GRADING	111320	SY		896	45.00	40320					40320
20121	GRADER	56	DY					275.00	15400			15400
20125	PLACE LOWER ZONE FILL - 8"	24862	CY		497	45.00	22370	6.00	149170			171540
20126	DOZER	21	DY					300.00	6300			6300
20127	RIDE-ON COMPACTOR	21	DY					175.00	3680			3680
20128	DUMP TRUCK	21	DY					350.00	7350			7350
20129	WATER TRUCK	21	DY					125.00	2630			2630
[illegible]	PLACE CLAY LINER - 24"	74213	CY		3562	45.00	160290	15.00	1113200			1273490
[illegible]	DOZER	148	DY					300.00	44400			44400
20132	RIDE-ON COMPACTOR	148	DY					175.00	25900			25900
20133	DUMP TRUCK	148	DY					350.00	51800			51800
20134	WATER TRUCK	148	DY					125.00	18500			18500
20135	INSTALL FLEXIBLE MEMB. LINER	111320	SY							7.50	834900	834900
20140	INSTALL GEOTEXTILES	111320	SY							1.00	111320	111320
20145	PLACE UPPER ZONE FILL - 24"	74213	CY		1488	45.00	66960	6.00	445280			512240
20146	DOZER	290	DY					300.00	87000			87000
20147	DUMP TRUCK	290	DY					350.00	101500			101500
20148	RIDE-ON COMPACTOR	290	DY					175.00	50750			50750
20149	WATER TRUCK	290	DY					125.00	36250			36250
20150	PLACE TOP SOIL - 6"	18553	CY		557	45.00	25070	10.00	185530			210600
20151	DOZER	23	DY					300.00	6900			6900
20152	DUMP TRUCK	23	DY					350.00	8050			8050
20153	GRADER	23	DY					275.00	6330			6330
20154	WATER TRUCK	23	DY					125.00	2880			2880
20155	SEEDING/MUCHING/STRAW	111320	SY							0.50	55660	55660
20160	PPE	887	MD					25.00	22180			22180
[illegible]	SURVEYOR	140	DY					600.00	84000			84000
[illegible]	H & S EQUIPMENT	220	MD					40.00	8800			8800
201	TOTAL				7096		319330		2505030		1061680	3886040

AR302685

PRICED BY : MENTA/STILLMAN
APPROVED BY : STILLMAN
ESTIMATE DATE : 12/10/93

WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 2
JOB NO : REAC1
RUN.DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
2	TOTAL				7096		319330		2505030		1061680	3886040

AR302686

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
3	OPT 4 - EXCAVATE & CAP											
301	EXCAVATE OUTSIDE CONTAINMENT											
30101	EXCAVATE & LOAD	25000	CY		672	45.00	30240					30240
30102	EXCAVATOR	42	DY					250.00	10500			10500
30110	HAULING	25000	CY		672	45.00	30240					30240
30111	TRUCK NO 1	42	DY					350.00	14700			14700
30112	TRUCK NO 2	42	DY					350.00	14700			14700
30120	BACKFILL & COMPACTION	25000	CY		1008	45.00	45360	6.00	150000			195360
30121	F.E. LOADER	25	DY					225.00	5630			5630
30122	DOZER	25	DY					300.00	7500			7500
30123	RIDE-ON COMPACTOR	25	DY					175.00	4380			4380
30124	WATER TRUCK	25	DY					125.00	3130			3130
30130	PPE	294	MD					25.00	7350			7350
30131	SURVEYOR	50	DY					600.00	30000			30000
30132	H & S EQUIPMENT	70	MD					40.00	2800			2800
301	TOTAL				2352		105840		250690			356530
302	CAP & CONTAIN LANDFILL (4 AC)											
30201	INSTALL SILT FENCING	575	LF		8	45.00	360	1.00	580			940
30202	INSTALL SAFETY FENCING	575	LF		8	45.00	360	2.50	1440			1800
30203	LOADER/BACKHOE	1	DY						200			200
30210	CLEANING & GRUBBING	4	AC							2600.00	10400	10400
30215	EXTEND EXISTING WELLS	11	EA							500.00	5500	5500
30220	FINE GRADING	19360	SY		160	45.00	7200					7200
30221	GRADER	10	DY					275.00	2750			2750
30225	PLACE LOWER ZONE FILL - 8"	4324	CY		96	45.00	4320	6.00	25940			30260
30226	DOZER	4	DY					300.00	1200			1200
30227	RIDE-ON COMPACTOR	4	DY					175.00	700			700
30228	DUMP TRUCK	4	DY					350.00	1400			1400
30229	WATER TRUCK	4	DY					125.00	500			500
30230	PLACE CLAY LINER - 24"	12907	CY		624	45.00	28080	15.00	193610			221690
30231	DOZER	26	DY					300.00	7800			7800
30232	RIDE-ON COMPACTOR	26	DY					175.00	4550			4550
30233	DUMP TRUCK	26	DY					350.00	9100			9100
30234	WATER TRUCK	26	DY					125.00	3250			3250
35	INSTALL FLEXIBLE MEMB. LINER	19360	SY							7.50	145200	145200
30240	INSTALL GEOTEXTILES	19360	SY							1.00	19360	19360

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ESTIMATE DATE : 12/10/93

WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 4
JOB NO : REAC1
RUN DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
30245	PLACE UPPER ZONE FILL - 24"	12907	CY		264	45.00	11880	6.00	77440			89320
30246	DOZER	11	DY					300.00	3300			3300
30247	DUMP TRUCK	11	DY					350.00	3850			3850
30248	RIDE-ON COMPACTOR	11	DY					175.00	1930			1930
30249	WATER TRUCK	11	DY					125.00	1380			1380
30250	PLACE TOP SOIL - 6"	3227	CY		96	45.00	4320	10.00	32270			36590
30251	DOZER	4	DY					300.00	1200			1200
30252	DUMP TRUCK	4	DY					350.00	1400			1400
30253	GRADER	4	DY					275.00	1100			1100
30254	WATER TRUCK	4	DY					125.00	500			500
30255	SEEDING/MUCHING/STRAW	19360	SY							0.50	9680	9680
30260	PPE	532	MD					25.00	13300			13300
30261	SURVEYOR	30	DY					600.00	18000			18000
30262	H & S EQUIPMENT	140	MD					40.00	5600			5600
302	TOTAL				1256		56520		414290		190140	660950
	TOTAL				3608		162360		664980		190140	1017480

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 5
JOB NO : REACT
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
4	OPT 5-EXCAVATE/TRANS OFFSITE											
401	EXCAVATE & BACKFILL OF SITE											
40101	EXCAVATE & LOAD - 5 PEOPLE	124000	CY		12400	45.00	558000					558000
40102	EXCAVATOR - 2 EACH	310	DY					334.00	103540			103540
40103	DOZERS - 2 EACH	310	DA					600.00	186000			186000
40110	BACKFILL (IMPORTED BORROW)	124000	CY		2976	45.00	133920	6.00	744000			877920
40111	F.E. LOADER	124	DY					225.00	27900			27900
40112	DOZER	124	DY					300.00	37200			37200
40113	RIDE-ON COMPACTOR	124	DY					175.00	21700			21700
40114	WATER TRUCK	124	DY					125.00	15500			15500
40120	PPE FOR EXCAVATION/LOADING	1550	MD					25.00	38750			38750
40121	SURVEYOR	160	DY					600.00	96000			96000
40122	H & S EQUIPMENT	250	MD					40.00	10000			10000
401	TOTAL				15376		691920		1280590			1972510
4[illegible]	TRANSPORT & DISPOSAL											
[illegible]	TRANSPORT	155000	TN							136.00	21080000	21080000
40202	INCINERATE	155000	TN							818.00	126790000	126790000
402	TOTAL										147870000	147870000
4	TOTAL				15376		691920		1280590		147870000	149842510

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 6
JOB NO : REAC1
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
5	OPT 6 - ONSITE THERMAL TRTMT											
501	EXCAVATION											
50101	CLEARING OF AREA	23	AC							2600.00	59800	59800
50102	ERSOSION CONTROLS	21	MO							2500.00	52500	52500
50103	EXCAVATOR	21	MO					5000.00	105000			105000
50104	DUMP TRUCKS (2 EACH)	42	MO					7000.00	294000			294000
50105	DOZERS (D-6 OR EQUIV)	21	MO					6000.00	126000			126000
50106	PERSONNEL - 4 PEOPLE FOR 50 HR/WK	21	MO	800.000	16800	45.00	756000					756000
50108	H+S PPE - EXCAVATION CREW	1680	MD					40.00	67200			67200
50109	H+S MONITORING DEVICES	600	DA					40.00	24000			24000
50110	SURVEYOR (EXC/FILL) 3DAY/WK	260	DA							600.00	156000	156000
501	TOTAL				16800		756000		616200		268300	1640500
502	MATERIAL PREP/FEED											
50201	BUILDING - 100' X 300'	1	LS						240000	60000.00	60000	300000
50202	POWER SCREEN - BUY	1	LS						130000			130000
50203	CRUSHER - BUY	1	LS						250000			250000
50204	MAINT ON SCREEN/CRUSHER	21	MO					3000.00	63000			63000
[illegible]	FUEL COSTS FOR EQUIP	21	MO					500.00	10500			10500
50206	LOADER TO HOPPER	21	MO					4500.00	94500			94500
50207	DOZER FOR STOCKPILE MAINT	21	MO					4500.00	94500			94500
50208	MAT'L PREP LABOR (60HR/WK)	21	MO	480.000	10080	45.00	453600					453600
50209	LOADER OPERATOR -24HR/DAY	21	MO	720.000	15120	45.00	680400					680400
50210	H+S LEVEL C - PREP/FEED	2200	MD					40.00	88000			88000
502	TOTAL				25200		1134000		970500		60000	2164500
503	THERMAL OPERATIONS											
50301	PLAN WRITING	1	LS							350000.00	350000	350000
50302	MOBILIZATION/START UP	1	LS							2800000.00	2800000	2800000
50303	SHAKEDOWN & TRIAL BURN	1	LS							1400000.00	1400000	1400000
50304	OPERATIONS	155000	TN							145.00	22475000	22475000
50305	DEMOBILIZATION	1	LS							720000.00	720000	720000
50306	ON-SITE LABORATORY]	600	DA						35000	2500.00	1500000	1535000
503	TOTAL								35000		29245000	29280000
504	ASH HANDLING & BACKFILLING											
50401	ASH STORAGE BLDG 100'X240'	1	LS						200000	50000.00	50000	250000
50402	INTERIOR BINS/WORK	1	LS							25000.00	25000	25000
50403	ASH FRONT END LOADER	21	MO					4500.00	94500			94500
[illegible]	ASH OPERTOR - 24HR/DAY	570	DA	24.000	13680	45.00	615600					615600
50405	FE LOADER FOR BACKFILL	21	MO					4500.00	94500			94500
50406	DUMP TRUCK FOR ASH	21	MO					7000.00	147000			147000
50407	DOZER FOR ASH BACKFILL	21	MO					6000.00	126000			126000

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 7
JOB NO : REAC1
RUN DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
50408	COMPACTOR	21	MO					3500.00	73500			73500
50409	BACKFILL PERSONNEL 50HR/WK	21	MO	600.000	12600	45.00	567000					567000
50410	PPE - LEVEL D - ASH ONLY	570	MD					25.00	14250			14250
50411	LANDSCAPING/SEEDING	23	AC							800.00	18400	18400
504	TOTAL				26280		1182600		749750		93400	2025750
5	TOTAL				68280		3072600		2371450		29666700	35110750

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 8
JOB NO : REAC1
RUN DATE : 02/08/94

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
6	OPT 7 - ONSITE SEAVIEW TRTMT											
601	EXCAVATION											
60101	CLEARING OF AREA	23	AC							2600.00	59800	59800
60102	ERSOSION CONTROLS	23	MO							2500.00	57500	57500
60103	EXCAVATOR	23	MO					5000.00	115000			115000
60104	DUMP TRUCKS (2 EACH)	46	MO					7000.00	322000			322000
60105	DOZERS (D-6 OR EQUIV)	23	MO					6000.00	138000			138000
60106	PERSONNEL - 4 PEOPLE FOR 50 HR/WK	23	MO	800.000	18400	45.00	828000					828000
60108	H+S PPE - EXCAVATION CREW	1840	MD					40.00	73600			73600
60109	H+S MONITORING DEVICES	690	DA					40.00	27600			27600
60110	SURVEYOR (EXC/FILL) 3DAY/WK	280	DA							600.00	168000	168000
601	TOTAL				18400		828000		676200		285300	1789500
602	MATERIAL PREP/FEED											
60201	BUILDING - 100' X 300'	1	LS						240000	60000.00	60000	300000
60202	POWER SCREEN - BUY	1	LS						130000			130000
60203	CRUSHER - BUY	1	LS						250000			250000
[illegible]	MAINT ON SCREEN/CRUSHER	23	MO					3000.00	69000			69000
[illegible]	FUEL COSTS FOR EQUIP	23	MO					500.00	11500			11500
60206	LOADER TO HOPPER	23	MO					4500.00	103500			103500
60207	DOZER FOR STOCKPILE MAINT	23	MO					4500.00	103500			103500
60208	MAT'L PREP LABOR (60HR/WK)	23	MO	480.000	11040	45.00	496800					496800
60209	LOADER OPERATOR -24HR/DAY	23	MO	720.000	16560	45.00	745200					745200
60210	H+S LEVEL C - PREP/FEED	2500	MD					40.00	100000			100000
602	TOTAL				27600		1242000		1007500		60000	2309500
603	SEAVIEW OPERATIONS											
60301	PLAN WRITING	1	LS							350000.00	350000	350000
60304	OPERATIONS	155000	TN							175.00	27125000	27125000
60306	ON-SITE LABORATORY]	650	DA						35000	2500.00	1625000	1660000
603	TOTAL								35000		29100000	29135000
604	ASH HANDLING & BACKFILLING											
60401	ASH STORAGE BLDG 100'X240'	1	LS						200000	50000.00	50000	250000
60402	INTERIOR BINS/WORK	1	LS							25000.00	25000	25000
60403	ASH FRONT END LOADER	23	MO					4500.00	103500			103500
60404	ASH OPERTOR - 24HR/DAY	650	DA	24.000	15600	45.00	702000					702000
60405	FE LOADER FOR BACKFILL	23	MO					4500.00	103500			103500
[illegible]6	DUMP TRUCKS FOR ASH	23	MO					7000.00	161000			161000
[illegible]7	DOZER FOR ASH BACKFILL	23	MO					6000.00	138000			138000
60408	COMPACTOR	23	MO					3500.00	80500			80500
60409	BACKFILL PERSONNEL 50HR/WK	23	MO	600.000	13800	45.00	621000					621000
60410	PPE - LEVEL D - ASH ONLY	650	MD					25.00	16250			16250

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 9
JOB NO : REAC1
RUN DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
60411	LANDSCAPING/SEEDING	23	AC							800.00	18400	18400
604	TOTAL				29400		1323000		802750		93400	2219150
6	TOTAL				75400		3393000		2521450		29538700	35453150

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
7	OPT 8 - BIOLOGICAL TRMT											
701	BUILDING OF CELLS											
70101	BUY 8 100'X300' BLDGS	8	EA					240000.00	1920000	60000.00	480000	2400000
70102	INSTALL CLAY LINER	18000	CY	0.035	630	45.00	28350	15.00	270000			298350
70103	2 GOETEXT 1 MEMBRANE LINER	27000	SY							9.50	256500	256500
70104	GRAVEL - 12"	9000	CY	0.035	315	45.00	14180	12.00	108000			122180
701041	GEOTEXTILE LAYER	27000	SY							1.00	27000	27000
70105	SAND LAYER - 12"	9000	CY	0.035	315	45.00	14180	8.00	72000			86180
70106	SLOTTED 4" PIPE	7200	LF							11.00	79200	79200
70107	6" SOLID PIPE	7200	LF							16.00	115200	115200
70108	COLLECTION TANKS	16	EA							12000.00	192000	192000
70109	IRRIGATION SYSTEM	240000	SF							0.50	120000	120000
70110	DOZERS - 2 EACH	6	MO					6000.00	36000			36000
70111	COMPACTORS - 2 EACH	6	MO					3500.00	21000			21000
701	TOTAL				1260		56710		2427000		1269900	3753610
702	EXCAVATION OF SOIL (DURATIONS SHOWN ARE FOR 5 EXCAVATIONS 1/BATCH)											
	EXCAVATOR	5	MO					5000.00	25000			25000
70202	TRUCK - 2 EACH	10	MO					7000.00	70000			70000
70203	DOZERS 2 EACH	10	MO					6000.00	60000			60000
70204	PERSONNEL - 5 EACH	5	MO	1000.000	5000	45.00	225000					225000
70206	PPE - LEVEL C	500	MD					40.00	20000			20000
70207	SHEETPILING AS REQ'D	30000	SF							15.00	450000	450000
70208	INITIAL BACKFILL MATERIAL	25000	CY		360	45.00	16200	8.00	200000			216200
70209	SURVEYING	60	DA							600.00	36000	36000
70210	POWER SCREEN (INCL MOB/DEM)	5	MO					15000.00	75000			75000
70211	CRUSHER (INCL MOB/DEM)	5	MO					20000.00	100000			100000
702	TOTAL				5360		241200		550000		486000	1277200
703	FARMING ACTIVITY - 5 YEARS											
70301	TRACTOR/TILLER - PROCURE	2	EA					25000.00	50000			50000
70302	TRACTOR/TILLER MAINT	60	MO					1500.00	90000			90000
70303	TRACTOR/TILLER FUEL	60	MO					2000.00	120000			120000
70304	PERSONNEL - 2 EACH -40HR/WK	270	WK	80.000	21600	45.00	972000					972000
70305	PPE - LEVEL C	2500	MD					40.00	100000			100000
70306	UTILITIES/SUPPLIES	60	MO					2500.00	150000			150000
70307	ADDL SAND EACH BATCH-TOTAL	18000	CY	0.040	720	45.00	32400	8.00	144000			176400
703	TOTAL				22320		1004400		654000			1658400

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
704	BACKFILLING											
70401	DOZER (3 EACH)	15	MO					6000.00	90000			90000
70402	FRONT END LOADERS - 2 EACH	10	MO					4500.00	45000			45000
70403	DUMP TRUCKS - 3 EACH	5	MO					7000.00	35000			35000
70404	COMPACTOR	5	MO					3500.00	17500			17500
70405	PERSONNEL - 9 @ 60 HR/WK	5	MO	2160.000	10800	45.00	486000					486000
704	TOTAL				10800		486000		187500			673500
705	SITE RESTORATION											
70501	DECON & REMOVAL OF BLDGS	8	EA	240.000	1920	45.00	86400	5000.00	40000			126400
70502	DISPOSAL OF BLDGS	8	EA							5000.00	40000	40000
70503	REMOVAL OF SAND/GRAVEL	18000	CY		800	45.00	36000					36000
70504	DOZERS -2 EACH	2	MO					6000.00	12000			12000
70505	FE LOADERS 2 EACH	2	MO					4500.00	9000			9000
70506	TRANSPORT & DISPOSAL	18000	CY							250.00	4500000	4500000
70507	BACKFILL OF AREA	18000	CY		430	45.00	19350	6.00	108000			127350
70508	DOZER FOR BACKFILL	1	MO						6000			6000
70509	COMPACTOR	1	MO						3500			3500
[illegible]	TOTAL				3150		141750		178500		4540000	4860250
706	BIOLOGICAL TREATMENT STUDY											
70601	ENGINEERING COSTS	1	LS							750000.00	750000	750000
70602	BENCH SCALE TESTS	1	LS							150000.00	150000	150000
70603	ON-SITE SAMPLING	1	LS							100000.00	100000	100000
706	TOTAL										1000000	1000000
713	FARMING ACTIVITY - 10 YEARS											
71301	TRACTOR/TILLER - PROCURE	4	EA					25000.00	100000			100000
71302	TRACTOR/TILLER MAINT	120	MO					1500.00	180000			180000
71303	TRACTOR/TILLER FUEL	120	MO					2000.00	240000			240000
71304	PERSONNEL - 2 EACH -40HR/WK	540	WK	80.000	43200	45.00	1944000					1944000
71305	PPE - LEVEL C	5000	MD					40.00	200000			200000
71306	UTILITIES/SUPPLIES	120	MO					2500.00	300000			300000
71307	ADDL SAND EACH BATCH-TOTAL	18000	CY	0.040	720	45.00	32400	8.00	144000			176400
713	TOTAL				43920		1976400		1164000			3140400
723	FARMING ACTIVITY - 15 YEARS											
72301	TRACTOR/TILLER - PROCURE	6	EA					25000.00	150000			150000
[illegible]02	TRACTOR/TILLER MAINT	180	MO					1500.00	270000			270000
[illegible]3	TRACTOR/TILLER FUEL	180	MO					2000.00	360000			360000
72304	PERSONNEL - 2 EACH -40HR/WK	810	WK	80.000	64800	45.00	2916000					2916000
72305	PPE - LEVEL C	7500	MD					40.00	300000			300000
72306	UTILITIES/SUPPLIES	180	MO					2500.00	450000			450000

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 13
JOB NO : REAC1
RUN DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
72307	ADDL SAND EACH BATCH-TOTAL	18000	CY	0.040	720	45.00	32400	8.00	144000			176400
723	TOTAL				65520		2948400		1674000			4622400
7	TOTAL				152330		6854860		6835000		7295900	20985760

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WESTON CONCEPTUAL ESTIMATE
SO. MARYLAND WOOD TREAT
FFS REMEDIATION ALTERNATIVES

SHEET NO : 13
JOB NO : REACT
RUN DATE : 02/08/94

UNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
8	GROUNDWATER TREATMENT PLANT											
801	EQUIPMENT											
80101	EQUAL TANK	1	EA		48	45.00	2160		12000			14160
80102	FLOCCULATOR/CLARIFIER	1	EA		80	45.00	3600		32700			36300
80103	DYNASAND FILTER	1	EA		32	45.00	1440		22900			24340
80104	CARBON UNITS	2	EA	16.000	32	45.00	1440	6000.00	12000			13440
80105	DISCHARGE TANK	1	EA		16	45.00	720		8000			8720
80106	PRODUCT TANK	1	EA		16	45.00	720		8000			8720
80107	PUMPS - ALL TYPES	8	EA	24.000	192	45.00	8640	3500.00	28000			36640
801	TOTAL				416		18720		123600			142320
802	OTHER ITEMS											
80201	BUILDING 30 X 50	1500	SF							60.00	90000	90000
80202	ELECTRICAL TIE -INS	1	LS							5000.00	5000	5000
80203	ELECTRICAL EQUIP/MAT'LS	1	LS							30000.00	30000	30000
80204	PIPING - INSIDE BLDG	1	LS							25000.00	25000	25000
80205	CONTROL SYSTEM	1	LS							60000.00	60000	60000
80206	INSTRUMENTS/WIRING	1	LS							20000.00	20000	20000
80207	INITIAL SPARE PARTS ETC	1	LS							10000.00	10000	10000
[illegible]	INITIAL SITEWORK	1	LS							5000.00	5000	5000
80209	SAFETY SHOWERS & PLUMBING	1	LS							10000.00	10000	10000
802	TOTAL										255000	255000
803	EXTRACTION SYSTEM											
80301	INSTALL WELLS	5	EA							6000.00	30000	30000
80302	YARD PIPING	1000	LF							15.00	15000	15000
80303	WELL PUMPS	5	EA	24.000	120	45.00	5400	3500.00	17500			22900
80304	TIE IN ELECTRIC	1	LS							10000.00	10000	10000
803	TOTAL				120		5400		17500		55000	77900
8	TOTAL				536		24120		141100		310000	475220

ACCOUNT NO	DESCRIPTION	QUANT	UM	M HR UNIT	LABOR M HRS	LABOR RATE	LABOR AMOUNT	MATERIAL RATE	MATERIAL AMOUNT	SUB CONTRACT RATE	SUB CONTRACT AMOUNT	TOTALS
9	OPERATIONS											
901	GWTP OPERATIONS (BASED ON 1 YEAR OF OPS)											
90101	ELECTRICAL	365	DA					180.00	65700			65700
90102	MAINTENANCE & REPAIRS	12	MO					750.00	9000	500.00	6000	15000
90103	MISC COSTS	12	MO							1000.00	12000	12000
90104	LABORATORY ANALYSIS	12	MO							2000.00	24000	24000
90105	CARBON USEAGE	365	DA					290.00	105850			105850
90106	DISPOSAL OF SLUDGE	180	DM							250.00	45000	45000
90107	PERSONNEL - 1 @ 70 HR/WK	52	WK	70.000	3640	45.00	163800					163800
90108	PPE - LEVEL C	365	MD					40.00	14600			14600
901	TOTAL				3640		163800		195150		87000	445950
902	MONITORING WELL SAMPLING (BASED ON 1 YEAR COSTS)											
90201	ANALYTICS	496	EA							500.00	248000	248000
90202	PERSONNEL	2	EA	64.000	128	45.00	5760					5760
90203	PER DIEM/TRAVEL	16	DA					200.00	3200			3200
90206	REPAIRS/MAINTENANCE	1	LS							2000.00	2000	2000
	MISC SAMPLING MATERIALS	1	LS						500			500
902	TOTAL				128		5760		3700		250000	259460
9	TOTAL				3768		169560		198850		337000	705410
	GRAND TOTAL				326394		14687750		16518450		216270120	247476320