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THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

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TECHNICAL MEMORANDUM **CH2MHILL**

Results of Pesticide Vertical Profile Sampling

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Introduction

Previous surface soil sampling at the Defense Depot Memphis, Tennessee (DDMT) has indicated that pesticide concentrations, particularly dieldrin, exceed risk-based human health criteria across the DDMT Main Installation. As a result, soil removal may be required in numerous locations. However, samples collected before the Pesticide Vertical Profile Sampling were composited from the 0-1 foot interval. As a result, it was not established how deep the pesticides actually penetrated into the soil column. It was believed that the pesticides were sorbed onto only the upper few inches of organic rich soil, which would result in significant cost savings if soil removal was required. On February 11th, 1998, a discussion between staff from the Defense Depot Susquehanna, Pennsylvania; the Corps of Engineers Huntsville Division; and CH2M HILL indicated the need to characterize the vertical concentration of dieldrin in surface soil.

Soil samples were collected at DDMT from March 30, 1998 through April 1, 1998. Sampling was performed in three areas with a history of distinct soil management practices. The three groups identified within the Main Installation of DDMT were: 1) the Golf Course Area where pesticides were likely applied in broadcast fashion; 2) the Warehouse Areas where pesticides were likely applied in around the perimeter of buildings; and 3) the Open Grassy Areas where pesticides were likely applied in broadcast fashion, but were not subject to the same degree of spray irrigation as the Golf Course Area.

Within each of the three groups, two sample locations were selected for vertical profiling. The locations were adjacent to previously sampled areas so that the initial pesticide concentrations were known. Dieldrin was the primary pesticide of concern and was used as a primary criterion for selecting the locations of the vertical profiling. However, one of the two sample locations was partially based on the known concentrations of DDT and its degradation products DDE and DDD. The dieldrin-only locations were analyzed for dieldrin using modified SW-846 Method 8081. Samples from the dieldrin/DDT borings

were analyzed for the complete list of SW-846 Method 8081 organochlorine pesticides (Pesticide Suite). To evaluate other soil properties that might influence vertical transport of pesticides, samples were also analyzed for pH, total organic carbon (TOC), moisture content, and clay content (fraction passing a #200 sieve) (clay content not yet available).

Samples were collected with a Shelby tube that was inserted by either pounding or augering. The root zone was removed and analyzed as the uppermost sample of the profile. Samples were collected below the root zone at 4 inch intervals for the uppermost foot. These samples characterized the vertical profile of pesticides within the top foot the surface soil. When possible, a composite sample was collected from 12-24" interval. This sample represented concentrations that would be left in-situ if the top foot of soil were to be removed. Samples from the 8-12" and 12"-24" sample intervals were only analyzed if significant concentrations were detected in shallower samples.

Summary of Field Sampling

Soil samples were collected at the DDMT from March 30, 1998 through April 1, 1998. The soil samples were analyzed for dieldrin, pesticides, moisture content, clay content, total organic carbon (TOC), and pH. The following locations, identified in Figure 1, were sampled.

Location: **S(3.5)V**

Golf Course Area

Sampled: 3/30/98 – 16:40

Samples were located approximately 150 feet south of the intersection of K Street and 2nd Street on the west side of 2nd Street. Because of the density of the soil, a maximum depth of 12 inches was achieved with the hand auger; therefore, the bottom 1 foot composite sample was not obtained. Two holes were augered to provide enough root zone material, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 8-12" interval, which was a composite sample. The following samples were collected at this location.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	S35V1	Pesticide Suite Moisture Content Clay Content TOC pH
2 – 4"	S35V2	Pesticide Suite Moisture Content Clay Content TOC pH
4 – 8"	S35V3	Pesticide Suite Moisture Content Clay Content TOC pH
8 – 12"	S35V4	Pesticide Suite Moisture Content Clay Content TOC pH
12 - 14"	S35V5	Pesticide Suite Moisture Content Clay Content TOC pH

Location: B(3.5)V

Golf Course Area

Sampled: 3/31/98 – 17:40

Samples were located approximately 30 feet west of 1st Street on the golf course, near the edge of the DDMT reservation. A hand auger was used and samples were collected to a depth of 21 inches. Four holes were augered to provide enough root zone material, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 12–21" interval, which was a composite sample. The following samples were collected at this location.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	B35V1 B35V1D B35V1MS B35V1MSD	Dieldrin Moisture Content Clay Content TOC pH
0 – 4"	B35V2	Dieldrin Moisture Content Clay Content TOC pH
4 – 8"	B35V3	Dieldrin Moisture Content Clay Content TOC pH
8 – 12"	B35V4	Dieldrin Moisture Content Clay Content TOC pH
12 – 21"	B35V5	Dieldrin Moisture Content Clay Content TOC pH

Location: **A(10.2)V**

Warehouse Areas

Sampled: 4/1/98 - 09:15

Samples were located approximately 45 feet south of E Street and 150 feet east of 5th Street next to building 549. A hand auger was used and samples were collected to a depth of 24 inches. Two holes were augered to provide enough material for the root zone sample and the 0–4" sample, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 12–24" interval, which was a composite sample. The following samples were collected at this location.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	A102V1	Pesticide Suite Moisture Content Clay Content TOC pH
0 – 4"	A102V2 A102V2D A102V2MS A102V2MSD	Pesticide Suite Moisture Content Clay Content TOC pH
4 – 8"	A102V3	Pesticide Suite Moisture Content Clay Content TOC pH
8 – 12"	A102V4	Pesticide Suite Moisture Content Clay Content TOC pH
12 – 24"	A102V5	Pesticide Suite Moisture Content Clay Content TOC pH

Location: **A(15.6)V**

Warehouse Areas

Sampled: 4/1/98 – 11:30

Samples were located approximately 50 feet north of the railroad tracks which are north of buildings 529 and 429. A hand auger was used and samples were collected to a depth of 23.5 inches. Two holes were augered to provide enough material for the root zone sample, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 12–23.5" interval, which was a composite sample. The following samples were collected at this location.

Due to the previous day's rain, there was some standing water on the surface.

Sampling at this location was video taped by DDMT personnel.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	A156V1	Dieldrin Moisture Content Clay Content TOC pH
0 – 4"	A156V2	Dieldrin Moisture Content Clay Content TOC pH
4 – 8" (2-photos taken)	A156V3	Dieldrin Moisture Content Clay Content TOC pH
8 – 12"	A156V4	Dieldrin Moisture Content Clay Content TOC pH
12 – 23.5"	A156V5	Dieldrin Moisture Content Clay Content TOC pH

Location: A(2.7)V

Open Grassy Areas

Sampled: 3/31/98 – 17:40

Samples were located approximately 10 feet southwest of the front porch of the west unit in the northern most row of housing units. A hand auger was used and samples were collected to a depth of 23 inches. Two holes were augered to provide enough root zone material, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 12–23" interval, which was a composite sample. The following samples were collected at this location.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	A27V1	Pesticide Suite Moisture Content Clay Content TOC pH
0 – 4"	A27V2	Pesticide Suite Moisture Content Clay Content TOC pH
4 – 8"	A27V3	Pesticide Suite Moisture Content Clay Content TOC pH
8 – 12"	A27V4	Pesticide Suite Moisture Content Clay Content TOC pH
12 – 23"	A27V5	Pesticide Suite Moisture Content Clay Content TOC pH

Location: J(3.5)V

Open Grassy Areas

Sampled: 3/30/98 - 17:35

Samples were located approximately 90 feet east of 1st Street and near L Street. A hand auger was used and samples were collected to a depth of 24 inches. Two holes were augered to provide enough root zone material, and one of these holes was used for the remainder of the samples. All of the samples were grab samples from the specified intervals except for the 12–24" interval, which was a composite sample. The following samples were collected at this location.

Depth Interval	Sample ID	Analyses
0 – 2" (Root Zone)	J35V1	Dieldrin Moisture Content Clay Content TOC pH
0 – 4"	J35V2	Dieldrin Moisture Content Clay Content TOC pH
4 – 8"	J35V3	Dieldrin Moisture Content Clay Content TOC pH
8 – 12"	J35V4	Dieldrin Moisture Content Clay Content TOC pH
12 – 24"	J35V5	Dieldrin Moisture Content Clay Content TOC pH

Vertical Profile Results

The analytical results of the Pesticide Vertical Profile Sampling are presented in Table 1. Dieldrin, DDT, DDE, and DDD were detected in the samples collected during the investigation. Samples from the Golf Course Area contained detectable concentrations of dieldrin, DDT, DDE, and DDD. Samples from the Warehouse and Open Grassy Areas contained detectable concentrations of dieldrin, DDT, and DDE.

As shown in the Table 1, the pesticide results were compared to the EPA Region III Risk-Based Concentrations (RBCs) dated April 15, 1998 for soil at an industrial site. Dieldrin was the only analyzed constituent which exceeded a RBC. The concentrations in eight samples collected from the Golf Course Area and Open Grassy Areas exceeded the RBC for dieldrin of 360 µg/kg: S(3.5)V (0-2"), S(3.5)V (8-12"), J(3.5)V (0-2"), B(3.5)V (0-2"), B(3.5)V (0-2") Duplicate, B(3.5)V (0-4"), B(3.5)V (4-8"), A(2.7)V (0-2"). No concentration from a sample collected in the Warehouse Areas exceeded a RBC.

The vertical profile of the concentrations varied between areas and is described below:

Golf Course Area - The concentrations of the dieldrin, DDT, DDE, and DDD show an overall decrease below the 0-2" sample interval. However, dieldrin, DDT, and DDD are consistently detected throughout the 14" and 21" inch sample depths.

The vertical profile of the dieldrin, DDT, DDE, and DDD concentrations for S(3.5) V is shown in Figure 1 and a dieldrin and TOC vertical profile for S(3.5) V is shown in Figure 2. Dieldrin concentrations in the 0-2" and 8-12" sample intervals exceeded the RBC for dieldrin. Dieldrin concentrations show an initial decrease in S(3.5)V below the 0-2" sample interval. However, a possibly anomalous concentration of 550 µg/kg exists in the 8-12" interval. This concentration is located beneath a concentration of 150 µg/kg in the 4-8" interval and above a concentration of 76 µg/kg in the 12-24" interval. This increased value at the 8-12" interval can possibly be attributed to sample cross-contamination with the upper 0-2" sample interval resulting from the use of a hand auger in the relatively stiff clay.

Dieldrin concentrations in B(3.5)V decreased below the 0-2" sample interval. However, the concentrations in the samples from the 0-4" and 4-8" sample intervals remained above the RBC for dieldrin. Sample concentrations from the 8-12" and 12-21" intervals were detected but decreased below the RBC. A Dieldrin and TOC Vertical Profile for B(3.5)V is shown in Figure 3.

Based on the sample results from B(3.5)V and S(3.5)V, the dieldrin concentrations in the Golf Course Area may exist at levels exceeding the RBC to a depth of 8-12". However, due to the sampling method, cross-contamination may have existed between the upper root zone and the lower zones.

Warehouse Areas - The concentrations of dieldrin, DDT, and DDE decreased significantly below the 0-2" sample interval. The vertical profile of the dieldrin, DDT, DDE, and DDD concentrations for A(10.2) V is shown in Figure 4. The aforementioned pesticides were detected throughout the sample intervals to a depth of 4-8". However, the highest concentrations were limited to the 0-2" sample interval which corresponded with high TOC concentrations (46,200 mg/kg and 31,400 mg/kg). No sample concentrations exceeded a RBC in the Warehouse Areas.

Open Grassy Areas - As observed in the Warehouse Areas, the detected concentrations of dieldrin, DDT, and DDE decreased significantly below the 0-2" sample interval which contained significantly higher TOC concentrations (42,800 mg/kg and 22,600 mg/kg). The vertical profile of the dieldrin, DDT, DDE, and DDD concentrations for A(2.7) V is shown in Figure 5 and a dieldrin and TOC vertical profile for A(2.7)V and J(3.5)V are shown in Figures 6 and 7, respectively. One anomalous DDT concentration of 3,500 µg/kg was observed in the sample from A(2.7)V 4-8". This concentration was located below the 2-4" interval DDT concentration of 740 µg/kg. Two dieldrin concentrations of 850 µg/kg and 980 µg/kg exceeded the RBC for dieldrin of 360 µg/kg but were limited to the 0-2" sample interval.

Conclusions

Dieldrin, DDT, DDE, and DDD were detected in soil samples collected during the investigation. In general, the higher dieldrin, DDT, DDE, DDD concentrations were limited to the 0-2" sample intervals corresponding to the highly organic root zone. As shown in Table 1, many of the aforementioned pesticides were detected at the lowest depths of the investigation. However, the concentrations of each pesticide decrease significantly below the 0-2" sample interval. No DDT, DDE, or DDD concentration was detected above its respective RBC. No dieldrin concentration was detected above its RBC in samples collected in the Warehouse Areas. Dieldrin concentrations were detected above the RBC in samples collected from the 0-2" interval of the Open Grassy Areas. Samples collected from the Golf Course Area suggest that the dieldrin concentration in soil in the Golf Course Area may exceed the RBC for dieldrin to a depth of 8-12". However, this conclusion may be influenced by possible cross-contamination resulting from the type of investigation method (hand augering) and the consistency of the soil material (stiff clay).

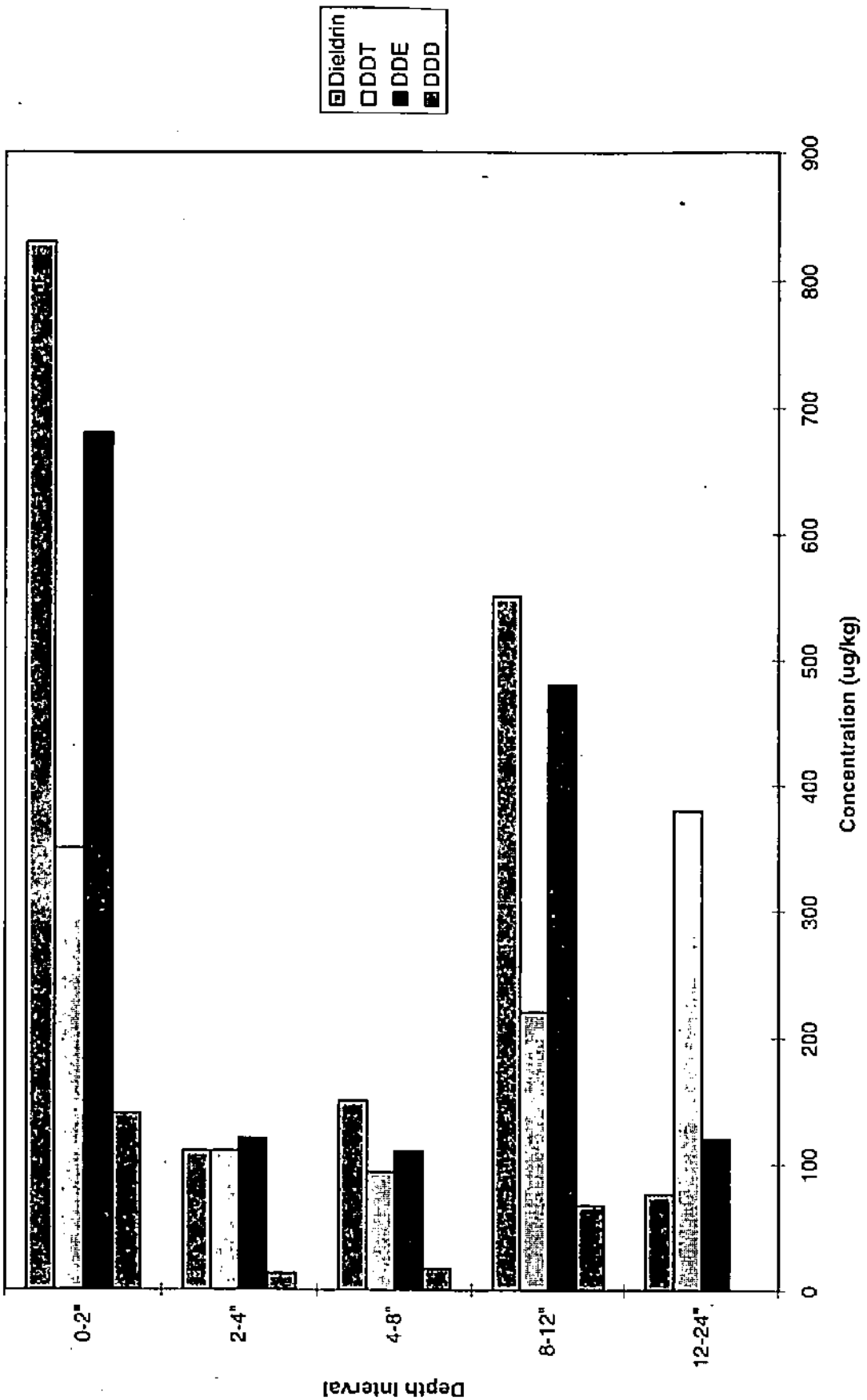
Tabl

Pesticide Vertical Profile Sampling
Defense Depot Memphis Tennessee

Area	Location	Depth Interval	Sample ID	% Moisture	pH	TOC mg/kg	Dieldrin ug/kg	4,4' - DDT ug/kg	4,4' - DDE ug/kg	4,4' - DDD ug/kg
	EPA Region III RBC (Industrial)						360	17000	17000	24000
Golf Course	S(3.5)V	0-2"	S35V1	15	6.8	8490	[redacted]	350 J	680	140 J
		2-4"	S35V2	17	7.0	3900	110	110	120	13 J
		4-8"	S35V3	34	6.8	4460	150	93	110	17 J
		8-12"	S35V4	18	6.8	3100	[redacted]	220	480	67 J
		12-14"	S35V5	19	7.3	3190	76	380	120	61 U
	B(3.5)V	0-2"	B35V1	24	6.0	20200	[redacted]			
		0-2"	B35V1D	23	5.9	19700	[redacted]			
		0-4"	B35V2	18	6.0	9650	[redacted]			
		4-8"	B35V3	18	5.9	7010	[redacted]			
		8-12"	B35V4	19	5.2	6530	64			
		12-21"	B35V5	19	5.0	2500	85			
Warehouse	A(10.2)V	0-2"	A102V1	20	6.5	46200	820 U	400 J	320 J	820 U
		0-4"	A102V2	16	6.7	3230	20 U	10 J	5.9 J	20 U
		0-4"	A102V2D	16	6.9	2020	4.6 J	10 J	7.1 J	16 U
		4-8"	A102V3	18	6.8	1720	3.7 J	6.4 J	3.9 J	16 U
		8-12"	A102V4				NA	NA	NA	NA
		12-24"	A102V5				NA	NA	NA	NA
	A(15.6)V	0-2"	A156V1	23	6.5	31400	240			
		0-4"	A156V2	21	6.8	7630	20			
		4-8"	A156V3	19	6.9	2570	3.1 J			
		8-12"	A156V4				NA			
		12-23.5"	A156V5				NA			
Open Grassy	A(2.7)V	0-2"	A27V1	23	5.7	42800	[redacted]	2000	880	430 U
		0-4"	A27V2	18	6.0	2470	91 J	740	120 J	160 U
		4-8"	A27V3	18	5.9	3210	600 U	3500	600 U	600 U
		8-12"	A27V4				NA	NA	NA	NA
		12-23"	A27V5				NA	NA	NA	NA
	J(3.5)V	0-2"	J35V1	27	6.1	22600	[redacted]			
		2-4"	J35V2	15	6.2	10100	67			
		4-8"	J35V3	17	6.5	2880	11			
		8-12"	J35V4				NA			
		12-24"	J35V5				NA			

Notes:
NA = Not analyzed due to low concentrations in samples at shallower depths.
RBC = Risk-Based Concentration
Shaded values exceeded the RBC.

Figure 1
S(3.5)V Pesticide Vertical Profile



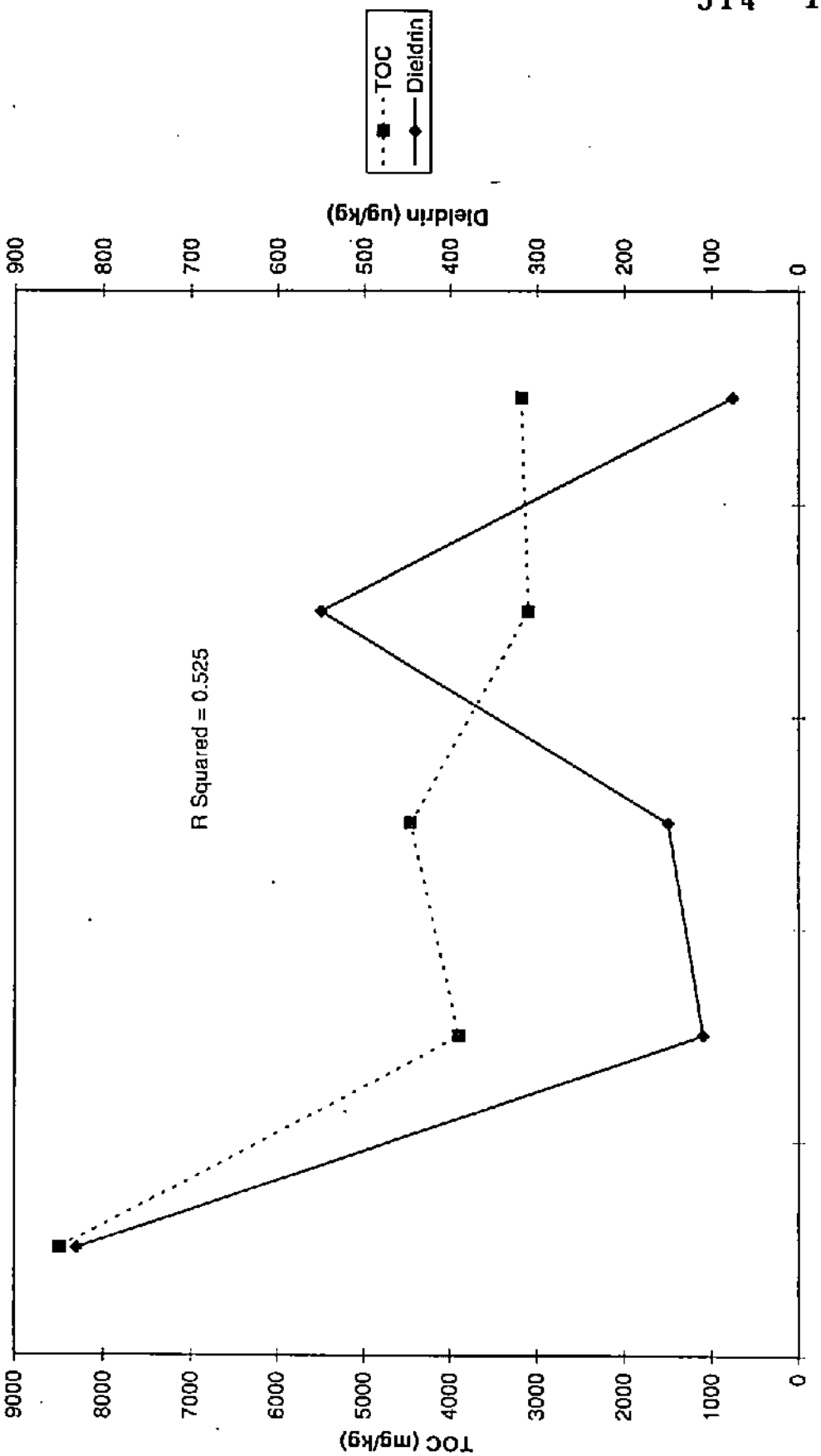


Figure 2
S(3.5)V Dieldrin and TOC Vertical Profile

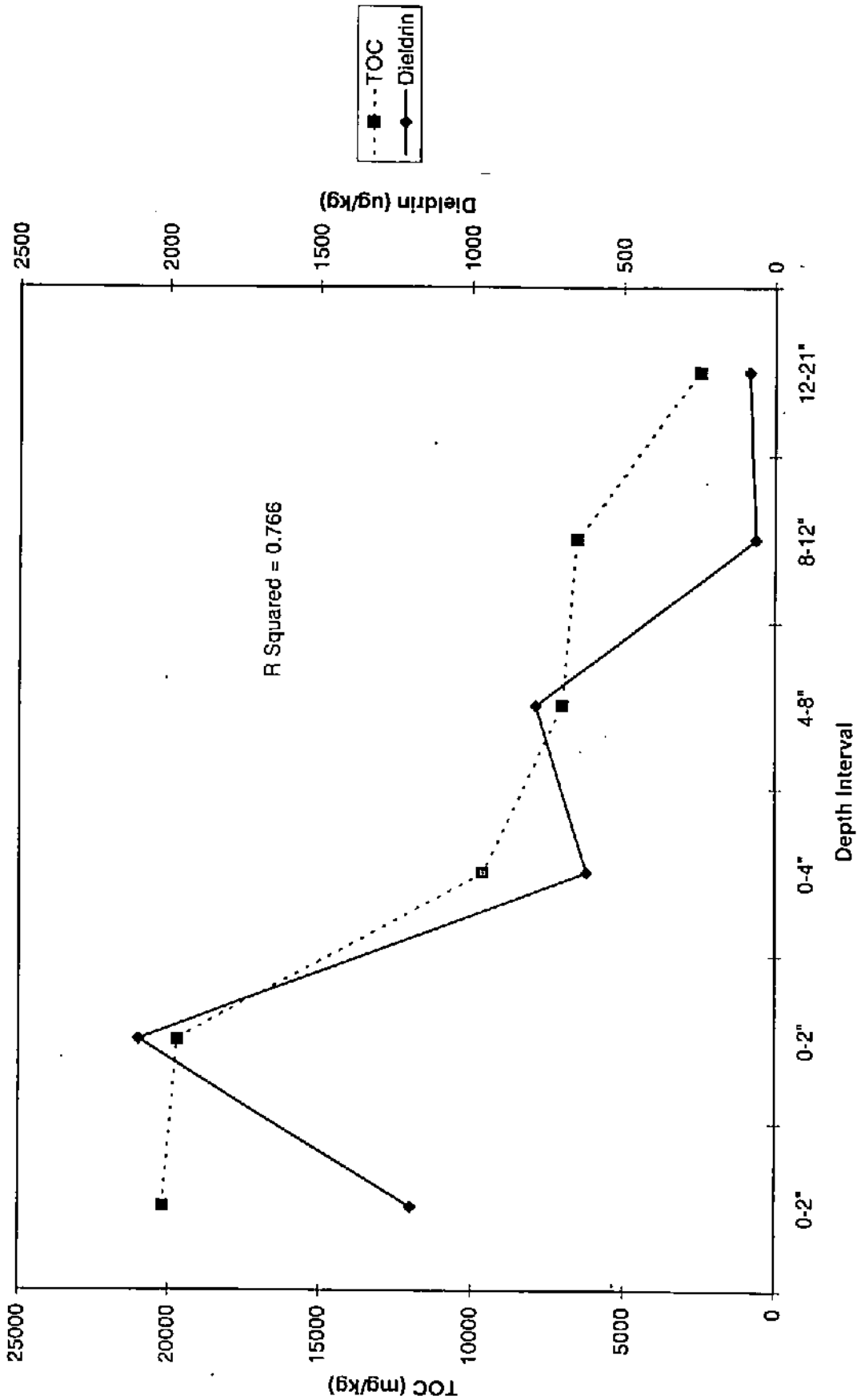


Figure 3
B(3.5)V Dieldrin and TOC Vertical Profile

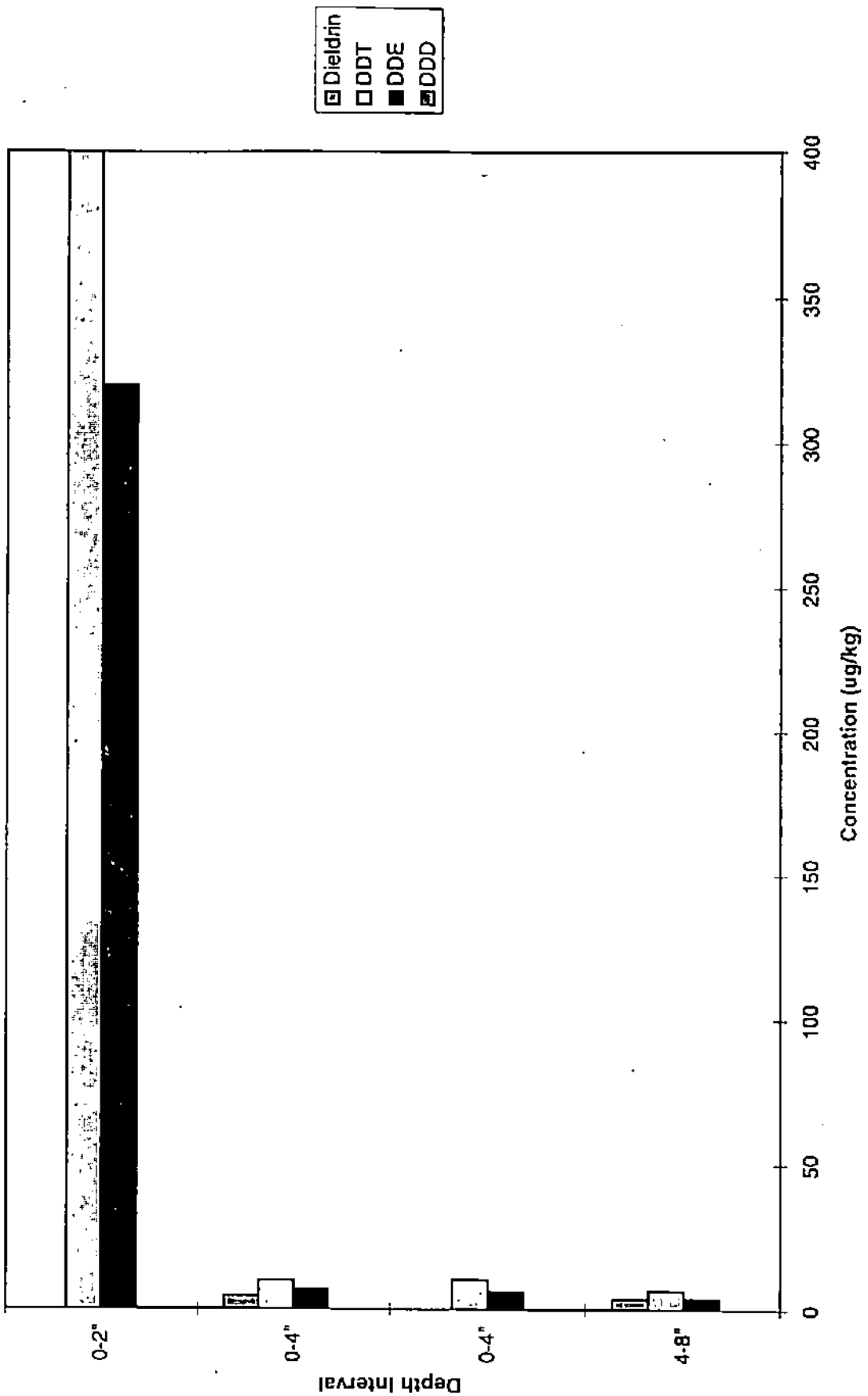


Figure 4
A(10.2)V Pesticide Vertical Profile

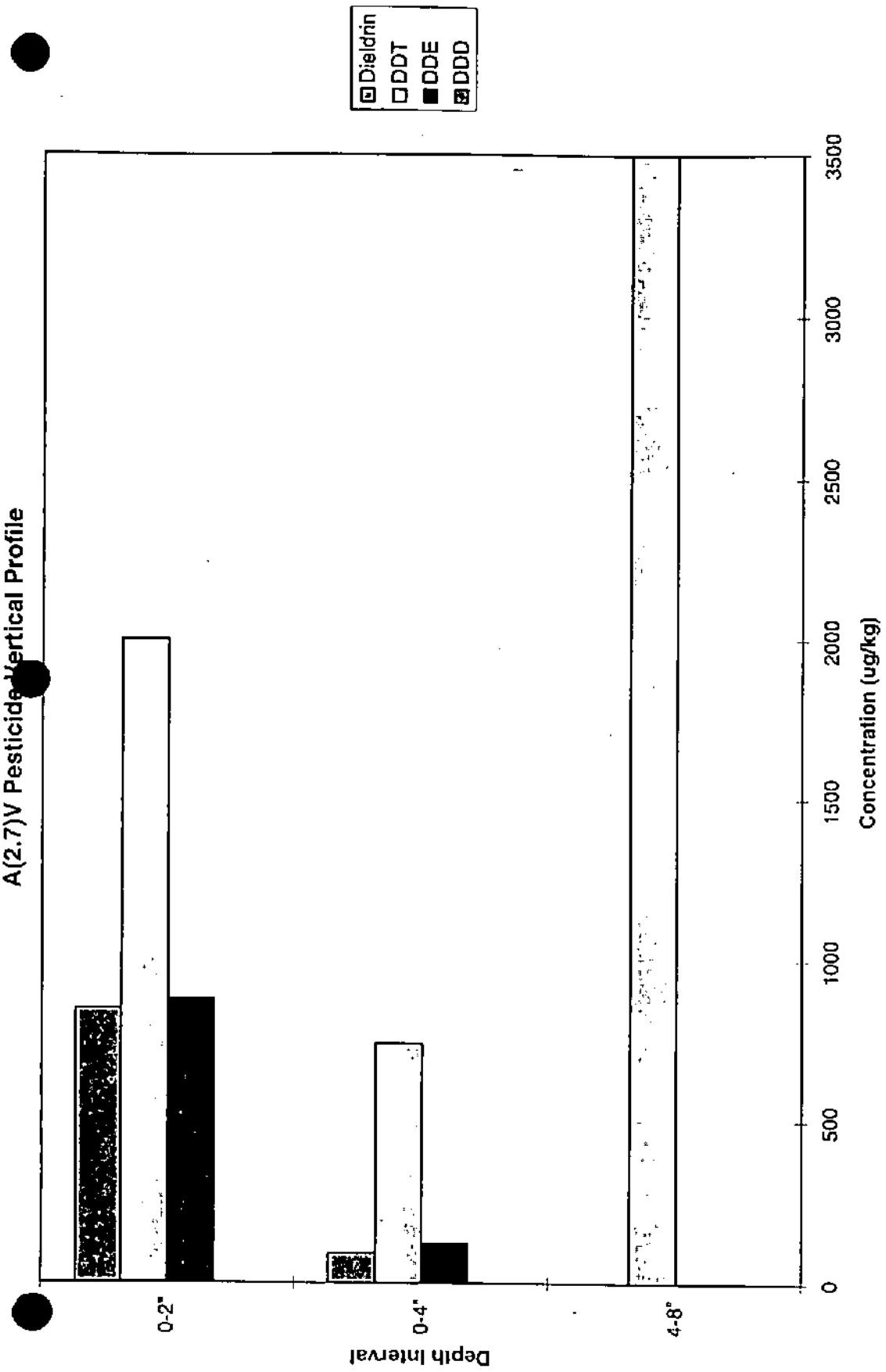


Figure 5
A(2.7)V Pesticide Vertical Profile

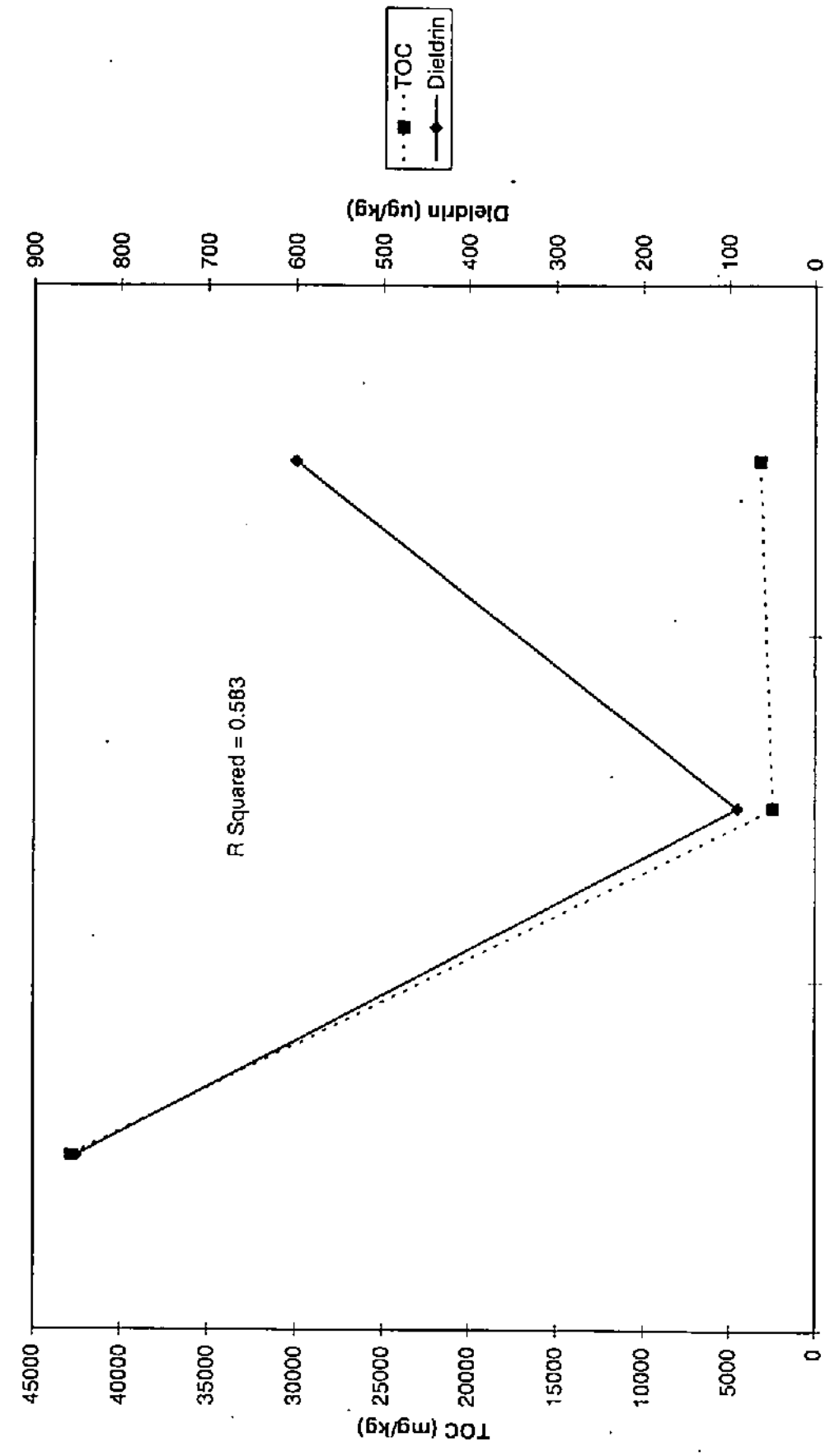


Figure 6
A(2.7)V Dieldrin and TOC Vertical Profile

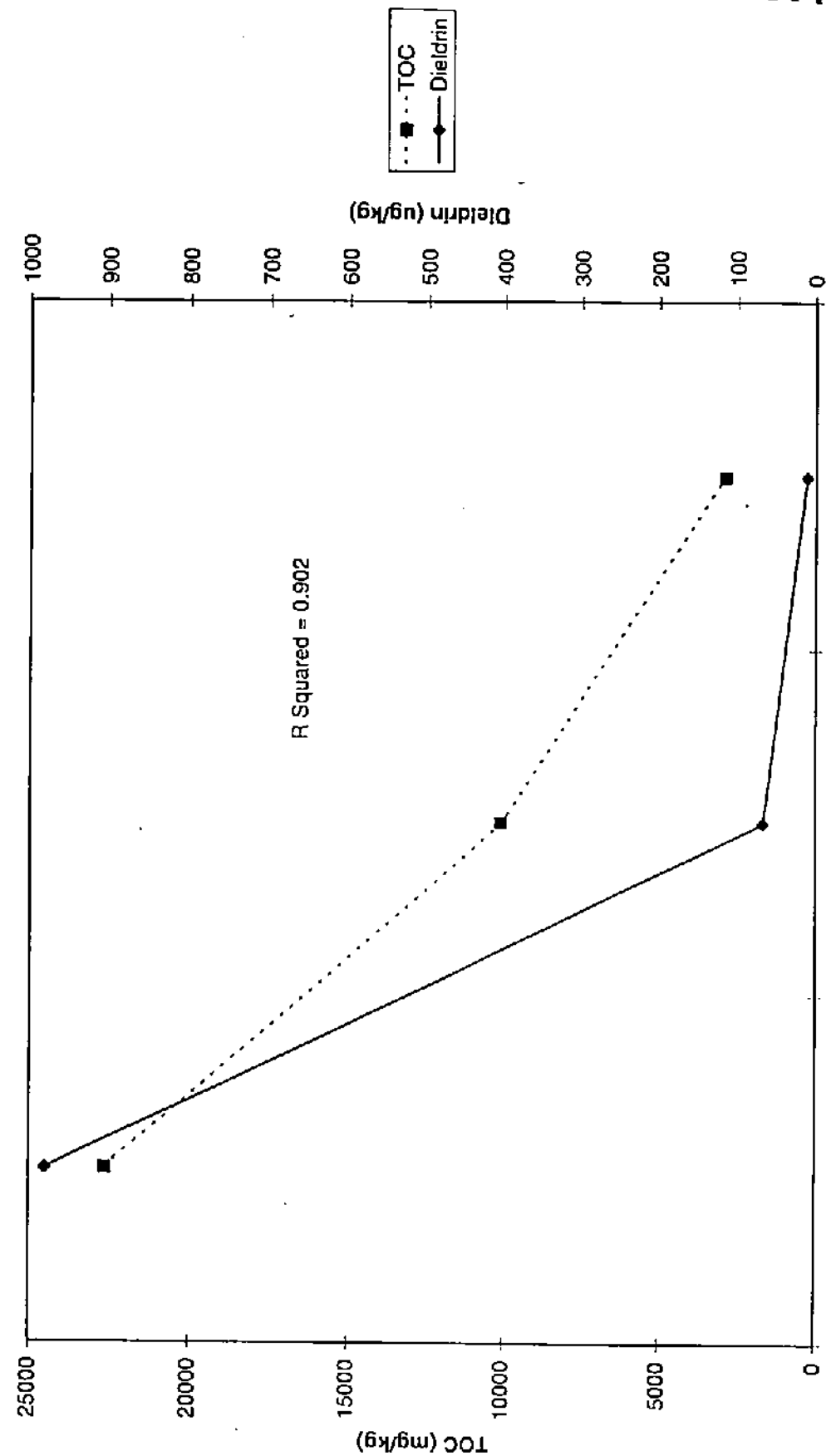
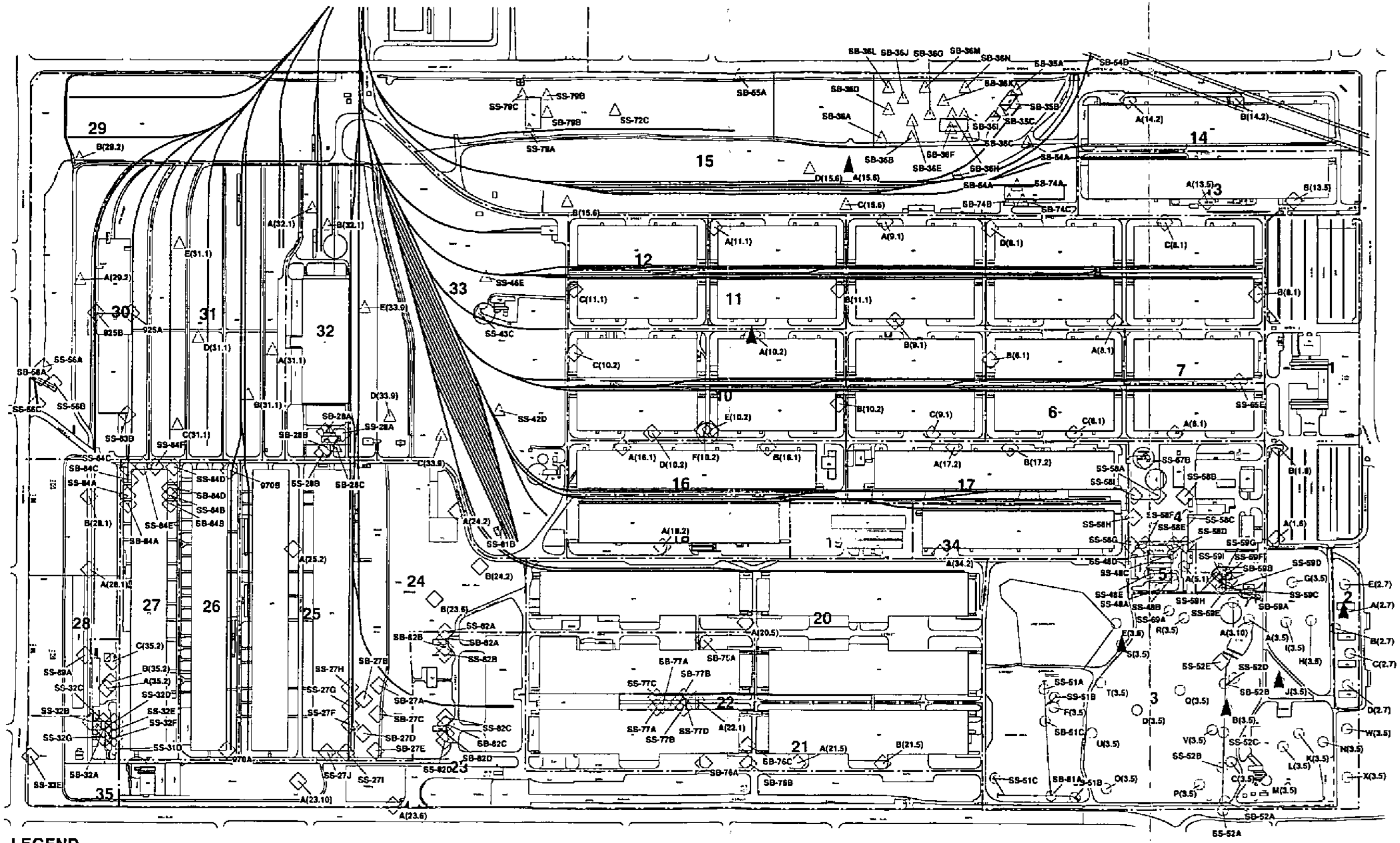


Figure 7
J(3.5)V Dieldrin and TOC Vertical Profile



LEGEND

- ○ GOLF COURSE AREA
- △ RR TRACKS & OPEN AREA
- // WAREHOUSE AREA
- ▲ VERTICAL PROFILE SAMPLE LOCATION

MAP SCALE: 1" = 500'

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FIGURE 1

DIELDRIN SAMPLE LOCATIONS AND GROUPS

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